ASERA

AUSTRALASIAN SCIENCE EDUCATION RESEARCH ASSOCIATION

The 47th Annual

ASERA Conference

27th June to 1 July, 2016

QT Hotel, Canberra

The Australasian Science Education Research Association – promoting science education and science education research in all contexts and at all levels of education

www.asera.org.au

Conference Programme and Abstracts

Hosted by The University of Canberra, ACT

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Welcome to ASERA 2016

We would like to acknowledge that Canberra and the national parliament, is situated on Ngunnawal land, and that Ngunnawal people remain the spiritual and cultural custodians of their land, and continue to practice their values, languages, beliefs and knowledge.

Thank you for joining us in Canberra at The QT Hotel to be part of the 47th Annual Conference of the Australasian Science Education Research Association (ASERA).

The ASERA conference provides an important venue for science educators to discuss their research and share ideas about all aspects of teaching and learning of science at primary, secondary and tertiary levels. For those who are 'new' to ASERA, we hope that you find the conference to be supportive, encouraging and nurturing with someone always on hand to offer constructive advice. For the annual conference attendees, we hope you enjoy the opportunity to catch up with 'old' friends and discuss ongoing issues in the educational arena.

We have a diverse range of topics this year included in both oral and poster presentations. These represent the perspectives of many different countries, researchers and purposes in relation to science education. We welcome the opportunities these perspectives bring to intellectual debate and discussion.

In preparing for the conference we wish to thank the staff at the QT hotel and Conference Logistics for their generous assistance.

Please enjoy the conference.

Leah Moore and Jim Woolnough

Co-convenors ASERA 47

Welcome to Canberra

Welcome to wintry Canberra. The QT hotel is centrally located within an easy walk of the city, Lake Burley Griffin and the Australian National University, as well as the conference dinner venue, The National Museum of Australia.

The University of Canberra

The University of Canberra was first established in 1967 as the Canberra College of Advanced Education, which became the University of Canberra in 1990. It has graduated over 70,000 students since 1970. The original Canberra CAE had a strong focus on professional education and this is a commitment continued today. It offers a range of applied degrees and has a strong commitment to work integrated learning. Its teacher education programs have been a core focus for the whole of its 46-year history.

Canberra – both a country town and Australia's capital

Canberra is Australia's youngest major city. Inaugurated in 1913, the first building work did not begin until around 1927.

City Centre and ANU Precinct: The area around the QT Hotel includes the city area (locally referred to as Civic) and the Australian National University (ANU).

Lake Burley Griffin: From the hotel it is a short walk to the Lake Burley Griffin. This lake was in the original plan of Walter and Marion Burley Griffin, but was only filled in 1964. It is a major centre for recreational and community activities.

ANU: The conference venue lies at the edge of the campus of the Australian National University. The extensive grounds of ANU are well worth a stroll for the attractive landscaping and a range of significant architecture.

The History of ASERA Conferences

In 1970 Peter Fensham (Monash University), the first Professor of Science Education in Australasia, initiated the first conference of what was then the Australian Science Education Research Association. The list of researchers, their institutional affiliations and research interests of those who attended this conference can be located at https://asera.org.au/about/. That beginning for ASERA (now the Australasian Science Education Research Association) makes it the second oldest science education research body in the world, after the National Association for Research in Science Teaching in the USA. It should be noted that this was also several months before the first conference of the then newly formed Australian Association for Research in Education (AARE). It is thus likely that ASERA was the first professional body in educational research in Australia.

The New Zealand dimension of ASERA began with the attendance of the late Roger Osborne at the 1977 conference, but was not formalized in the name change to "Australasian" until 1990, 7 years after ASERA first met in New Zealand.

The general belief at the first conference was that every second meeting would need to be organized by Monash, a reflection of the fact that in 1970 Monash was the only substantial centre for science education research in Australia. The notion that Monash would be responsible for every second ASERA was part of the 'gentle coercing' that had the Macquarie organizers agree to host the second conference, and is why the third conference was held at a very different form of venue - a secondary science curriculum project headquarters in Melbourne. Such was the very rapid growth of Australian science education research and a strong association that this perspective only lasted until ASERA 5.

Venue	Conference Convener(s)
ASERA 1 -1970, Melbourne	Peter Fensham, Lindsay Mackay & Dick White (Monash University)
ASERA 2- 1971, Sydney	David Cohen & Neil Baumgart (Macquarie University)
ASERA 3 -1972, Melbourne	Probably Les Dale (ASEP) & Peter Fensham (Monash) (Australian Science Education Project headquarters, Toorak, Melbourne) It has not been possible to establish with certainty who organized the conference.
ASERA 4 -1973, Brisbane	Colin Power & Dick Tisher (University of Queensland)
ASERA 5 -1974, Melbourne	Russell Linke & Leo West (Monash University)
ASERA 6 -1975, Adelaide	Arthur Lucas (Flinders University)
ASERA 7 -1976, Newcastle	Max Maddock (University of Newcastle)
ASERA 8 -1977, Wagga Wagga	Tony Blake (Riverina CAE) (now a campus of Charles Sturt University)
ASERA 9 -1978, Brisbane	Cam McRobbie (Mt Gravatt CAE) (now a campus of Griffith University)
ASERA 10 -1979, Perth	Dennis Goodrum (Churchlands CAE) (now a campus of Edith Cowan University)

ASERA 11- 1980, Melbourne	David Symington (State College of Vic, Toorak) (now a campus of Deakin University)
ASERA 12 -1981, Hobart	Paddy Lynch & Andrew Davies (University of Tasmania)
ASERA 13 -1982, Sydney	Bill Butts (Macquarie University)
ASERA 14 -1983, Hamilton (NZ)	Roger Osborne (University of Waikato)
ASERA 15 -1984, Melbourne	Dick Gunstone & Jeff Northfield (Monash University)
ASERA 16 -1985, Rockhampton	Ken Appleton (Capricornia Institute of Advanced Ed) (now a campus of UCQ)
ASERA 17 -1986, Adelaide	Chris Dawson, Mike Sullivan and Effie Best (University of Adelaide)
ASERA 18 -1987, Wagga Wagga	Doug Hill (Riverina CAE) (now a campus of Charles Sturt University)
ASERA 19 -1988, Sydney	Colin Gauld & Barry Newman (University of New South Wales)
ASERA 20 -1989, Melbourne	Dick Trembath (Chisholm Inst Technology, Frankston campus) (now a campus of Monash University)
ASERA 21 -1990, Perth	David Treagust (Curtin University of Technology)
ASERA 22 -1991, Surfers Paradise	Cam McRobbie (Queensland University of Technology)
ASERA 23 -1992, Hamilton (NZ)	Malcolm Carr (University of Waikato)
ASERA 24 -1993, Lismore	Keith Skamp (University New England, Northern Rivers campus) (now Southern Cross University)
ASERA 25 -1994, Hobart	Brian Jones & Max Walsh (University of Tas)
ASERA 26 -1995, Bendigo	Peter Searle & Brian Hand (LaTrobe University, Bendigo campus)
ASERA 27 -1996, Canberra	Tim Hardy & Marilyn Fleer (University of Canberra)
ASERA 28 -1997, Adelaide	Yvonne Zeegers & Paul Strube (University of SA)
ASERA 29 -1998, Darwin	Bill Palmer (Northern Territory University) (now Charles Darwin University)
ASERA 30 -1999, Rotorua (NZ)	Bev France & Mavis Haigh (Auckland College of Education), (now Auckland University)
ASERA 31 -2000, Fremantle	Léonie Rennie (Curtin University of Technology)
ASERA 32 -2001, Sydney	Peter Aubusson (University of Western Sydney)
ASERA 33 -2002, Townsville	Steve Ritchie (James Cook University)
ASERA 34 -2003, Melbourne	Rod Fawns & Christine Redman (University of Melbourne)
ASERA 35 -2004, Armidale	Debra Panizzon (University of New England)
ASERA 36 -2005, Hamilton (NZ)	Judy Moreland (University of Waikato)
ASERA 37 -2006, Canberra	Jim Woolnough & Leah Moore (University of Canberra)
ASERA 38 -2007, Fremantle	Grady Venville (University of Western Australia), Vaille Dawson & Rachel Sheffield (Edith Cowan University)
ASERA 39 -2008, Brisbane	Gillian Kidman, Donna King, Steve Ritchie (Queensland University of Technology)
ASERA 40 -2009, Geelong	Coral Campbell (Deakin University)
ASERA 41 -2010, Newcastle	Dave Palmer, Vicki Parkes, Mitch O'Toole (University of Newcastle)
ASERA 42 -2011, Adelaide	Yvonne Zeegers, Kathy Paige (University of South Australia)

ASERA 43 -2012, Sunshine Coast	Deborah Heck, Margaret Marshman, Beverly Lowe, John Hunt, Tim Strohfeldt (University of the Sunshine Coast)
ASERA 44 –2013, Wellington, NZ	Lorraine Spiller, Rosemary Hipkins (NZCER), Azra Moeed and Dayle Andersen (Victoria University of Wellington)
ASERA 45 -2014, Melbourne	Debra Panizzon, Greg Lancaster, Karen Marangio, Stephen Keast (Keasty), Rebecca Cooper, Gillian Kidman, Deborah Corrigan, and Mahbub Sarkar (Monash University)
ASERA 46 -2015, Perth	Christine Howitt, Grady Venville, Vaille Dawson, Katherine Carson (The University of Western Australia)
ASERA 47 -2016, Canberra	Leah Moore and Jim Woolnough (University of Canberra)

ASERA Executive Board

The members of the ASERA Executive Board are:

Alister Jones - Managing Director

Peter Aubusson - Member

Ange Fitzgerald - Secretary

Steve Ritchie - Policy

Deb Corrigan – RISE

David Geelan - RISE

Bronwen Cowie - Emerging Research Support

David Treagust - International

Coral Campbell – Conference Assistance

Leah Moore – Conference Assistance

Kathryn Paige - Member

Rebecca Cooper - Member

ASERA 2016 Program Overview

Tuesday 28th June

9:00 am – 5:00 pm	Pre-Conference Workshops
6.00 pm	Registration desk open
6.00 – 8.00 pm	Welcome reception

Wednesday 29th June

8.00am – 9.00am	Registration desk open
8.30am – 8.55am	Official welcome to ASERA 2016
9.00am – 5.00pm	Paper and poster presentations
5.30pm – 6.30pm	Fireside chat (ECA & PhD Students)

Thursday 30th June

8.00am – 9.00am	Registration desk open
8.30am – 4.15pm	Paper and poster presentations
11.50pm – 12.45pm	ASERA AGM
5.30pm – 11.00pm	NMA Exhibition viewing and pre-dinner drinks
7.00pm – 11.30pm	Conference dinner

Friday 1st July

9.15am – 12.35pm	Paper presentations
12.40pm – 1.30pm	Lunch and delegates depart

Conference Dinner

National Museum of Australia

The National Museum of Australia is a striking building situated on the shores of Lake Burley Griffin. It affords views across the lake towards the Parliamentary Triangle and central Canberra.

The museum was established in 1980 but only took up residence in its present permanent home in 2001. It preserves and interprets Australia's social history, exploring the key issues, people and events that have shaped the nation. Its deconstructivist architectural style, by architect Howard Raggatt, makes it one of the newest iconic buildings in Canberra.

The museum is a pleasant (if slightly chilly) 25 minute walk (according Google maps) from the QT Hotel along the lake foreshore.

A bus will also be provided to transport guests from the QT hotel to the museum following the AGM.

5:30-7:00 pm: Opportunity to view the museum, pre-dinner drinks and canapes

7:00-11:30 pm: Conference dinner and dance.

	Ballroom 2	Ballroom 3	Studio 1	Studio 2	Studio 3
8.30 – 8.55	**WELCOME TO ASERA 2016 in Main Ballroom**				
Session 1 **9.00 – 9.40**	**Amanda Berry, Julie Luft, Brooke Whitworth, Shannon Dubois, Vanessa Kind** *From Carnival to Coherence: Conceptualizing Trajectories of Science Teacher Learning* **Chair: Jenny Martin**	**Joel Rioux** *Embedding Aboriginal Perspectives and Knowledge in the Biology Curriculum: The Little Porky* **Chair: Michael Tynan**	**Dorothy Smith, Richard Gunstone, Pamela Mulhall** *Articulate Science: openness and open-mindedness in relationships between scientists and society.* **Chair: Tracey-Ann Palmer**	**Anna Gorges** *Students' Language Repertoire as a Resource for Meaning Making in a Multilingual Secondary Science Classroom in Luxembourg* **Chair: Wendy Nielsen**	**Hyung Kyu Ku, Hye-Eun Chu, Seung-urn Choe & Sonya Martin** *Examining teachers' perceptions and students' interest for arts-integrated STEM lessons in primary school classrooms in Australia and Korea.* **Chair Linda Hobbs**
Session 2 **9.45 – 10.25**	**Jenny Martin** *Thank God You're Here! Learning to think like a science teacher* **Chair: Amanda Berry**	**Michael Tynan** *Evaluating the CSIRO Indigenous STEM Education Project* **Chair: Joel Rioux**	**Tracey-Ann Palmer, Peter Aubusson, Paul F. Burke** *Boys and girls choosing and rejecting science: Same, same, but different.* **Chair: Dick Gunstone**	**Wendy Nielsen, Helen Georgiou & Pauline Jones** *Research in student-generated digital media: Multimodal methods in science* **Chair: Anna Gorges**	**Linda Hobbs, John Cripps Clark & Barry Plant** *Making STEM sustainable – developing a comprehensive STEM vision* **Chair: Hye-Eun Chu**
10.25 – 10.45	**MORNING TEA**				
10.25 – 11.30	**POSTER SESSION 1 in Main Ballroom**				
	Shu-Chiu Liu *Environmental education through documentaries: assessing learning outcomes of an introductory environmental studies course*	**Michael Fitzgerald, Pedro Russo, Edward Gomez & Thilina Heenatigala** *IAU astroEDU: an open-access platform for peer-reviewed astronomy education activities*	**Hayashi Nakayama & Tomokazu Yamamoto** *A Case Study of Improving Students' Views of Science Lessons through Science Lesson Study Activities in a Pre-service Teacher Training Course*	**Anne Galvin & Rekha B. Koul** *The use of ICT Science resources by Australian Upper Primary Teachers.* **Pei-Ying Wu, Yu-Hsuan Chang, Yan-Yu Lin, Yu-Ting Tsai, Sheng-Ju, Chu & Meng-Tzu Cheng**	**M. Vermeulen & F. Janssen** *The why, what and how of making inquiry-based teaching practical.* *Developing an inquiry-based instructional module for improving 9th grade low achievers' scientific understanding and learning interest*

	Ballroom 2	Ballroom 3	Studio 1	Studio 2	Studio 3
Session 3 **10.50 – 11.30**	**Christine Howitt & Léonie Rennie** *Extending Young Children's Science Learning through Personal Photobooks* **Chair: Judith Gomes**	**Enny Susiyawati & David Treagust, Mihye Won** *Difficulties in learning plant anatomy: A Study of Undergraduates' Interpretations of Leaf Photographs* **Chair: Lam Hoang Pham**	**Jessy Abraham & Katrina Barker** *Motivation and engagement with physics: A comparative study of girls in single sex and coeducational classrooms* **Chair: Jaehyeok Choi**	**Andy Ka-Leung Ng, Derek Hang-Cheong Cheung & Henry Hin-Yan Chan** *Effects of prior science knowledge on learning outcome enhancement in a science general education course* **Chair: Felicity Mclure**	**Hye-Eun Chu, Sonya Martin, Kongju Mun, Seung-urn Choe, Bronwen Wade-Leeuwen, Katherine Stewart, Cathie Howe & Jinwoong Song** *The Fusion of Science and Arts: An interactive digital platform to enhance STEAM (Science, Technology, Engineering, Arts and Mathematics) teaching and learning exchanges by science teachers in Korea and Australia* **Chair: Kathy Smith**
Session 4 **11.35 -12.15**	**Léonie Rennie & Christine Howitt** *Developing and Field-Testing a Framework to Describe Young Children's Interactions with Science Exhibits* **Chair: Leah Moore**	**Lam Hoang Pham & Peter Hubber** *Representational Issues In Senior School Students Learning Solution Chemistry* **Chair: Bronwen Cowie**	**Reem A. AlGhmadi, David Treagust & Venkat Vishnumolakala** *Physics and Saudi Girls: Their Perceptions, Motivations and Career Perspectives* **Chair: Jessy Abraham**	**Mageswary Karpudewan, Chong Keat Meng & Chua Kah Heng** *Modeling Science Related Attitude of Malaysian Lower Secondary Students* **Chair: Andy Ka-Leun Ng**	**Joseph Ferguson & Lihua Xu** *Investigating 'Non-formal' Reasoning in Science Through Video-Based Studies of Classroom Interactions* **Chair: Hye-Eun Chu**
Session 5 **12.20 – 1.00**	**Judith Gomes & Marilyn Fleer** *Preschool teachers conceptualising science in the preschool environment: Concepts or activities?* **Chair: Christine Howitt**	**Bronwen Cowie** *Reconfiguring and or reconceptualising boundaries* **Chair: Enny Susiyawati**	**Jaehyeok Choi, Heekyong Kim, Yong Jae Joung & Kwanghee Jo** *A Self-Study about Teacher Educator's and Preservice Teachers' Epistemological Views on the Course for Secondary School Physics Instruction* **Chair: David Treagust**	**Felicity McLure, Mihye Won & David Treagust** *Implementing the Thinking Frames Approach in Years 8-10: A Teacher's Reflections* **Chair: Mageswary Karpudewan**	**Kathy Smith** *Positioning teachers as self-directed learners – the challenge of passive disconnection* **Chair: Lihua Xu**

1.00 – 1.45	LUNCH				
	Ballroom 2	Ballroom 3	Studio 1	Studio 2	Studio 3
Session 6 **1.50 – 2.30**	**Iain Hay** *The Science Teaching Clinic Model:* It's about moving from here to there and more. **Chair: Manjual Sharma**	**David Paterson** *Strategies for teaching Nature of Science and improving student engagement* **Chair: Leissa Kelly**	**David Geelan, Valeria Cabello Gonzalez, Christoph Kulgemeyer** *Physics Teacher's Verbal Explanations of Physics Concepts – A Research Review and Discussion* **Chair: Donna King**	**Saima Salehjee, Mike Watts** *'Being sciencey': Science identity, inherent inclination and social influence.* **Chair: Derek Hang-Cheong**	**Christine Preston & Laura Monk** *The Influence of Toys on Early Primary Students' Conceptions about Sound* **Chair: Sandy Robbins**
Session 7 **2.35 – 3.15**	**Wendy Cave, Iain Hay** *From little things, big things grow: Enhancing science education through inquiry-based learning, a Principal's journey.* **Chair: Tom Gordon**	**Leissa Kelly, John Cripps Clark & Kathleen Hayes** *Scientists in class: The pedagogy of authenticity in science communication* **Chair: David Paterson**	**Donna King & Lyn English** *Engineering Design In The Primary School: Applying STEM Concepts To Build An Optical Instrument* **Chair: David Geelan**	**Derek Hang-Cheong Cheung, Andy Ka-Leung Ng & Henry Hin-Yan Chan** *Impact of Science Core-text Course on Arts and Social Science Faculty students* **Chair: Saima Salehjee**	**Sandy Robbins** *Gathering snapshot data about students' perceptions of their science learning* **Chair: Christine Preston**
3.15 – 3.30	**AFTERNOON TEA**				
Session 8 **3.35 – 4.15**	**Manjual Sharma, Scott Kable & Alexander Yeung** *ASELL Schools: Using science investigations to guide teachers' implementation of inquiry-based teaching in their classrooms* **Chair: Wendy Cave**	**Yen-Hung Shen, Pin-Yin Liao & Wen-Gin Yang** *The Identification of Specific Difficulties with the Logical Semantic Meanings of "or" in Science among Senior High School Students and College Students: A comparison of English and Mandarin* **Chair: Pey-Yan Liou**	**Barry J. Fraser, Rekha Koul** *Case studies: teaching science, technology, engineering and mathematics (STEM) to primary-school students* **Chair: Christine Preston**	**Kimberley Pressick-Kilborn, Wan Ng, Tracey-Ann Palmer, Peter Aubusson, Sandy Schuk & Paul Burke** *Enablers and barriers to effective primary science and technology teaching* **Chair: Dave Palmer**	**Liana Aisyah, Missy Morton & Lindsey Conner** *Teaching Science to Students with Disabilities: Insights from 3 Indonesian High Schools* **Chair: Peter Hubber**

	Ballroom 2	Ballroom 3	Studio 1	Studio 2	Studio 3
Session 9 **4.20 – 5.00**	**Tom Gordon, Manjual Sharma & Helen Georgiou** *A tool for shifting from prescription to inquiry.* **Chair: Iain Hay**	**Pey-Yan Liou & Chen-Lung Wang** *A Content Analysis of PISA and TIMSS Studies from 1996 to 2015: The Nexus of ILSAs and Science Education* **Chair: Yen-Hung Shen**	**Christine Preston** *But there's more! Further insights into diagrams effects on primary students' understanding about electric circuits* **Chair: Rekha Koul**	**Dave Palmer** *Achievement Emotions And Action Tendencies In Naturalistic Education Settings* **Chair: Kimberley Pressick-Kilborn**	**Peter Hubber & Amanda Berry** *Video as a tool for promoting teacher learning of a representation construction approach to teaching science* **Chair: Liana Aisyah**
5.30 – 6.30	**FIRESIDE CHAT (The Main Ballroom)** ***(Informal pre-Dinner meeting for Early Career Academics and HDR students)***				

	Ballroom 2	Ballroom 3	Studio 1	Studio 2/3
Session 1 **8.30 – 9.10**	**George Aranda, Joseph Ferguson, Russell Tytler & Radhika Gorur** *Confusion, reasoning and learning in inquiry science.* **Chair: Anne Forbes**	**Deborah Corrigan, Gregory Lancaster, Lisa Fazio, Joanne Burke** *Exploring contemporary practices of science with preservice and inservice teachers* **Chair: Dianne Nichols**	**Coral Campbell, Ryan Healy** *Students' improved attitudes to science and mathematics using a problem-based project.* **Chair: Kai Ming Kiang**	***SCIENCE COMMUNICATION IN SCIENCE EDUCATION SYMPOSIUM*** **Sean Perera** *Science communicators in the classroom: An exercise to bridge science communication and science education* **Chair: Peter Fensham**
Session 2 **9.15 – 9.55**	**Anne Forbes, R. Craven & Alexander Yeung** *Changes in 'nature of science' understandings in primary science teachers and students, following participation in an inquiry-based, student-led, mentor-supported science program.* **Chair: Pei-Ying Wu**	**Kathryn Paige, David Lloyd & Richard Smith** *Eco justice, critical pedagogy and Science Teacher Education.* **Chair: Deborah Corrigan**	**Jennifer Yeo & John Gilbert** *What It Takes to Produce a Scientific Explanation in Dynamics, and the Challenges Students Face* **Chair: Coral Campbell**	**Lynn Walker, Janet Smith & Mike Gaffney** *Mentoring in Science and Mathematics Teaching—Leveraging Technology across Australia* **Chair: Leah Moore**
Session 3 **10.00 – 10.40**	**Pin-Yin Liao, Chih-Ling Peng, Jian-Cheng Wu, Jian-Min Chen & Chun-Yi Liu** *Science news as possible influence on non-scientific ideas about earthquakes* **Chair: George Aranda**	**Dianne Nichols** *Assessment of teacher professional development as a change agent for the mining and mineral processing industries.* **Chair: Kathryn Paige**	**Kai Ming Kiang** *Improving the effectiveness of a science classics-reading course through the use of micro-modules* **Chair: Jennifer Yeo**	**Lynn Walker & Leah Moore** *Fostering Pedagogical Content Knowledge in Preservice STEM Teachers* **Chair: Sean Perera**
10.40 – 11.00	**MORNING TEA**			

	Ballroom 2	Ballroom 3	Studio 1	Studio 2/3
10.40 – 11.45	**POSTER SESSION 2 in Main Ballroom (running parallel to paper Session 4)**			
	Shiho Miyake *Zoo Visitors' Evaluation on a College Students' Environmental-Themed Picture Book and its Story-Telling Activity* **Kathleen Hayes** *Investigating the use of digital games as learning tools at specialised Science Centres*	**Meng-Fei Cheng, Tsung-Yu Wu & Hang-Chang Ma** *Exploring Middle School Teachers' and Ninth Graders' Understanding of Scientific Models*	**Romklao Artdej & Khon Kaen** *Case Studies on Pre-service Chemistry Teachers in Training Pedagogical Design of Model-based Instruction*	**Glenn Beaumont** *Curiosity and learning science in the Middle Years* **Yueh-Hsia Chang** *Exploring the Relationship between Inquiry Learning Approach, Personality Traits, and Learning Outcomes in 11th Grade Bio-Energy Class*
Session 4 **11.05 – 11.45**	**S Qureshi, J. Ojeil, V. R Vishnumolakala, D F Treagust, D Southam, M Mocerino** *Qatari students' perceptions of their process-oriented guided inquiry learning (POGIL) environment,* **Chair: William Palmer**	**Reece Mills, Louisa Tomas, Brian Lewthwaite** *A Cautionary Tale of Using Slowmation with School-Aged Learners* **Chair: Peter Hubber**	**Anindito Aditomo** *Science and Religion in Online Argumentation about Socio-scientific Issues: A Case Study from Indonesia* **Chair: David Treagust**	**Evelien Brascamp, Sean Perera** *Do scientists listen to the public?* **Chair: Lynn Walker**
11.50 – 12.45	**ASERA AGM: Ballroom 2**			
12.50 – 1.45	**LUNCH**			
Session 5 **1.50 – 2.30**	**Peter Fensham** *Science teaching and learning and SES: A persistent association, ripe for studying in in Australia* **Chair: Léonie Rennie**	**William Palmer** *Elements of chemistry: the books and their authors (1900-2010)* **Chair: David Geelan**	**David Treagust; Mihye Won** *STEM education: What does it mean and where are we headed?* **Chair: Michael Michie**	**Wan Ng; Jennifer Ferguson** *Partnership Initiative to Enhance Secondary Students' Interest in Science: Teachers' Perspective* **Chair: Emily Haag**
	Ballroom 2	Ballroom 3	Studio 1	Studio 2/3

Session 6 **2:35 – 3:15**	**Carrie Swanson** *"We had first hand experiences": Shifting conceptual understandings through the drama-based inquiry approach Mantle of the Expert* **Chair: Harry Kanasa**	**Deborah Corrigan, David Geelan – RISE Editors** *The importance of reviewing for journals to an academic* **Chair: Vaille Dawson**	**Michael Michie** *A comparison of the Indonesian Kurikulum 2013 with the Australian Curriculum, focusing on science for junior secondary schools.* **Chair: Mihye Won**	**Emily Haag & Leah Moore** *Lost in translation: Using critical analysis of the media to explore scientific literacy and promote informed citizenry among pre-service science teachers* **Chair: Wan Ng**
Session 7 **3:20 – 4:00**	**Rebecca Cooper, Stephen Keast & Karen Marangio** *The day we made pancakes at university: Where is the science in that??* **Chair: Carrie Swanson**	**Shih-Wen Chen, Wen-Jin Yang & Chih-Hsiung,Ku** *Improving students' reading literacy in the science classroom through the perspective of the language of science* **Chair: Deborah Corrigan**	**Beverly Lowe-Dann** *A study of school and teacher responses following the launch of the new Australian Science Curriculum* **Chair: Brendan Briggs**	**Ali Hassan Najmi** *Developing a Pedagogical Framework for Information and Communication Technology Usage that Transforms the Saudi Arabian Science Teaching.* **Chair: Connie Cirkony**
4.00 – 4.20	**AFTERNOON TEA**			
Session 8 **4.25 – 5.05**	**Harry Kanasa & Kate Thompson** *The third space: using a STEM studio in pre-service teacher training* **Chair: Rebecca Cooper**	**Vaille Dawson & Katherine Carson** *Using Socioscientific Issues to Improve Students' Scientific Literacy Skills* **Chair: Shih-Wen Chen**	**Brendan Briggs & Leah Moore** *The impact of socio-political context on national science curriculum developers: A comparative study.* **Chair: Beverley Lowe-Dann**	**Connie Cirkony & Peter Hubber** *Learning in STILE: Students engaging with an online science learning platform.* **Chair: Ali Hassan Najmi**
5.30 – 7.00 **7.00-11.30**	**Visit the Exhibitions at the National Museum and Pre-Dinner Drinks** **Conference Dinner and Dance**			

	Ballroom 2	Ballroom 3	Studio 1	Studio 2/3
Session 1 **9.15 – 9.55**	**Reeja Mathew, Mihye Won & David Treagust** *To what extent is multiple representation-based teaching effective in producing scientific understanding?* **Chair: Yi-Fen Yeh**	**Kennedy Kam-Ho Chan & Benny Hin-Wai Yung** *Developing pedagogical content knowledge for teaching a new topic: More than teaching experience and subject matter knowledge* **Chair: Joanne Burke**	**Emily Rochette** *A Case for the Importance of Geoscience Education* **Chair: Leah Moore**	**Coral Campbell, Russell Tytler, Gail Chittleborough, Peta White, Gaye Williams, David Symington, Garrett Upstill, Nicola Dziadkiewicz & Elise Roper** *The SMiS Model: successful partnerships in practice.* **Chair: Zhijun Xu**
Session 2 **10.00 – 10.40**	**Yi-Fen Yeh** *Uses of graphical representations in high school textbooks* **Chair: Reeja Mathew**	**Joanne Burke** *'Believe it, or not' – Connecting science teachers' beliefs, knowledge and practice.* **Chair: Rehka Koul**	**Michael Fitzgerald, David McKinnon & Lena Danaia** *Astronomical Research and Robotic Telescopes in Science Education* **Chair: Emily Rochette**	**Lihua Xu, Wanty Widjaja & Joseph Ferguson** Seeing through the eyes of the teacher: investigating primary school teachers' professional noticing in science through a video-based methodology **Chair: Coral Campbell**
10.45 – 11.05	**MORNING TEA**			
Session 3 **11.10 – 11.50**	**Yun-Ping Ge, Len Unsworth, Kuo-Hua Wang & Huey-Por Chang** *The effect of explicit visual cues in reading biological images* **Chair: Jacqueline Mendes**	**Rekha Koul, Rachel Sheffield, Susan Blackley, Nicoleta Maynard & Rebecca Walker** *Makerspace in STEM (MIS): Creating a Community of Practice* **Chair: Kennedy Kam-Ho Chan**	**Rod Lane** *Improving the climate understandings of preservice teachers: an online learning approach* **Chair: Michael Fitzgerald**	**Zhijun Xu & Maurice Cheng** *Investigating high school students' Chemistry Representation Competences (CRC) – Understanding properties and structures of covalent substances* **Chair: Lihua Xu**

	Ballroom 2	Ballroom 3	Studio 1	Studio 2/3
Session 4 **11.55 – 12.35**	**Jacqueline Mendes, Maria Helena Carneiro** *Better understanding photosynthesis: the pedagogical role of schematic diagrams* **Chair: Yun-Ping Ge**		**Adit Gupta; Anita Sharma** *An Assessment Of The Chemistry Laboratory Learning Environments And Teacher Student Interactions At The Higher Secondary Level* **Chair: Rod Lane**	
12.40 – 1.30	**LUNCH**			
DELEGATES DEPART				

Abstracts – Paper and Poster Presentations

Jessy Abraham & Katrina Barker
School of Education, Western Sydney University

Motivation and engagement with physics: A comparative study of girls in single sex and coeducational classrooms

Wednesday, 10:50-11:30

It has been argued that the establishment of single sex classes for females can increase their motivation and participation in physics. This paper reports on findings from a multi-occasional study among 90 female Year 11 physics students in single sex and co-educational high schools in Australia. The aim of this study was to identify the differences in motivation, engagement and sustained enrolment plans in relation to physics between female students in single sex and co-educational settings. Fine-grained analyses at a physics topic-specific level indicated differences between these cohorts in their interest value, career value, gender stereotyped attitudes, performance perceptions, sustained engagement and sustained enrolment intentions in relation with physics. Results revealed that both cohorts have high levels of achievement motivation in relation to physics irrespective of their classroom composition; however girls from single-sex schools showed higher values for some constructs across various physics topics. This paper highlights the scarcity of research into girls' sustained participation in physics, once they commence study of physics, and the difference class composition makes to girls achievement motivation and future enrolment intentions.

Anindito Aditomo
University of Surabaya, Indonesia

Science and Religion in Online Argumentation about Socio-scientific Issues: A Case Study from Indonesia

Thursday, 11:05-11:45

Being able to participate in argumentation about socio-scientific issues is an important part of scientific literacy. In some societies, the challenge of learning to argue is made more complicated by conflicts between science and religious doctrines. This study seeks to understand how the science-religion tension is manifested in online argumentation. A discussion thread from a popular blog on homosexuality in Indonesia was used as a case study. The analysis focused on argumentation structure and types of grounds/supports employed to justify claims. The blog author's claim was that homosexuality is not listed as a disorder by the Indonesian Psychiatric Association. Of the seventy-one ensuing comments, all except one implicitly conceded the blog author's claim. Nonetheless, most claimed that homosexuality *should* be listed as a disorder. These comments employed nine types of grounds, which included moralistic ones (e.g. homosexuality as sinful, against "Indonesian values", and leading to moral degradation), but also grounds related to misconceptions about the nature of science (e.g. scientific claims should be supported by an absolute consensus

among scientists; conflicting evidence means that science is uncertain and cannot be trusted). In terms of structure, most of the arguments were relatively simple (Levels 2 and 3 in Erduran et al.'s (2004) framework). In the presentation, I will discuss how these findings may inform science educators about ways to help students from religious backgrounds to engage in scientific argumentation about controversial issues.

Liana Aisyah[1], Missy Morton[2], and Lindsey Conner[3]
[1]Sunan Kalijaga State Islamic University of Yogyakarta, Indonesia
[1,2,3] University of Canterbury, Christchurch, New Zealand

Teaching Science to Students with Disabilities: Insights from 3 Indonesian High Schools

Wednesday, 3:35-4:15

Teaching science to students with disabilities is considered a big challenge for many teachers and often attributed as one of the explanations behind the continuing underrepresentation of persons with disabilities in science related careers. In this presentation, we will share experiences of Indonesian science teachers in developing and implementing strategies to teach science to students with disabilities, particularly those with visual impairment and those with hearing and speech impairment in inclusive settings.
The findings presented in this presentation are part of an ethnographic study of science education for students with disabilities in 3 inclusive high schools in Indonesia. Methods of data gathering included: (1) participatory observation in science classes; (2) semi-structured interviews and informal conversations with science teachers and students with disabilities.
Despite the lack of specific training on how to teach science to students with disabilities, science teachers in this study showed a considerably good understanding of some basic principles of how to teach students with disabilities. By listening to students' voices, knowledge sharing with colleagues, and making the best use of available resources, they were also able to modify teaching strategies and assessment to help make science more accessible to these students and enhance learning for all students in general.

Reem A. AlGhmadi, David Treagust & Venkat Vishnumolakala
Curtin University, Perth, Western Australia

Physics and Saudi Girls: Their Perceptions, Motivations and Career Perspectives

Wednesday, 11:35-12:15

International research has shown that there are several reasons for girls not choosing physics in school such as perceiving they are not good at science, the difficulty of learning science and not enabling to see themselves as scientists. It is likely that the same situation exists in Saudi Arabia as there are not many girls choosing physics as a major subject in Saudi schools or university. This research investigates girls' perceptions of physics and the science curriculum in order to gain a clearer understanding of the reasons for the low number of female students in Saudi society who continue to study science. The research used a mixed methods design including quantitative and qualitative data. In this presentation, we report on the quantitative data from 800 Saudi girls high school students who answered a questionnaire designed to determine Saudi girls' perceptions of and motivation toward and career perspectives for studying science and physics.

Mita Anggaryani
Australian National University

School-based DRR interventions in Indonesia: A case study of Yogyakarta

POSTER

Indonesia can be considered as the Laboratory of Disasters, due to its geographical, geological and demographic condition. The strategy use of school-based Disaster Risk Reduction (DRR) interventions is crucial for achieving sustainable development in Indonesia. However, there are some challenges in implementing school-based DRR interventions programs, such as the lack of teaching resources, and skills. There is also a bias in interpreting DRR interventions in schools since there is unclear guidance from relevant institutions, such as Education Departments. Therefore, this present study investigated how school-based DRR interventions implemented in disaster prone area. The investigation conducted in Yogyakarta Province, one of a disaster-prone province in Java, Indonesia. The methods used in this study are literature review and interview. The interview used a purposive sample with some key informants from governmental institutions. Regarding DRR, Yogyakarta Province is more advanced compared to other provinces. However, this study indicates two primary problems in implementing school-based DRR interventions in Yogyakarta. First of all, the understanding of DRR interventions between stakeholders still unequal. Second, the support for teachers in communicating DRR still poor. This result leads to a possible conclusion that the poor communication between stakeholders may have a significant impact on teachers' performance in class.

George Aranda, Joseph Ferguson, Russell Tytler and Radhika Gorur
Deakin University, Melbourne, Victoria

Confusion, reasoning and learning in inquiry science.

Thursday, 8:30-9:10

Traditionally confusion is considered to be a negative experience in the classroom. However in the context of inquiry science, confusion can be central to reasoning and learning.
This project was part of the ARC-funded program, *The Science of Learning Research Centre*, and specifically explored inquiry based science learning in a collaborative environment. Over 6 lessons in distinct topics, year 7 students undertook a series of inquiry challenges involving reasoning through constructing representations. The lessons were conducted in a classroom with multi tracked video and audio facilities that allowed capture and analysis of the talk and gesture of each student group.
We analysed episodes of confusion where the students were unsure of the concepts, nature of the task or resources that were central to solving the challenge. We identified a variety of resources students drew on, and pathways through which students engaged with the challenge, remained in a confused state or withdrew from the challenge. In our paper we present a model that identifies pathways by which confusion leads to productive outcomes.
We argue that confusion is central to productive inquiry processes and explore in the paper the conditions under which confusion can lead to engagement and reasoning. This has implications for the design and implementation of inquiry based science learning.

Romklao Artdej
Khon Kaen University, Thailand

Case Studies on Pre-service Chemistry Teachers in Training Pedagogical Design of Model-based Instruction

POSTER

The purpose of this study was to investigate pre-service chemistry teachers' pedagogy design capacity of model-based instruction. Four pre-service chemistry teachers who studied in the science education program were selected as case studies. Lesson plans and reflection assignments were gathered individually to assess how they modified their lesson plans after getting feedback. The types of modification found in their lesson plans were employed in data analysis. Such feedbacks acted as a scaffold for helping them to comprehend in the design of lessons to enhance modeling process. Written reflection assignments were also used to support findings from lesson plans. Findings obviously revealed that the type of modification found in lesson plans from four case studies was different. Importantly, the frequency of modifications is directly relevant to the personal belief and subject matter knowledge. This research yields valuable information for teacher preparation to concern this prior to providing an opportunity in teaching practice.

Glenn Beaumont
University of Queensland, Brisbane, Queensland

Curiosity and learning science in the Middle Years **POSTER**

Research into declining enrolments in high school science has tended to measure and highlight students' interest, while the underlying influence of curiosity remains relatively unexplored in this context. Declines in adolescent curiosity are alluded to by researchers. However, the predominant focus of inquiry has been on adults and children.

This study posits that the interplay of curiosity, science education and adolescent development requires understanding if teachers are to foster genuine scientific inquiry in students -- inquiry that is driven by a curious mind. It aims to identify the presence of general and scientific curiosity reported across the Middle Years (Grades 6-9). A mixed methodology design is used to explore the dimensions of adolescent curiosity; changes in curiosity, through adolescence; teaching and learning influences; and student responses to their own scientific curiosity.

Student and teacher perspectives, derived from responses to a survey of adolescent curiosity, interviews, and current theories provide insights to inform the teaching and learning of science for adolescents.

Preliminary results indicate underlying curiosity as relatively stable across years 6 to 9 with many indicators of scientific curiosity in student responses. However, initial inferences drawn from interviews indicate that the classroom may not be where scientific curiosity flourishes.

Amanda Berry[1], Julie Luft[2], Brooke Whitworth[3], Shannon Dubois[4] & Vanessa Kind[5]

[1]Royal Melbourne Institute of Technology, Victoria; [2]University of Georgia, USA; [3]Northern Arizona University, USA; [4]Valparaiso University, USA; [5]Durham University, UK

From Carnival to Coherence: Conceptualizing Trajectories of Science Teacher Learning

Wednesday, 9:00-9:40

Science teacher professional development is a complex issue. Different times during a teacher's career necessitate different professional learning opportunities, with different knowledge bases, practices and attributes that need to be cultivated during these times. For science teachers, it is not usually evident how to progress towards different professional roles, such as a department head, a leading teacher, curriculum developer, or science teacher educator. Drawing upon existing research pertaining to the professional learning of science teachers, this paper suggests a conceptual framework that can be used by policymakers, researchers, teacher educators, and teachers to support the ongoing learning of teachers. The framework comes from examining studies that characterize areas of science teacher learning, and it acknowledges that teachers can change over time; that knowledge, practices, and attributes are involved in this change; and that the situated position of teachers contributes to this change. By articulating this framework, we anticipate that crucial components of science teacher development may be better understood, which in turn, can inform program development, teacher learning, and potential policy decisions. Most importantly, this framework offers science teachers a new way to consider their own professional growth.

Evelien Brascamp & Sean Perera
Australian National University, Canberra, ACT

Do scientists listen to the public? **Thursday, 11:05-11:35**

Dialogue – a model of science communication that attempts to address limitations of unidirectional information dissemination, is criticised for its failure to achieve desired scientific engagement with the public. A key criticism is scientists not *listening* to the public. The present study investigates this issue through in-depth exploration of science communication literature that describes evidences of listening in activities designed to scientifically engage the lay public through dialogue.

Our study shows that dialogue is difficult to implement. Theoretically, dialogue is a matter of honesty, openness, mutual understanding and co-creation, essentially characterised by comprehensive, therapeutic, critical and appreciative levels of listening. Hence, scientists need to listen and incorporate public input during dialogue. Practically, however, there appear to be difficulties in executing dialogue, for example, conflicting agendas, lack of resources, language issues, trust and relative perceptions of risk. Sadly, we found no empirical data demonstrating that scientists listen to the public. Moreover, we found that public opinion is not part of scientific dialogue. Instead, dialogue is used to force public opinion. We conclude by identifying possible empirical investigations for the future, supported by recommendations emerging from the reviewed literature.

Brendan Briggs[1] & Leah Moore[2]
[1]University of Canberra, ACT & ACT Education Directorate; [2]University of Canberra

The impact of socio-political context on national science curriculum developers: A comparative study.

Thursday, 4:25-5:05

National science curriculum, in intent and action, is contentious worldwide. As both a societal value statement and system of intentional practice, it is a product of dynamic interplay between academics, educators, administrators, politicians, industry and community groups. The choices made by its developers influence the way millions of students relate to and engage with science across the course of their lives.

Drawing on the insights and experiences of twelve curriculum developers across Australia, New Zealand and South Africa, this paper investigates the research question: "How does socio-political context impact the way curriculum developers represent science in national curricula?" Through comparative thematic analysis of semi-structured interviews, it explores the ways in which curriculum developers manage the complexity of eclectic curriculum conceptions and balance the academic, cognitive, humanistic, social and technological needs of government and citizens in their respective nations.

Initial findings from this research suggest that socio-political context impacted curriculum developers from each of the three countries in similar ways. All developers worked within and to a continuum of liberal and conservative perspectives on science that fluctuated in parallel to socio-political shifts in government ideologies, pedagogical movements and community worldviews.

Joanne Burke
Monash University, Melbourne, Victoria

'Believe it, or not' – Connecting science teachers' beliefs, knowledge and practice.

Friday, 10:00-10:40

This paper reviews literature that explores the links between the knowledge teachers possess, their instructional practice and their beliefs about teaching and learning in the field of science education. Research has acknowledged that the most important factor in student achievement is the quality of the teacher (Hattie, 2009; Rowe, 2003) and that teacher knowledge is a major indicator of teacher quality (Shulman, 1987). Teachers' knowledge includes knowing their students, how they learn, the content, the subject and how to teach it (AITSL, 2016). Besides knowledge, teachers also have beliefs. It has been suggested that teachers' beliefs control the gaining of knowledge but that knowledge also influences beliefs (Mansour, 2008). This paper, discusses the interdependent relationship between knowledge and beliefs and how these factors influence teachers' pedagogical reasoning and ultimately their classroom practice.

Coral Campbell[1] & Ryan Healy[2]
[1]Deakin University, Melbourne, Victoria; [2]Christian College, Geelong, Victoria

Students' improved attitudes to science and mathematics using a problem-based project.

Thursday, 8:30-9:10

Education strategies which teach subjects in isolation seem to be turning some students off science and mathematics. This research project, undertaken at a local primary school with year six students, investigated a teacher's integrated approach that allowed students to explore multiple ideas through a valid context. Across a twelve week term, students participated in a newly developed unit on "Structures" which integrated science, technology (design & ICT) mathematics, and literacy, using both explicit and implicit teaching approaches The research used a case study approach to analyse the four forms of data collected: teacher/researcher journal, surveys of students' science and maths attitudes administered pre and post the unit, student focus group interviews and the perceptions of the students' classroom teacher to any change to student attitudes to science and mathematics during normal classroom activities (outside the unit). The findings highlighted improvements in children's attitudes to, and understandings of, mathematics and science. The importance of these will be discussed in relation to the children's engagement in these key learning areas.

Coral Campbell, Russell Tytler, Gail Chittleborough, Peta White, Gaye Williams, David Symington, Garrett Upstill, Nicola Dziadkiewicz & Elise Roper.
Deakin University, Melbourne, Victoria

The SMiS Model: successful partnerships in practice.

Friday, 9:15-9:55

Both nationally and internationally, there is major concern about students' engagement in science, technology and mathematics. Government, industry and education institutes are seeking ways to enhance students' experiences in these areas. One such initiative led by the CSIRO, the Scientists and Mathematicians in Schools (SMiS) program, has been involved in linking scientists, mathematicians and ICT professional with volunteer teachers for almost a decade.

The presentation will draw on a recent evaluation of SMiS to provide insight into the nature and affordances of the model. It will draw on survey data and case studies of partnerships in action and vignettes of specific practice to illustrate aspects of the model, the diverse ways in which scientists, mathematicians and ICT professionals can work with teachers to enhance student engagement in STEM subjects, and conditions for successful partnerships.

The evaluation found that the one-to-one negotiation of partnerships, a key feature of the SMiS model, contributed both to its diversity and its success as recognized by teachers and STEM professionals.

Wendy Cave[1] & Iain Hay[2]
[1]Macquarie Primary School, ACT; [2]University of Canberra, ACT

From little things, big things grow: Enhancing science education through inquiry-based learning, a Principal's journey.

Wednesday, 2:35-3:15

This paper highlights a six year journey led by the school principal of a large ACT Public School, to enhance science education through inquiry-based learning. It documents the cultural change, resourcing, and operational alignments required to develop organisational curiosity to bridge boundaries between school, industry and academia. The paper also illustrates how the school as a learning organisation infuses inquiry through science to develop a learning community based on authentic collaborations and research opportunities that move the learning and teaching of science beyond established borders.

Kennedy Kam-Ho Chan & Benny Hin-Wai Yung
The University of Hong Kong

Developing pedagogical content knowledge for teaching a new topic: More than teaching experience and subject matter knowledge

Friday, 9:15-9:45

Teaching experience has been implicated as an important factor in Pedagogical Content Knowledge (PCK) development. However, little is known about how experienced teachers may draw on their prior teaching experience to facilitate their new PCK development. This case study examined how two experienced high school biology teachers with adequate subject matter knowledge (SMK) approached the teaching of a new topic and their PCK development. Multiple data sources included classroom observations, semi-structured interviews, field notes and classroom artifacts. Data showed that both teachers' prior teaching experience informed their planning to teach the new topic, but in qualitatively different ways. This, in turn, influenced their new PCK development. It was found that while strong SMK acted to support new PCK development in the experienced teachers, it could also hinder the development. It depended on whether the teacher had a disposition to draw on, in the lesson planning stage, a generalized mental framework that enabled the teacher to capitalize on his existing strengths in SMK to develop new PCK. It is argued that helping teachers to acquire such a disposition should be a focus for teacher training in light of continual curriculum changes.

Yueh-Hsia Chang
Tamkang University, Taiwan

Exploring the Relationship between Inquiry Learning Approach, Personality Traits, and Learning Outcomes in 11th Grade Bio-Energy Class

POSTER

Reform efforts for science education urge inquiry as a central strategy of science instruction. This study investigated high school students' perceptions about an inquiry-based class and examined to which level the students took lead in generating questions, collecting data, and interpreting results in science inquiry. Factors that may have influenced the students' attitude toward inquiry-based instruction and learning outcomes were also examined. 34 11^{th} grade high school students in a microbial fuel cells (MFCs) course participated in this study. Data was collected through Student Conceptions on Inquiry Science Learning (SCISL), Student Science Learning Achievement (SSLA), and Attitude toward Inquiry-based Learning (AIL) questionnaires. The results indicated that after taking the course, students' learning outcomes including affective and cognitive performance in MFCs course improved significantly. The study results also revealed that the high school students and the teacher perceived the class environment differently on whether the science class is constructed as being student-initiated or teacher-guided inquiry. In addition, factors such as students' demographic characteristics, confidence in inquiry learning, prior knowledge, and personality traits were explored. The study results can provide important implications in the understanding of students' learning behaviours for inquiry learning.

Shih-Wen Chen[1], Wen-Jin Yang[2] & Chih-Hsiung Ku[1]
[1]National DongHwa University, Taiwan; [2]National Taiwan University

Improving students' reading literacy in the science classroom through the perspective of the language of science

Thursday, 3:20-4:00

With the increasing concern about the issues of science, language, and literacy, a growing number of research studies have often suggested that developing reading literacy have become more critical for pupils. However, according to the relevant literature reviews and out previous research studies, pupils typically struggled with understanding the language of science in three reading difficulties of identifying textual structures, distinguishing nominal group patterns, and classifying semantic relations in the science texts. Therefore, this study attempted to improve students' reading understanding through a dual-scaffolding instruction which named as Science Reading Treatment (SRT) which includes Systemic-Function text and SQ3R pedagogy. A total of 99 primary school pupils of grade-five were participated in this study and then accepted the SRT by a science teacher. The quantitative data from three questionnaires was analyzed by descriptive statistics and t-test to explore pupils' reading understanding. The results revealed that pupils significantly understood better in the three reading difficulties after the 10-week SRT, particularly for those low-achieved pupils. To conclude, every science lesson is a language lesson. Pupils need to learn how to read the language of science, and science teachers would play the crucial role in coaching and guiding them to read and understand better.

Meng-Fei Cheng, Tsung-Yu Wu & Hang-Chang Ma

National Changhua University of Education, Taiwan

Exploring Middle School Teachers' and Ninth Graders' Understanding of Scientific Models

POSTER

In recent years, there has been great emphasis on models and modelling in science learning. This study explores middle school science teachers' and ninth-grade students' performance in terms of understanding of scientific models as well as their construction and evaluation of these models. It also examines whether there is a correlation between these three aspects.

The study participants comprised 95 science teachers and 608 ninth-grade students. To investigate the students' understanding of scientific models, they were asked to fill out a Students' Understanding of Models in Science (SUMS) survey. To explore the students' model construction and evaluation, they were asked to explain three different magnetic phenomena and to provide the criteria they used to evaluate scientific models.

The results show that the teachers' performance on these three aspects was significantly better than that of the students. Moreover, those teachers who had a better understanding that scientific models are not the replica of target events could develop higher levels of models while the opposite was true for the students. Also, both teachers and students with a better understanding of the changes in models could provide higher levels of scientific model evaluation criteria. The findings of the study contribute to a better understanding of the gap between teachers and students so as to better design the modeling curriculum.

Derek Hang-Cheong Cheung, Andy Ka-Leung Ng and Henry Hin-Yan Chan
The Chinese University of Hong Kong

Impact of Science Core-text Course on Arts and Social Science Faculty students

Wednesday, 2:35-3:15

It has been concerned that students who major in Arts and Social Science, who presumably have less scientific knowledge, possess difficulty in engaging in university science related courses. The concern is pressing, when it comes to a compulsory, science core-text course - "In Dialogue with Nature" in The Chinese University of Hong Kong. This course requires students to read science core-texts to explore how renowned thinkers investigate nature and reflect on issues that have enduring concerns for human. As a compulsory science related course, knowing the learning outcomes attainment of students from different faculties is of utmost importance. The present project focuses on comparing the intended learning outcomes attainment of students from Arts and Social Science faculties with those of the other faculties. Entry-exit surveys were conducted with 385 students to investigate students' perception on the learning outcomes before and after taking the course. Results showed that students from the concerned faculties possess significant improvement in their perceptions on the intended learning outcomes. The increments in certain learning outcomes in the concerned faculties are even higher than the others. Efforts spent by students are also analyzed to possibly account for the discrepancies among faculties. In general, the results show that learning science through core-texts is beneficial to students who major in Arts and Social Science.

Jaehyeok Choi[1], Heekyong Kim[2], Yong Jae Joung[3] & Kwanghee Jo[4]
[1]Chonnam National University, Korea: [2]Kangwon National University, Korea; [3]Gongju National University of Education, Korea; [4]Chosun University, Korea

A Self-Study about Teacher Educator's and Preservice Teachers' Epistemological Views on the Course for Secondary School Physics Instruction

Wednesday, 12:20-1:00

The purpose of the study is to investigate the epistemological view of teacher educator and students in a science teaching method course. The participants were a teacher educator and 18 preservice science teachers who at the time of this study took the teacher educator's course designed to support teaching in a secondary science classroom. We used the self-study method for understanding the epistemological view of participants. The data source included teacher educator's reflective journal, the video recorded lessons of the course (eleven 3-hours lessons), focus group interviews, students' reflective journals. Questionnaires were administered at the beginning, middle, and the end of the course. During the course, weekly group meeting of critical collaborators analyzed the emerging issues based on the lesson clips, teacher educator's reflective journal. The results showed that there were the differences between goal and expectation of participation in the course, and this obstructed the success of the course. The students focused on the knowledge for passing the secondary teacher selection test. They had different views about the need of the pedagogical contents knowledge and practice from the teacher educator. The study identified the tensions among the teacher educator's multiple identities as a lecturer, a faculty, and a researcher.

Hye-Eun Chu[1], Sonya Martin[2], Kongju Mun[3], Seung-urn Cho[3], Bronwen Wade-Leeuwen[1], Katherine Stewart[1], Cathie Howe[4] & Jinwoong Song[2]
[1]Macquarie University, Sydney; [2]Seoul National University, Korea; [3]Ewha University, Korea; [4]Macquarie ICT Innovations Centre, Sydney

The Fusion of Science and Arts: An interactive digital platform to enhance STEAM (Science, Technology, Engineering, Arts and Mathematics) teaching and learning exchanges by science teachers in Korea and Australia

Wednesday, 10:50-11:30

In this presentation, we share findings from an international collaborative project involving science teacher educators, artists, and science teachers from Korea and Australia who developed STEAM (Arts integrated STEM) curriculum materials to support students to explore similarities and differences existing in nature and culture in both countries. Using an online platform, teachers and students partnered to enact STEAM lessons designed to promote joint learning about science and culture. We share lesson examples focused on how geographical differences affect various science phenomenon, including differences in the weather and seasons and in plants and habitats. We share examples of student artwork to demonstrate how STEAM lessons incorporate the arts as a tool for expanding science learning opportunities that can increase student interest and positively impact on student achievement in science. We share findings from the evaluation of our pilot implementation of the project and we raise questions about how to effectively engage various stakeholders to create and implement STEAM lessons that can facilitate students' science learning experiences while also expanding teacher and students' appreciation of the arts, literature, and culture in relation to science. We conclude by discussing implications for curriculum development and implementation and by sharing plans for future research.

Connie Cirkony & Peter Hubber
Deakin University, Melbourne, Victoria

Learning in STILE: Students engaging with an online science learning platform.

Thursday, 4:25-5:05

Science classrooms have a history of integrating digital technologies in classrooms, and are increasingly blending both face-to-face and online instruction. It is not clear whether these blended learning environments are improving student learning in the science classroom. In this research the affordances of Student-Teacher Interactive Learning Environment (STILE) are being used to extend the traditional online learning platform to support a more interactive and multimodal approach to science education, with the added potential of supporting inquiry-based representation construction pedagogy. This paper describes initial analysis of an ethnographic study investigating how a group of Year 9 science students are using STILE alongside digital technologies to understand the concept of energy and how it applies to sustainable housing. Using a distributed cognition framework, the authors drew on multiple data generated through video capture, video-based stimulated recall interviews, and student-constructed representations, to understand how students are engaging and learning in a science classroom. Initial findings suggest the STILE platform can be productively enlisted to enable students to effectively integrate both digital and analog technologies to support their conceptual learning, along with their social interactions in both small and large groups.

Rebecca Cooper, Stephen Keast & Karen Marangio
Monash University, Melbourne, Victoria

The day we made pancakes at university: Where is the science in that??

Friday, 3:20-4:00

This paper discusses the authors use of a handout called “the day we made pancakes at school” with pre-service teachers (PSTs) as a stimulus for thinking about the nature of science and how to explain scientific concepts to students at different secondary school levels. Initially, the handout was used only as a worksheet but as we evaluated its use, we felt it was necessary to have PSTs make pancakes as an activity in class. After making pancakes, PSTs fill in the handout for homework and return the following week to submit their responses, which are discussed in class. Data was collected over several years from PSTs in our General Science Education classes. The data is focussed on their experiences of the task (making pancakes, filling in the handout and the discussion lesson), how they felt, what they learnt and what they understood as the purpose of the task. Findings indicate that: some PSTs struggled to see the science in making pancakes and thus, to explain the science concepts involved as they often failed to see the complexity of science explanations and the need for multimodality in explanations to support learning. Further, PSTs struggled with the notion that they had struggled.

Deborah Corrigan & David Geelan
RISE Editors

The importance of reviewing for journals to an academic

Thursday, 2:35-3:15

In this session we will outline the academic benefits for reviewing for academic journals, and in particular Research in Science Education – the journal of ASERA. The process involved in reviewing, how to provide a good review and what the editorial process generally involves will all be discussed. The role of being a member of na editorial board will also be considered. This session will be particularly important for early and mid career academics and is designed to be interactive with a range of participants and expertise available.

Deborah Corrigan, Gregory Lancaster, Lisa Fazio & Joanne Burke
Monash University, Melbourne

Exploring contemporary practices of science with preservice and inservice teachers

Thursday, 8:30-9:10

The REMSTEP project aims to promote reconceptualising Mathematics and Science Teacher Education Programs by fostering partnerships between scientists and educators to improve confidence and competence in STEM education.
One response from Monash University's Faculties of Science and Education has been to design a masters unit to assist pre- and in-service science teachers to explore contemporary science practices and examine how varied understandings can influence science communication. The unit encourages teachers to explore their understandings of Nature of Science (NoS) and contrast their views with those known to be widely held by society (Cobern & Loving, 1998). Teachers are challenged to construct visual representations of contemporary science practices which reflect their understandings of NoS and provide insights into thinking that shaped their design. In order to build more authentic understandings of contemporary science practices each student 'shadows' research scientists and engages them in conversations to explore the scientists' NoS views and practice as mapped against a framework of five levels of science cognitive engagement.
Preliminary findings suggest that teachers were initially uncomfortable with the challenge of constructing visual representations and surprised how diverse the views of NoS can be. These views can directly impact on ways of communicating contemporary science practices.

Bronwen Cowie
The University of Waikato, New Zealand

Reconfiguring and or reconceptualising boundaries

Wednesday, 12:20-1:00

Notions of boundaries, borders, border-crossing and broking, variously conceived, are featuring in a number research programs at the moment. Within in my work in New Zealand this family of ideas is emerging as provocative and relevant in a number of ways, some of which include: (i) the interplay of the 'real' and the 'virtual' as this relates to the use of the Internet and internet-based resources is to provide students access to scientists, to practical demonstrations and experimental work; (ii) the boundary between formal and informal education; (iii) the boundary between home and school and the role of the family in learning, and (iv) the productive relation between science, school science and children's home and community ways of thinking, interacting, valuing and being (in the physical world). The intention of this paper is to provoke discussion on the implications for curriculum, teaching and assessment of this blurring across multiple boundaries.

Vaille Dawson & Katherine Carson
University of Western Australia

Using Socioscientific Issues to Improve Students' Literacy Skills

Thursday, 4:25-5:05

The aim of the research reported here was to trial a climate change module, the purpose of which was to improve young people's ability to construct an argument about a climate change socioscientific issue (SSI). The study was conducted in a school with a high proportion of socially disadvantaged refugee children with English as a second language. The teacher, an early career science teacher, participated in a half-day professional development workshop on climate change science and argumentation. He then explicitly taught his 31 Grade 10 (15-16 year old) students about argumentation as part of a five week (20 lesson) topic on earth and space sciences. Using a pre-experimental design, 30 students completed a pre- and posttest questionnaire to determine their understanding of climate change and their ability to construct an argument. Using a one way repeated measures ANOVA, it was found that students' understanding of climate change and the greenhouse effect improved significantly ($p<0.001$). There was also an improvement in the quality of students' argumentation about a climate change SSI and a significant increase ($p<0.05$) in the number of types of reasons provided. The teacher perceived that engaging in structured discussion and writing arguments improved students' literacy levels.

Peter Fensham
Monash University, Melbourne, Victoria

Science teaching and learning and SES: A persistent association, ripe for studying in in Australia

Thursday, 11:50-12:30

A positive association between students' learning of science and the socio-economic family status or background of students (SES) is internationally pervasive and durable. The association poses a major equity problem, although, for Australia a relatively modest one compared with some other countries. Nevertheless, the PISA project reported, for Australia, a difference of 20+% of the average science performance score across the SES length - a significant difference, worth reducing if possible.
Compared with their interest in the associations between science learning and gender and culture, science education researchers have given little attention to this ongoing SES association. More recently, however, studies of its multiple aspects are now appearing from other countries. In Australia, despite the decade long political prominence that social disadvantage in education has had, little study of its science education aspects has yet been undertaken. The paper reviews a few older Australian studies of the association to make suggestions about contemporary research that could provide evidence to turn political interest into positive policy actions to lessen this source of disadvantage.

Joseph Ferguson & Lihua Xu
Deakin University, Melbourne, Victoria

Investigating 'Non-formal' Reasoning in Science Through Video-Based Studies of Classroom Interactions

Wednesday, 11:35-12:15

Scientific reasoning has been promoted as an important part of school science curricula and widely researched in science education literature (Driver, 1994; Russ, et al., 2008). However, an often-neglected aspect of reasoning is how concrete manipulations of external objects can contribute to reasoning about scientific phenomena (Magnani, 2004). The 'non-formal' ways of reasoning have gained some recognition in recent years (e.g. Clement, 1991), partly because of the advancement of methodologies in capturing the reasoning processes. In this paper, we explore the non-formal aspects of students' reasoning in science through three empirical studies that employed video-based research methodologies. All three studies captured classroom interactions through a multi-camera and multi-audio approach and two of the studies identified participants' interpretations of classroom events through video-simulated post-lesson interviews. The combination of multi-camera video capture complemented by other data sources provided the opportunities to examine students' manipulative, model-based reasoning in great detail and from multiple viewpoints (camera, teacher, students, researchers). This paper highlights the situated, distributed and embodied nature of reasoning revealed by the employment of video-based methodologies, which is contrasted with the logical and formal reasoning that is often privileged in school science curricula and classroom teaching.

Michael Fitzgerald[1], David McKinnon[1] & Lena Danaia[2]
[1]Edith Cowan University, Perth; [2]Charles Sturt University, NSW

Astronomical Research and Robotic Telescopes in Science Education

Friday, 10:00-10:40

For the past two decades, many endeavours have been undertaken world-wide to bring authentic science education to the general classroom. Not least of these efforts has been in the field of astronomy. New technologies, such as robotic internet telescopes, have enabled the capacity for teachers and students to take real scientific-grade astronomical measurements and very high quality original 'pretty pictures' with minimal technical knowledge. Two major reviews of the field undertaken have shown that while most technical and resource issues are currently largely solved, there is still minimal implementation of this technology in the classroom.
In this presentation, I will summarise the recent reviews and the typical blocking factors identified so far. A number of case studies will be presented where robotic telescopes have been used by teachers and students who have bucked the trend in Australia, the UK and the USA. Some of these teachers and students have even been published or are on the way to publishing in the astronomical literature while being mentored by experienced scientists.

Michael Fitzgerald[1], Pedro Russo[2], Edward Gomez[3] & Thilina Heenatigala[2]
[1]Edith Cowan University, Perth, Western Australia; [2]Leiden University, Holland; [3]Las Cumbres Observatory Global Telescope Network

IAU astroEDU: an open-access platform for peer-reviewed astronomy education activities

POSTER

astroEDU is an open access platform for peer-reviewed astronomy education activities. It addresses key problems in educational repositories such as variability in quality, not maintained or updated regularly, limited content review, and more. This is achieved through a peer-review process similar to what scholarly articles are based on. Activities submitted are peer-reviewed by an educator and a professional astronomer which gives the credibility to the activities. astroEDU activities are open-access in order to make the activities accessible to educators around the world while letting them discover, review, distribute and remix the activities. The activity submission process allows authors to learn how to apply enquiry-based learning into the activity, identify the process skills required, how to develop core goals and objectives, and how to evaluate the activity to determine the outcome. astroEDU is endorsed by the International Astronomical Union meaning each activity is given an official stamp by the international organisation for professional astronomers.

Anne Forbes, Rhonda Craven & Alexander Yeung
Australian Catholic University

Changes in 'nature of science' understandings in primary science teachers and students, following participation in an inquiry-based, student-led, mentor-supported science program.

Thursday, 9:15-9:55

A randomized controlled trial was conducted in six pairs (experimental and control) of Catholic and Public primary schools, with science mentor support from a local secondary school, in two regional and one urban area within NSW to determine the effect on 'nature of science' understandings in primary school participants following participation in two types of school science programs: their normal science program (control) or an inquiry-based, student-led, mentor-supported science program named *MyScience* (experimental). Twelve primary schools were randomly allocated to one of the protocols, and participants (21 primary teachers and 620 primary students) completed pre and post online surveys containing items related to 'nature of science' skills, knowledge and understandings, such as the importance of: the tentative nature of science, 'fair testing', taking careful measurements, replication, and creativity when doing science. Findings are presented and discussed, and related to future research projects.

Barry J. Fraser & Rekha Koul
Curtin University, Australia

Case studies: teaching science, technology, engineering and mathematics (STEM) to primary-school students

Thursday, **3:35-4:15**

The role of science, technology, engineering and mathematics (STEM) cannot be underestimated in preparing global citizens for the challenges of the future. Opportunities that engage and support young people in pursuing their love of STEM, or even better understand what STEM entails; help to strengthen the future workforce and international standing (Chubb, 2015). As a part of STEM education and skills development, primary-school students were introduced to STEM lessons in an effort to lay a foundation for the future.
Design, delivery and assessment of three STEM-related lessons will be discussed in this presentation. The research methods involved interpretative qualitative approaches based on exploratory case studies. The three selected lessons, teaching 'Brakes', 'Oil Spills' and 'Solar Houses', integrate all the four STEM learning areas. The variation in content across the lessons offers inspiration and reassurance that STEM can lead to a variety of wonderful and exciting career pathways. Taking students on this journey and helping them to find their own pathways in STEM exposed students to learning new things and making independent choices. Pedagogical content knowledge generated through student and teacher feedback about these lessons proved useful as a scaffold for teachers in STEM learning areas.

Anne Galvin & Rekha Koul
Curtin University, Perth, Western Australia

The use of ICT Science resources by Australian Upper Primary Teachers. POSTER

Studies have confirmed that there has been concern in many sectors about the teaching of science in primary schools. This situation can be partly attributed to the poor Science background of the teachers. The use of Information and Communication Technology (ICT) resources has the potential to enhance the science content knowledge of these teachers thus partially offsetting the deficit in their science background.

The principle aim of this study was to investigate the use of science ICT-resources by teachers of Upper Primary students in Australia and to make recommendations to assist them to enhance their science content knowledge before classroom delivery. A mixed research methodology was employed to collect data from primary school principals and teachers. A total of 31 schools and 47 teachers participated.

This poster focuses on a sub-section of the findings of this study which showed that a large proportion of the teachers had a relatively poor background in the sciences and did not participate in courses/activities to enhance their science content knowledge. It was concluded that the effective use of ICT-resources to enhance primary teachers' science content knowledge should be of interest and consequence to the generalist primary school teacher who is obliged to teach Science.

Yun-Ping Ge[1], Len Unsworth[2], Kuo-Hua Wang[1] & Huey-Por Chang[3]
[1]National Changhua University of Education, Taiwan; [2]Australian Catholic University; [3]Open University of Kaohsiung, Taiwan

The effect of explicit visual cues in reading biological images

Friday, 11:10-11:50

Drawing on cognitive theories, this study intends to investigate the effects of explicit visual cues which have been proposed as a critical factor in facilitating understanding of biological images. Three images from Taiwanese textbooks with implicit visual cues, involving the concepts of biological classification system, fish taxonomy, and energy pyramid, were selected as the reading materials for the control group and re-designed in tree structure or with additional arrows as the images for treatment group. A quasi-experiment with an online reading test was conducted to examine the effect of the different image conditions on reading comprehension of the two groups. In total 193 Taiwanese participants from year 7 were assigned homogenously into either control group or treatment group according to the pre-test of relevant prior knowledge of the topics. The result reveals that the explicit visual cues significantly facilitate higher reading comprehension only in the subsets of classification system ($F=4.441$, $p=.036$) and fish taxonomy ($F=11.321$, $p=.001$).

David Geelan[1], Valeria Cabello Gonzalez[2] & Christoph Kulgemeyer[3]
[1]Griffith University, Queensland; [2]Universidad de Chile; [3]University of Bremen, Germany.

Physics Teacher's Verbal Explanations of Physics Concepts – A Research Review and Discussion

Wednesday, 1:50-2:30

Research efforts in Australia (Geelan, 2012, 2013), Chile (Cabello Gonzalez, 2013, 2014) and Germany (Kulgemeyer, 2014, 2015, 2016) are exploring the ways in which teachers verbally explain concepts in physics to their students. Teacher explanations in the physical sciences share some features with everyday explanations and some features with the explanations in scientific papers, but also have features shared with neither. This paper does not present an original report of research findings, but rather reviews the similarities and differences of these research projects and their foci, and critically reviews the field. The specific theoretical frameworks and methodological approaches employed are reviewed and discussed, and the significance of this work for physics education outlined. Drawing on work from Treagust and Harrison (1999), Ogborn et al. (1996) and Sevian and Gonsalves (2008) as well as the authors, directions for further research and collaboration are proposed, and the ways in which research on teacher explanations can be (a) influential in physics teacher education and (b) extended to other scientific and mathematical disciplines are considered.

Judith Gomes & Marilyn Fleer
Monash University, Melbourne, Victoria

Preschool teachers conceptualising science in the preschool environment: Concepts or activities?

Wednesday, 12:20-1:00

Recent research interest is growing worldwide in the area of early childhood science education. Studies have shown that emphasis is given in some countries on teaching science from early years. These studies have indicated that science pedagogy in early years needs much attention. There is increased concern among teachers on how to teach science in the early years. Pedagogy in early childhood settings seeks for constant interaction and utilising the teaching moments. In this regard, less is known about teacher's interpretation of the environment and the nature of relationship teachers relate to the everyday environment to teach science. Drawing upon cultural-historical theory (Vygotsky, 1987), this paper seeks to know the nature of relationship preschool teachers engage with the environment to teach science. Data for this case study forms part of a larger study. 6 hours of video data and 303 photographs were drawn for this study. Photographs and teacher interviews were analysed following Hedegaard's (2008) three levels of analysis. Findings from this study show that teachers in the same context have different interpretation of the environment to teach science - *activity oriented sciencing* and *conceptually oriented sciencing*. The complexity of the relationship with the environment and the teachers' conceptualising the affordances in the environment gives deeper insight on teacher philosophy and further curriculum development and pedagogy in early year science teaching.

Tom Gordon, Manju Sharma & Helen Georgiou
University of Sydney

A tool for shifting from prescription to inquiry.

Wednesday, 4:20-5:00

The aim of this project is to examine the effect of including inquiry-based learning activities into the education outreach program run by the Sydney University School of Physics called Kickstart Physics which impacts on approximately a quarter of the total number of students that sit the NSW HSC Physics examination each year.
A first paper was produced with results showing that the inclusion of inquiry oriented elements into the Kickstart workshop, was beneficial to student learning.
A second experiment will extend the inquiry process from Kickstart workshops to the School classroom by using an educational tool which converts a prescriptive activity to an inquiry oriented learning activity.
The evaluation includes analysis from students and teachers.
The results from the first experiment indicated that a shift towards inquiry oriented methodology across the workshop increased student engagement with the workshop materials and students reported an increase in mental effort while completing the workshop. Preliminary results from the second experiment will be presented at the conference.

Anna Gorges & Christina Siry
University of Luxembourg

Students' language repertoire as a resource for meaning making in a multilingual secondary science classroom in Luxembourg

Wednesday, 9:00-9:40

In Luxembourg, more than 50% of the students speak at home language(s) different from their languages of instruction. The Luxembourgish school system requires students to learn all three state languages: Luxembourgish, German, and French. While the Luxembourgish society is multilingual, the instruction at school is strictly monolingual in either Luxembourgish, German or French depending on the grade and subject. Thus, the school system demands students to "language" in a way that is not meaningful to them and which causes their ability to communicate in multiple languages to become a shortcoming. In order to provide all students with an equal and fair chance to succeed at school, it is important to emphasize that plurilingual language repertoires are a resource, which should not be deprived by the demand of monolingual language standards, but valued in their diversity. In my research, I show in which ways students use their plurilingual language repertoire for meaning making, if granted the space to do so. With help of an ethnographic case study, I trace with the example of a small-group interaction between three students, different translanguaging strategies used to co-construct scientific concepts in a 9th grade science classroom at an alternative high school in Luxembourg.

Adit Gupta & Anita Sharma
MIER College of Education, Jammu, India

An assessment of the chemistry laboratory learning environments and teacher student interactions at the higher secondary level

Friday, 11:55-12:35

Chemistry laboratories provide students a chance to test their ideas and learn difficult concepts by performing experiments. The study assesses students' perceptions of their learning environments and their teacher-student interactions in a chemistry laboratory setting at the higher secondary level in selected private schools using the Science Laboratory Environment Inventory (SLEI) and Questionnaire on Teacher Interaction (QTI). The sample consists of 250 students studying in classes 11^{th} and 12^{th}. The learning environments in the chemistry laboratory at the higher secondary level show that the mean scores of the preferred form of the SLEI are higher than the actual form. This means that the students' preferred learning environments that are more open ended in terms of decision making on the part of the students, seek better material support to perform the laboratory experiments in terms of equipment, chemicals and more cohesiveness with one another in terms of providing support for each other etc. The results on the QTI show that the students see their teachers as good leaders most of the time and have also rated their teachers in terms of exhibiting helpful and friendly nature, understanding and giving students freedom and responsibility in the chemistry laboratory. No significant gender differences have been reported in the chemistry laboratory learning environments however, significant gender differences were found to exist in students' perceptions of their teacher interpersonal behaviour in chemistry laboratory settings.

Emily Haag & Leah Moore
University of Canberra, ACT

Lost in translation: Using critical analysis of the media to explore scientific literacy and promote informed citizenry among pre-service science teachers

Thursday, 2:35-3:15

The study investigates scientific literacy, critical analysis of the media, informed citizenry, and the tension between communication and education, contextualised by socio-scientific and historical perspectives, and evaluated through results of a classroom activity involving scaffolded media analysis and linked focus groups. The study aims to advance pedagogical use of critical analysis of the media. The following research questions are explored: How useful is a structured approach to critical analysis of the media? How is it used to support literacy and informed citizenry?
In a first year university science course, 122 students evaluated written media sources, all focused on NASA's announcement of the discovery of flowing water on Mars. Although fifty percent of the students thought the news story would affect a large number of people and have serious consequences, a majority did not find the news relevant to their lives (73%) nor related to local concerns (60%). While most students said the activity helped them to think more critically about scientific media (79%), the aim of critical reading was not apparent to all. Participants thought authority of the source and evidence presented in the media were the most important criteria for evaluation. They also cited personal interest as their main criterion for selecting what they read.

Iain Hay
University of Canberra, ACT

The Science Teaching Clinic Model: ***It's about moving from here to there and more.***

Wednesday, 1:50-2:30

This paper explores the development of the *Science Teaching Clinic Model* of work integrated learning through university/school partnerships. The paper also presents some of the key findings from research about the model, which has been conducted over the past 10 years. The paper highlights the importance of authentically engaging pre-service teachers (PSTs) pedagogical content knowledge development in a practice-based approach. There is discussion about how to provide PSTs with the opportunities to build on their existing science knowledge and develop a broader range of skills in the teaching of science to young children. The paper shows how the science teaching clinics provide the opening for more in-depth reflection on experiences, which in turn enhance the development of personal pedagogic frameworks and shifting STEM education from the tutorial room to the practical space in schools.

Kathleen Hayes
Australian National University, Canberra, ACT

Investigating the use of digital games as learning tools at specialised Science Centres.

POSTER

Science centres have long been recognized as pivotal influences on students' engagement in science and are increasingly being used to support the school science curriculum as part of Victoria's science education strategy. These centres have more flexibility than schools to experiment with novel learning tools and several have incorporated digital games into their programs. This provides an opportunity to investigate the potential of digital games for teaching science that currently remains mostly unverified by researchers and under-realized in schools. The aim of my research is to establish why six loosely connected specialized science centres, each focusing on a distinct area in science, choose to use or not use digital games in their programs. Interviews with staff revealed that all centres shared goals and values in teaching but varied in their use of games. Degree of game use largely depended on the accessibility of a centres' field of science. The findings suggest that centres with more abstract or physically inaccessible topics are potentially more likely to use games as learning tools. These findings will inform science educators about the pedagogy of new and potentially key players in Australian science education and their approaches to using digital games for teaching science.

Linda Hobbs, John Cripps & Barry Plant
Deakin University, Melbourne, Victoria

Making STEM sustainable – developing a comprehensive STEM vision

Wednesday, 9:45-10:25

In Australia, concerns have been voiced about both performance and participation of students in science, Technology, Engineering and Mathematics (STEM) related subjects through all sectors, and whether they are fully prepared for the modern workplace (Australian Industry Group, 2013). State and federal education authorities have reacted by initiating a range of policy changes culminating in the National STEM School Education Strategy (Education Council 2015).
The challenge for educators is to translate a largely ill-defined, politically charged and narrowly utilitarian policy agenda of securing a future workforce, into a valid and coherent curriculum. The objective of this paper is to articulate a comprehensive, multi-faceted and coherent *STEM vision* that addresses the subtle and complex challenge of preparing "twenty-first century" citizens within the constraints of a traditional school system and curriculum.
This paper explores the question: How can a multi-faceted vision of STEM education in a teacher professional learning program sustainably and effectively meet the specific needs of schools? We report on insights from a teacher professional development program, *Successful Students-STEM Program,* operating in ten schools in regional Victorian city, Australia, designed to develop year 7 and 8 Science, Technology and Mathematics teachers' capacity to teach STEM. The research is showing that a STEM vision needs to be more than discrete STEM-related activities slotted into an already bulging curriculum to be sustainable.

Christine Howitt[1] & Léonie Rennie[2]
[1]The University of Western Australia, Perth; [2]Curtin University, Perth, Western Australia.

Extending Young Children's Science Learning through Personal Photobooks

Wednesday, 10:50-11:30

The *Small Steps in Science* project (ARC-funded LP110200756) aimed to explore 3- and 4-year-old children's learning through photobooks following their interaction with a science centre's Early Childhood Outreach exhibits. Fifteen parent/child dyads were video-recorded interacting with the components of the 1-hour program into community playgroups across 2012-2013. Screen shots from the videos were used to develop personalised photobooks for each child. One week after the program was delivered the photobooks were used in conversation with the children (supported by their parents) to allow the children to demonstrate their understanding of how the components of the program worked. The photobooks were then taken home. Seven weeks after the program parents were interviewed about how the photobooks were used at home. Following cross case analysis, the photobooks were found to provide the children with a context for conversation, means to demonstrate competence, multiple forms of communication, and means to participate on their terms. At home, the photobooks supported the children in both a cognitive and affective manner. The individualised photobooks were found to be a focus for the children to share their knowledge of the outreach program, gave the children a voice, and provided them with time to express their understandings.

Peter Hubber[1] & Amanda Berry[2]
[1]Deakin University, Melbourne; [2]RMIT, Melbourne, Victoria

Video as a tool for promoting teacher learning of a representation construction approach to teaching science

Wednesday, 4:20-5:00

Advances in digital videography have fostered a substantial increase in the use of video in teacher professional development. Video can capture much of the complexity of classroom interactions which, when used in contexts that allow teachers time to reflect on these interactions, can provide powerful tools for teacher learning. However, for video to be effective requires a targeted focus around particular purposes such as better understanding student interactions flowing from science inquiry pedagogies, and effects of strategies such as questioning and problem posing. This paper reports on a project that enables high quality video of teacher and student groups to be captured and edited by teachers themselves for the purpose of supporting learning about a representation-construction approach to teaching science. Representation construction is a guided inquiry pedagogy in which students actively generate and explore representations of scientific phenomena. This paper will draw on the experiences of three schools, with teachers at Year 7/8, who used this video capture approach within a science topic. In enacting the representation construction approach the teachers videotaped aspects of their lessons to reflect on their practice and prepare video clips to share among the other teachers within a video club professional learning environment.

Harry Kanasa & Kate Thompson
Griffith University, Queensland

The third space: using a STEM studio in pre-service teacher training

Thursday, 4:25-5:05

Pre-service teachers are traditionally trained in higher education (the first space) and school-based settings (the second space) so that theory and content can be complemented and reinforced with practical experience. This study reports on the use of a STEM studio (the third space) to raise teacher self-efficacy. Pre-service teachers act as STEM coaches to mentor high school students on an independent, STEM based project or inquiry. The results of a pilot study will be presented that suggests the efficacy of this approach as well as the plans for the follow up study to be conducted later this year.

Mageswary Karpudewan[1], Chong Keat Meng[2] & Chua Kah Heng[1]
[1]Universiti Sains Malaysia; [2]Methodist Secondary School (ACS) Kampar, Malaysia.

Modeling Science Related Attitude of Malaysian Lower Secondary Students

Wednesday, 11:35-12:15

This study attempted to model the science-related attitudes of Malaysian lower secondary students enrolled in national secondary schools. A positive science classroom and science laboratory learning environment is essential to foster positive attitude towards learning of science. Students' positive attitude is perceived important especially among the lower secondary students. This is because the attitude that they have cultivated will ultimately influence their decision to enroll in science related courses at the upper secondary and tertiary level. Science Attitude Model of these students is explained using Science Laboratory Environment (SLE), Science Classroom Learning Environment (SCLE) and Science Related Attitude (SRA). For this purpose data has been collected from 500 students (185 male students and 315 female students) between 14-15 years range. The data obtained has been analyzed using covariance-based structural equation modeling (CB-SEM) approach. The result shows that SRA is influenced by the school science laboratory learning environment and school science classroom learning environment. The findings imply that individual engaged more in science laboratory and science lessons in the classroom expressed more positive attitude towards learning science. The results suggest that the lower secondary school students should be provided with more positive science classroom as well as science laboratory learning environment that could ultimately promote positive attitude towards learning science. Positive attitude expected to improve students' performance as well as encourage more students to enroll in science related courses near future.

Leissa Kelly[1], John Cripps[1] & Kathleen Hayes[2]
[1]Deakin University, Melbourne, Victoria; [2]Australian National University, Canberra, ACT.

Scientists in class: The pedagogy of authenticity in science communication

Wednesday, 2:35-3:15

Bringing scientists and contemporary science into the experience of students is widely acknowledged as important but its use to teach science communication with tertiary students has not been investigated. In a bid to remedy this, the module 'Scientists in Seminar' was implemented in an undergraduate communicating science unit as part of the REMSTEP program which provided students with an opportunity to interact with scientists and communicate contemporary scientific research. This paper presents the results of this teaching innovation and describes how tertiary students responded to an authentic experience of science communication. Data was from focus group interviews with students and interviews with tutors revealed that students highly valued the scientists' visit but were less motivated by the follow on task where they created a resource to communicate the scientists' presentation to school students. The variation in engagement across the module stemmed from students' identity as current science students and future science professionals which affected the value they placed on participating in certain activities. These findings can guide future implementations of authentic experience in science communication teaching and provide insight into the role of identity in students' motivation.

Kai Ming Kiang
The Chinese University of Hong Kong

Improving the effectiveness of a science classics-reading course through the use of micro-modules

Thursday, 10:00-10:40

The Chinese University of Hong Kong has launched two compulsory classics-reading courses for all students since 2012. One of these courses, In Dialogue with Nature, requires students to read science-related classics in order to cultivate their scientific mindset. There are evidences that the course has been highly regarded by the students in general. However, students without science background have been reportedly encountering difficulty in studying this course even though the course objective is to teach only the method, characteristics and influence of science but not the actual scientific knowledge. A set of micro-modules was developed to supplement these students with concepts that are deemed to be fundamental to the understanding of the classics. This presentation reports the statistical analysis of the effectiveness of the course as well as the micro-modules by two measurement tools. First, students' self-reported perceptions on their achievements in the course were collected by the entry and exit surveys. Second, academic grades of the students were also utilized. The analysis shows strong signs of positive effects by the micro-modules to the actual users, the targeted groups of students, and the entire class. This finding suggests the importance of leveling students' background understanding when cultivating their scientific mindset.

Donna King & Lyn English
Queensland University of Technology, Brisbane, Queensland

Engineering Design In The Primary School: Applying Stem Concepts To Build An Optical Instrument

Wednesday, 2:35-3:15

Internationally there is a need for research that focuses on STEM (Science, Technology, Engineering and Mathematics) education to equip students with the skills needed for a rapidly changing future. One way to do this is through designing engineering activities that reflect real-world problems and contextualize students' learning of mathematics, science and technology concepts. This study examined the learning that occurred when fifth-grade students completed an optical engineering activity using an iterative engineering design model. Through a qualitative methodology using a case study design, we analysed multiple data sources including students' design sketches from eight focus groups in four classes. Three key findings emerged: first, the collaborative process of the first design sketch enabled students to apply core science, mathematics and technology concepts to model construction; second, during the construction stage students used experimentation for the positioning of lenses, mirrors and tubes resulting in a simpler "working" model than originally planned in the design sketch; and third, the redesign process enabled students to apply structural changes to their design that improved strength, weight, portability and visibility of the instrument. We found that the engineering design model was useful for structuring stages of engineering design.

Rekha Koul, Rachel Sheffield, Susan Blackley, Nicoleta Maynard & Rebecca Walker
Curtin University, Perth, Western Australia

***Makerspace in STEM* (MIS): Creating a Community of Practice** **Friday, 11:10-11:50**

The desire and perceived need for increased numbers of students opting for STEM (science, technology, engineering and mathematic) subjects in senior secondary and tertiary STEM-related courses have been a challenge for educators globally (Chubb, 2015). This project sought to engage interested female primary education students encouraging them to engage and identify with science and mathematics communities. The *Makerspace in STEM (MIS) Project* that will be reported on in this session, focuses on the engagement of female pre-service teachers (PSTs) and female engineering students (ESs) in developing a Community of Practice (CoP) that seamlessly transitioned from physical to virtual communication and learning spaces: Makerspace. The project considers the affordances and limitations of the STEM Makerspace to foster a CoP. This project also describes a new model of pre-service teacher learning: the *Reflective Identity Formation Model* (Sheffield & Blackley, 2015). The Makerspace CoP has shown to be an organic and dynamic means to encourage and support tertiary students to step into a community space in STEM education.
The presentation will focus on: (1) How did the academics and students (pre-service teachers and engineers) engage with and participate in the MIS project CoP? (2) How did the CoP support students to develop their STEM confidence and capability? (3) How did the CoP impact academics and students (pre-service teachers and engineers) in transforming their identity through their participation?

Hyung Kyu Ku[1], Hye-Eun Chu[2], Seung-urn Choe[1] & Sonya Martin[1]
[1]Seoul National University, Korea; [2]Macquarie University, Sydney, NSW

Examining teachers' perceptions and students' interest for arts-integrated STEM lessons in primary school classrooms in Australia and Korea.

Wednesday, 9:00-9:40

This presentation describes a cross-cultural, distance-learning project using an arts integrated STEAM (Science, Technology, Engineering, Arts and Mathematics) program.
The lessons in this STEAM program incorporated aspects of the 5E inquiry model and modeling process skills to engage elementary students in Australia and Korea to consider how the weather and seasons are influenced by the relative geographical location of students in each country. We share findings from a qualitative study of our implementation of four earth science related STEAM lessons with 2 teachers and 60 students in grades five and six in Australia and Korea (total 4 teachers, 120 students).
We highlight design components and describe the teachers' and students' STEAM learning experiences. Using excerpts from participant interviews and responses from open-ended questionnaires, we report how STEAM lessons impacted on students' science learning and on participants' perceptions about STEAM. We describe challenges and benefits of using an online platform to engage grades 3-5 students in asynchronous and synchronous learning opportunities to improve science learning while expanding awareness about cultural differences and similarities between Australians and Koreans. We conclude with implications for research on cross-cultural STEAM education activities and we discuss plans to develop STEAM related modeling strategies to enhance science learning.

Rod Lane
Macquarie University, Sydney, NSW

Improving the climate understandings of preservice teachers: an online learning approach

Friday, 11:10-11:50

Developing a deep and accurate understanding of key weather and climate processes is challenging for both teachers and students. This is a concern given current national efforts to build the mathematical and scientific literacy of Australian citizens. Tropical cyclones are an example of a complex system commonly misconceived by teachers and students. Many pre-service teachers believe that tropical cyclones can form anywhere around the Australian coastline, that they are responsible for tsunamis and that they increase in intensity as they move over the land. This paper describes the features of an online module designed to enhance pre-service teachers' depth of understanding of weather and climate processes. In particular, the module aims to promote constructive confusion and cognitive disequilibrium to address pre-service teachers' alternative conceptions. Also discussed are preliminary results from the piloting of the module.

Pin-Yin Liao[1], Chih-Ling Peng[2], Jian-Cheng Wu[3], Jian-Min Chen[4] & Chun-Yi Liu[5]
[1] National Taiwan Normal University; [2,3,4,5] Development Centre for Compilation and Translation, National Academy for Educational Research

Science news as possible influence on non-scientific ideas about earthquakes

Thursday, 10:00-10:40

Students learn about the causes and seismology of earthquakes from a multitude of sources. Tsai (2001) reported that Taiwan 6th grade students who received knowledge from the public media had more "myths" and "scientific/myths" worldviews. This study aims to investigate the misconceptions and false statements on earthquake reporting by the media in the past fifteen years in Taiwan. We used an archive of the China Times as our primary source on the media's reporting of earthquakes. The archive from the years 1999 to 2014 contains 2,230,225 texts. Four types were identified under these headings: (a) "Ancient mythical representation": This myth "The bull of the earth turns his body" was frequently used to describe the occurrence of earthquakes. (b) "Animals can predict earthquakes": This type of news also has been reported continuously. (c) "Incorrect reporting of the magnitude of an earthquake": The media, through its limited understanding of seismology, attempts to convey information to the audiences which turns out to be false. The average error rate was 10% per year. (d) "Disaster prophecy": This type of news did not occur regularly. 1999 and 2011 were the peak years of prophecy. The former was predicted by gods like Matsu that were spread by temples in the form of leaflets. The later was predicted by I Ching bloggers, in the form of internet dissemination, and extensive public media coverage. Strategies for teaching earthquakes and suggestions for media and science are proposed.

Pey-Yan Liou & Chen-Lung Wang
National Central University, Taiwan

A content analysis of PISA and TIMSS studies from 1996 to 2015: The nexus of ILSAs and Science Education

Wednesday, 4:20-5:00

This study aims to apply content analysis to examine the patterns of 64 empirical studies using the *Programme for International Student Assessment* (PISA) or the *Trends in International Mathematics and Science Study* (TIMSS) data published in science education journals listed in the Social Science Citation Index from 1996 to 2015. Five categories, including outcome variables, variable levels, research topics, target samples, and countries, were examined. Findings showed that achievement-related variables are the most investigated outcomes, and attitudinal variables are also examined ones in more than half of the studies. Student-level variables were utilized in almost all of the studies, and school-level variables were also used in more than one-third of the studies. The relationships between students' science achievement and variables at different levels are the most investigated issues. While the total surveyed student is as the target samples in many studies, specific student bodies, especially gender, are also investigated as the main samples in a few articles. The U.S. was the most investigated country, while East Asian countries, Taiwan and Hong Kong, were also the ones within the single country analysis.

Shu-Chiu Liu
National Chiao Tung University, Taiwan

Environmental education through documentaries: assessing learning outcomes of an introductory environmental studies course

POSTER

Film is a popular and potentially effective teaching tool to convey environmental issues and raise awareness. The use of film as supplementary materials in the classroom has become common for higher education teachers of environmental studies. It is, however, rare that film is incorporated as the primary instructional medium. This paper reports a case study on an environmental course where a series of popular documentaries were selected and used to engage students in exploring and reflecting on a wide range of locally significant environment issues. For the purpose of evaluating the course, we look at changes in students' environmental values, attitudes, and behavioural intention following the course, and perceived learning experiences and learning outcomes. Data were gathered from two classes through (a) a pre and post survey (n_A = 17; n_B = 17) using a Likert questionnaire, (b) follow-up interviews with a selective sample of students, and (3) students' course work. Preliminary results as well as the design and implementation of the course will be discussed in the paper.

Beverly Lowe-Dann
University of the Sunshine Coast, Queensland

A study of school and teacher responses following the launch of the new Australian Science Curriculum

Thursday, 3:20-4:00

This research investigated how three primary schools and their teachers prepared to implement a new national science curriculum. It demonstrated the importance of effective support from the government level to the local level to initiate major change, including the value of leadership and sustained effective professional development and school processes in order to achieve the new science curriculum standards and objectives.
Study methods included surveys, interviews, observations and field notes. All 52 teachers from the three case study schools were surveyed, while three teachers from each school provided an overall nine teacher studies in the nested case study design. They participated in semi-structured individual interviews of approximately 30 minutes, before and after the initial 10-week teaching period with the new Curriculum. They were also observed teaching two science lessons using field notes and recorded observations.
Results revealed varied implementation processes and practices in schools and in classrooms. However, highly effective practices included leadership involvement in change, appropriate and sustained professional development, and a school culture with capacity building routines.
This study was the first to investigate Science Curriculum implementation in regional schools in Queensland, Australia.

Jenny Martin
Australian Catholic University

Thank God You're Here! Learning to think like a science teacher

Wednesday, 9:45-10:25

The research addresses the problem in initial teacher education (ITE) that preservice teachers experience limited opportunities for risk taking. The capacity for risk taking is associated with developing expertise in making educational decisions, the cornerstone of effective teaching. Whilst this criticism is generally applicable to teaching rounds, where student teachers have been found to stay within their comfort zones with the view of passing a round rather than maximizing the opportunity for learning under mentorship, the criticism also applies to university-based learning experiences. The context of the research is a new 2-year Masters of Teaching course in Melbourne, Australia, in which preservice teachers do not have teaching rounds in their first semester. The presentation is concerned with the question: How can we reposition these ITE students to think like science teachers? The use of the comedy genre, Thank God You're Here was incorporated into the design of the university-based experience as an innovative measure for introducing risk. Significant repositioning of the preservice teachers was found as a result of being supported to take risks, make educational decisions and reflect upon the teaching-learning process in interaction and for planning. The research is of significance to researchers and teacher educators concerned with understanding and promoting preservice teacher agency.

Reeja Mathew, Mihye Won & David Treagust
Curtin University, Perth, Western Australia

To what extent is multiple representation-based teaching effective in producing scientific understanding?

Friday, 9:15-9:55

Recent studies on the importance of visualisation in education have led to the emergence of a teaching method using multiple representations (Ainsworth & Vanlabeke, 2004; Dori & Belcher, 2005; Larkin, 2014). According to cognitive flexibility theory (Spiro & Jehng, 1990), features of a concept are often lost when using a single representation, which can be overcome with the use of multiple representations. This study investigates the effect of multiple representations on students' understanding of high school physics concepts. In this study, the researcher used a variety of representations such as pictures, graphs, tables, demonstrations, equations, and online simulations. One topic of study was projectile motion for which students were encouraged to develop representations based on the underlying concept and then manipulate the basic motion equations to find the correct solution. Initial analysis showed that high achieving students benefitted with this teaching method with their post-test results showing considerable improvement. However, the same could not be said about the low achieving students who struggled with the format as well as their ability to choose the correct representation. Along with a discussion about the effectiveness of this teaching method, we will also discuss its effect on students' attitude and interest in science.

Ainsworth, S., & Vanlabeke, N. (2004). Multiple forms of dynamic representation. *Learning and Instruction*, 14(3), 241-255. doi:10.1016/j.learninstruc.2004.06.002

Dori, Y.J., & Belcher, J. (2005). Learning electromagnetism with visualizations and active learning. In J. K. Gilbert (Ed.), *Visualization in science education* (pp. 198-216). Dordrecht, Netherlands: Springer

Larkin, J. H. (2014). The role of problem representation in physics. In A. L. Stevens, & D. Gentner (Eds.), *Mental models* (pp. 75-98). New York: Psychology press.

Spiro, R. J., & Jehng, J. C. (1990). Cognitive flexibility and hypertext: theory and technology for the nonlinear and multidimensional traversal of complex subject matter. In D. Nix, & R. Spiro (Eds.), *Cognition, education, and multimedia: Explorations in high technology* (pp. 163-205). Hillsdale, NJ: Lawrence Erlbaum.

Felicity McLure[1&2], Mihye Won[2] & David Treagust[2]
[1]Brindabella Christian College, Canberra, ACT; [2]Curtin University, Perth, Western Australia

Implementing the Thinking Frames Approach in Years 8-10: A Teacher's Reflections

Wednesday, 12:20-1:00

The benefits of using constructivist teaching strategies are often discussed by educational researchers and impressed upon classroom teachers. However, in the science classroom, constructivist methods are often inconsistently implemented. The Thinking Frame Approach (TFA) (Newberry & Gilbert, 2011; Newberry, Gilbert, & Hardcastle, 2005) explicitly encourages students to develop their scientific ideas by producing their own diagrams as well as verbal and written explanations to improve learning and communication skills. As a Science teacher of Years 8-10, the first author developed lessons in a wide variety of topics based on the TFA in order to study its impact on students' conceptual understanding and written explanations. The impact of the TFA on her teaching included a greater appreciation of the benefits of teacher-constructed heterogeneous small groups; understanding of the

influence of students' alternative conceptions and the importance of challenging those conceptions; and an increased facility in allowing students time to construct explanations through argumentation and use of multiple representations. Reactions of other teachers and parents to the TFA will be discussed as well as challenges encountered, such as establishing effective small groups to support learning for all students.

Newberry, M., & Gilbert, J. K. (2011). The thinking frames approach. Retrieved 7/6/13, from http://www.azteachscience.co.uk/resources/continuing-professional-development/the-thinking-frames-approach.aspx

Newberry, M., Gilbert, J. K., & Hardcastle, D. (2005). Visualising progression through the science curriculum in order to raise standards. *School Science Review, 86*(316), 87-96.

Pannida Meela & Romklao Artdei
Khon Kaen University, Thailand

Fostering High School Students' Scientific Modeling through Model based Inquiry

POSTER

Model based inquiry is a lab-based strategy, which affords students the opportunity to develop scientific modelling. This study aimed to investigate the effect of model based inquiry on students' scientific modelling performance of solid, liquid, and gas, which is a significant content in high school science. The scientific modelling performance test was administered to 37 grade 11 students who studied in a chemistry class at a rural school in Thailand. All items of the test required them to express four elements of scientific modelling – drawing, core concept, representation, and labelling. Findings in this study present that the students significantly improved all components of scientific modelling. As a result, it could be concluded that model based inquiry could be served as an approach supporting students' scientific modelling performance.

Jacqueline Mendes & Maria Helena Carneiro
University of Brasilia, Brazil

Better understanding photosynthesis: the pedagogical role of schematic diagrams

Friday, 11:55-12:35

Schematic diagrams are relatively complex images frequently present in science textbooks. This study investigates the role of schematic diagrams in aiding undergraduate students *(n=8)* in achieving a better understanding of photosynthesis. The study was designed in two recorded and transcribed phases: individual interviews followed by a sequence of three lessons focusing on the teaching and learning process about photosynthesis. In both phases students were asked to read schematic diagrams related to photosynthesis. Concept maps were created to represent the concepts showed by the students. Results exposed that although students made use of a repertoire of concepts to explain the photosynthesis, they do not connect these concepts in a coherent way. This could be related to the fact that students are submitted to an excess of information, which does not allow them to build a meaningful learning of the concepts. The main reasons identified to explain the difficulties students

present while reading schematic diagrams points to students` alternative conceptions on photosynthesis, indicating a lack of in-depth knowledge regarding the information carried by the diagrams as well as the way the information is presented. Despite the difficulties, schematic diagrams allowed students to organize their ideas for a better comprehension of the photosynthesis.

Michael Michie
Batchelor Institute for Indigenous Tertiary Education, Batchelor, Northern Territory

A comparison of the Indonesian Kurikulum 2013 with the Australian Curriculum, focusing on science for junior secondary schools.

Thursday, 2:35-3:15

The introduction of a new curriculum in Indonesian schools seeks to bring about changes in Indonesian society as well as the students' knowledge base. The curriculum is based on two layers of competencies – Core Competencies and Basic Competencies. Core Competencies are applicable at all class levels and for all subjects. They include religious and social attitudes as well as knowledge, skills and the application of knowledge.
The science curriculum for junior high school is promoted as *integrative science*, and some of the basic competencies demonstrate a cross-curriculum approach more successfully than others. This approach is considered partly as a response to Indonesian students' poor performance in international testing such as PISA and TIMMS.
Comparison with the Australian Curriculum: Science reveals a number of similarities as well as differences. Content is similar, as are key ideas and skills, and each curriculum has its approach to assessing achievement. Sustainability is a major cross-curriculum feature of both curricula.
The introduction of Kurikulum 2013 has not been without controversy. The new minister has stepped in to allow schools to use the previous curriculum while Kurikulum 2013 undergoes further trialling.

Reece Mills, Louisa Tomas & Brian Lewthwaite
James Cook University, Townsville, Queensland

A Cautionary Tale Of Using Slowmation With School-Aged Learners

Thursday, 11:05-11:45

Existing studies that have investigated the efficacy of slowmation construction as a conceptual change strategy strongly advocate for its use in teacher education courses, and recommend extending its application to school-aged learners. Given that very limited empirical research has explored this possibility, the current study responds to this gap in the literature by investigating how creating a slowmation influences Year 9 science students' conceptual development. Notwithstanding the well-documented merits of using slowmation with pre-service teachers, significant pedagogical implications arose from implementing this instructional approach in a junior secondary school context. In this qualitative case study, the analysis of audio data generated during the construction process revealed that opportunities for conceptual development were inhibited by: (1) students' preoccupation with the procedural aspects of constructing a slowmation; (2) time constraints; (3) students' apparent lack of motivation to understand the science content and represent it accurately; and (4)

students privileging and bypassing modes of representation. On one occasion, the teacher's epistemological perspective of constructivist learning impeded an opportunity for conceptual development, which warrants further investigation. Pedagogical implications for using slowmation with school-aged learners are also discussed.

Shiho Miyake
Kobe College, Japan

Zoo Visitors' Evaluation on a College Students' Environmental-Themed Picture Book and its Story-Telling Activity **POSTER**

Children and adults alike can learn scientific literacy at Zoos. In this regards, the author has developed an environmental education picture book titled 'A Tale of the Elephant Named Rani-Hiroko in the Osaka Zoo' with college students aged 20-22. Although they are not professionals in animal ecology, they have learned the sociological importance of sharing environmental values and awareness that leads to the cultivation of global citizenship. This paper reports the results of the audience's evaluation points based on their open feedback after the students had conducted a story-telling activity at the zoo. Among the audience, 26 respondents answered the feedback queries, and their descriptions were categorized according to the aspects in the picture book and the story-telling activity. As a result, there are three areas that interest the audience. They are (a) response: acknowledgement, criticism, and understanding, (b) target: a general environmental issue, the elephant named Rani-Hiroko plus the student-actors, and (c) means of communication: pictures, words, voice volume, intonation and behaviour. This signifies that the audiences were concerned with various focuses from content to delivery. Their comprehensive evaluative feedback would contribute to the improvement of communicative activities endeavoured by non-professionals in informal educational settings.

Ali Hassan Najmi
Monash University, Melbourne, Victoria

Developing a Pedagogical Framework for Information and Communication Technology Usage that Transforms the Saudi Arabian Science Teaching.

Thursday, 3:20-4:00

This study explores the introduction of ICT into eight Saudi Arabian science classrooms to determine its impact on the prevailing teacher-centred and traditional transmissive teaching approaches. It was revealed, through interviews and classroom observations that by selective use of ICT in science classrooms, teachers became more student-centred in terms of their selected pedagogies and ICT used. This is significant because culturally, Saudi Arabian classrooms are commonly teacher-centred. The findings indicated that effective and successful use of ICT in science classrooms is unlikely to be achieved if ICT was used in traditional ways as a delivery tool for lessons as ICT should engage students in learning, knowledge construction and collaboration. This study also concluded by proposing an integrating pedagogical framework that illustrate effective use of ICT in science classes. This pedagogical framework may be of use to teachers who are required to integrate ICT into their teaching practices.

Hayashi Nakayama[1] & Tomokazu Yamamoto[2]
[1]University of Miyazaki, Japan; [2]Hyogo University of Teacher Education, Japan

A Case Study of Improving Students' Views of Science Lessons through Science Lesson Study Activities in a Pre-service Teacher Training Course

POSTER

We continuously try to improve students' views of science lessons through science lesson study activities in a pre-service teacher training course. This research identifies the effectiveness of repeated trial science lessons and their immediate assessment by students of the teacher training course. We assessed this trial by comparing students' written answers at the beginning and end of the course. During the course, five trial science lessons were conducted in a primary school as well as three additional introductory lessons. Immediately after each trial lesson, students assessed it by completing a questionnaire with 14 items. After the trial lessons, more students used the words "idea", "interest", "question", "problem", "concern", "knowledge", "opinion", "persuade", and "context" than before; contrarily, "experiment", "safety", "motivation", and "observation" were used less than before. A series of trial science lessons might make students focus more on the cognitive than the emotional aspect as well as the activity itself. Thus, we think that our work is effective.

Wan Ng & Jennifer Fergusson
University of Technology, Sydney, NSW

Partnership Initiative to Enhance Secondary Students' Interest in Science: Teachers' Perspective

Thursday, 1:50-2:30

In Australia, the issue of student disengagement in school science continues to pose a threat to lifting the participation rates of students undertaking STEM courses and careers. Research into a recent federally-funded science partnership initiative to address this is reported in this paper. The partnership was between secondary science teachers, scientists, a teacher educator and an educational technology company to produce science e-modules on adaptive, personalised learning platforms, enabling students to engage in inquiry-based investigations of real world problems. One of the aims of the partnership project was to build theoretical and new pedagogical skills in teachers to deliver science. Using a mixed-method approach, the research investigated science teachers' pedagogical involvement and their perceptions of the project's impact on their teaching and students' learning. The findings indicate that the teachers believed that new technology could motivate and enhance students' learning. Their pedagogical effectiveness depended on their ability to internalise the new technological and content knowledge resulting from the partnership and realign them with their existing pedagogical framework. The research is significant in facilitating continuous discourse about new evidence-based pedagogical approaches to engaging students to learn STEM subjects in a 21st century digitally-connected future that is focused on personalise learning.

Andy Ka-Leung Ng, Derek Hang-Cheong Cheung and Henry Hin-Yan Chan
The Chinese University of Hong Kong

Effects of prior science knowledge on learning outcome enhancement in a science general education course

Wednesday, 10:50-11:30

In The Chinese University of Hong Kong, it is compulsory for all students to take a general education foundation course 'In Dialogue with Nature' that requires them to read science-related classics and engage in discussion on perennial issues. A concern is that students who have not taken any science subjects in high school might not benefit from the course. To examine the influence of prior science knowledge on the effectiveness of the course, entry-exit surveys were developed to collect students' perception on their learning outcome enhancement. Students were asked to rate in a six-point Likert scale on a set of learning outcomes-related statements at the beginning and at the end of the course. Students, regardless of their science background, reported a statistical significant increment in all statements related to course-specific learning outcomes between the two surveys. Besides, students without prior science knowledge even have a significantly greater increment in most statements when compared to those with prior knowledge. For statements concerning generic skills, students reported a statistical significant increment between the two surveys but no statistical significant group differences in the degree of increment is observed. The study affirms that the course could help all students achieve the learning outcomes.

Dianne Nichols
Education Queensland

Assessment of teacher professional development as a change agent for the mining and mineral processing industries.

Thursday, 10:00-10:40

This research study examines a variety of science educators who attended professional development programs about the mining and mineral processing industries. The research study investigated the science educators' ability to apply their content knowledge of the applied science associated with the mining and mineral processing industries to the curriculum documents and in doing so whether they had a change in attitude about the mineral and mining process industries. A mixed method approach was used to collect primary data. This included qualitative data collected using the feedback survey that then informed the next step of data collection, being the clarification tool. This data collection tool comprised of follow-questions, interviews and documentation of science educators as they wrote the teaching resource.
The primary data collected form the science educators who attended the professional development programs showed that the science educators were able to report a change in their content knowledge of the mining and mineral processing industries. Further, they were able to apply their knowledge of the mining and mineral processing industries to the science curriculum documents and they reported a change in their attitude towards the mining and mineral processing industries. The science educators were also able to form professional networks with researchers and scientists working in the mining and mineral processing industries for the duration of the program. However, when the professional development program concluded, the professional partnerships that had been established during the program did not continue.

Wendy Nielsen, Helen Georgiou & Pauline Jones
University of Wollongong, NSW

Research in student-generated digital media: Multimodal methods in science

Wednesday, 9:45-10:25

Research into teaching and learning when science students generate multimodal texts is promising yet in its infancy: Preservice primary teachers develop content knowledge when making a slowmation as an explanation for children (Hoban & Nielsen, 2010; Nielsen & Hoban, 2015); university science students engage with content in novel ways when creating a digital explanation, for example, musical explanations in biochemistry (Vanderlelie, 2016) or worked examples in electrical engineering (Belski & Belski, 2016). How science students make meaning through these creations is the focus of our on-going interdisciplinary research. In this paper, we discuss approaches to researching meaning making in constructing digital multimodal texts. Modes are semiotic resources (Jewitt, 2014; Kress, 2014) and may include text, image, moving images, sound and hypertext, among others. Capturing what students do and think as they create digital explanations presents interesting methodological challenges. We use case study methods (Stake, 1995; Yin, 2014) with audio and video to capture groups of students creating a digital explanation. Promising new analytic tools are being developed from systemic functional linguistics (Halliday, 1976; Jones & Macken-Horarik, 2014) and Legitimation Code Theory (Maton, 2015). These analytic tools offer new insight into how learners make meaning while generating multimodal digital explanations.

Kathryn Paige, David Lloyd & Richard Smith
University of South Australia, Adelaide

Eco justice, critical pedagogy and Science Teacher Education.

Thursday, 9:15-9:55

Beyond economic rationalism places environment within our eco systems and towards developing a sense of belonging and a sense of place. How do you develop empathy and understanding for other species, understanding fairness within generations and fairness between generations? Having empathy for the eco systems which we are members is an integral part and is essential for our personal, social and environmental well being (Louv, 2011). We are seeing eco justice as an essential part of our world view and a prerequisite for keeping a healthy environment, including community and personal physical and mental health. Ecojustice seeks to preserve and, where appropriate, enhance ecological well-being and the integrity of the ecological commons - the 'properties' of the Earth that sustain all life, including human life, properties called 'ecosystem services' (Costanza, 2012) or 'the larger systems of life that we depend upon' (Martusewicz, Lupinacci,, and Schnakenberg, 2010: 11). Hodson (2003) says that "there is increasing recognition of the need for science education to look at the wider social, political, economic and ethical issues that surround the practice of science", and an informed eco-justice education which of its nature requires an understanding of the natural world, can identify wider issues. It is about connecting to life worlds, and using socially just and critical pedagogies such as thoughtful activity that is creative, emotional or practical, and is intellectually demanding, connected and working with difference (Lingard & Keddie, 2013). The notion of 'slow pedagogy' raised by Payne and Wattchow (2009 cited in Warkentin, 2011: 227) 'allows us to pause or dwell in spaces for more than fleeting moments and therefore encourages us to attach to and receive meaning

from that place'. It supports connections to place through experiential learning. Using literature and personal and professional autobiographies of three science teacher educators a set of sustainability educational practices and principles that have been the basis of primary/middle science courses have emerged over the last two decades (Paige, Smith & Lloyd, 2016). The emergent principles in a socially critical science educational context form the basis of the paper.

Costanza, R. (2012), "Ecosystem health and ecological engineering", *Ecological Engineering*, Vol. 45, pp. 24- 29.
Hodson, D. (2003). Time for action: Science education for an alternative future. *International Journal of Science Education, 25*, 645-670.
Lingard, B & Keddie,A (2013) Redistribution, recognition and representation: working against pedagogies of indifference : *Pedagogy, Culture & Society*, 2013, Vol.21(3), p.427-447
Louv, R. (2011) *The Nature Principle: Human Restoration and the End of Nature-Deficit Disorder*, Algonquin Books
Martusewicz, R., Lupinacci, J., and Schnakenberg, G. (2010), "EcoJustice education for science educators", in Mueller, M. (Ed.), *Cultural Studies and Environmentalism*, Springer, New York, pp.11-27.

Tracey-Ann Palmer, Peter Aubusson & Paul Burke
University of Technology, Sydney, NSW

Boys and girls choosing and rejecting science: Same, same, but different.

Wednesday, 9:45-10:25

Australia's future prosperity needs a supply of scientists and scientifically literate individuals with the choice of science at school being a critical step on the path to fulfilling these needs. Gender-based preferences for some science subjects have been cited as an important factor affecting choice of science at school. A Best Worst Scaling survey was used to measure the relative importance of 21 factors that male and female students consider when choosing and rejecting subjects. Results from 333 students suggest that male and female students choose and reject subjects in a very similar manner but there are differences in the degree of importance students placed on some factors. Girls considered their interest, enjoyment, past ability and type of classwork as being relatively more important than boys did when choosing subjects. Girls considered their past ability and difficulty of a subject as more important than boys did when rejecting subjects. This research indicates that girls may be more inclined than boys to consider how much they enjoy and can succeed in a subject when choosing subjects which may have negative implications for science choice as science subjects can be perceived as boring and difficult.

Dave Palmer
University of Newcastle, NSW

Achievement emotions and action tendencies in naturalistic education settings

Wednesday, 4:20-5:00

When one has an emotional experience, it is often accompanied by an action tendency, which is a feeling of wanting to immediately enact a behaviour. For example, the emotion of boredom can create a feeling of wanting to escape. Research on motivation for learning has established the importance of achievement emotions, but the role of action tendencies is not known. The purpose of this study was to investigate whether students in normal lessons might experience an action tendency for learning, or in other words, a felt state of wanting-to-learn. The participants were a stratified sample of 52 Australian grade 10 students, each of whom was individually interviewed immediately following a normal lesson. The ten students who were in science lessons will be used to illustrate the main trends. It was found that a valenced and dynamic state of action tendency for learning occurred throughout the lesson, and this pattern was pervasive among the students. The main precursors were positive or negative emotions that were anticipated or experienced during the lesson. It was concluded that the construct of an action tendency for learning can be a useful way to analyse the influence of emotions in science lessons.

William Palmer
Curtin University, Perth, Western Australia

***Elements of chemistry*: the books and their authors (1900-2010)**

Thursday, 11:50-12:30

This is the fifth and final paper in the series '*Elements of chemistry*: the books and their authors'. The first paper (ASERA, 2012) covered the period 1700-1820; the second paper (ASERA, 2013) covered the period 1820-1850; the third paper (ASERA, 2014) covered the period 1840-1870 with some overlap; and the fourth paper in the series (ASERA, 2015) and covered the period from 1860 to 1900. The title, *Elements of chemistry* or *The elements of chemistry*, is a very common and very ancient title for chemistry textbooks, yet it is still used currently. Following the books with this title will demonstrate how different textbook authors tackled writing chemistry textbooks at different times, at different academic levels and in different countries. The opportunity will also be taken to provide some aspects of the life histories of the authors of the books, thus placing the texts within an historical context. More than a hundred and forty books were found with the title *Elements of chemistry* between 1700 and 2010; about thirty of these will be chosen to illustrate the history of the chemistry textbook and the lives of their authors in the period 1900 to 2010.

David Paterson
Cashmere High School, New Zealand & Curtin University, Perth, Western Australia

Strategies for teaching Nature of Science and improving student engagement

Wednesday, 1:50-2:30

Including Nature Of Science (NOS) has been a feature of recent curriculum development in many countries, with the intention of making science more relevant to students, thereby improving their engagement and retention into senior science subjects.
These issues have been examined over the last six years in a large New Zealand (NZ) secondary school in a mixed methods case study using interviews with students and teachers along with lesson observations and TOSRA (Test of Science-Related Attitudes) surveys.
The primary research question of the study was: How effective is the NOS strand in the NZ science curriculum in terms of engaging Year 9 students in a school science programme?
A key finding of the research has been that teachers support the teaching of NOS. However, they need clear strategies that work in the classroom. A selection of teaching strategies identified in the study that have been found to both successfully deliver NOS and improve engagement will be presented. Practical steps that can help teachers deliver NOS will also be discussed.

Sean Perera
Australian National University, Canberra, ACT

Science communicators in the classroom: An exercise to bridge science communication and science education

Thursday, 8:30-9:10

The present study describes a participatory science communication programme for university science undergraduates to contribute to and be influenced by high school-based science education experiences. This paper presentation outlines the experiences of twenty-two ANU science undergraduates who undertook science communication school internship placements in three Canberra high schools, where they contributed to science teaching content, facilitated group learning, mentored projects and offered positive role modelling in order to inspire secondary school students about post-compulsory science education. Through these experiences, the science undergraduates received a real-world setting to apply science communication knowledge and skills learnt at university, learn first-hand about best practices in secondary science pedagogy and, importantly, evaluate personal career choices about secondary science teaching. Underpinning the above experiences were phenomenological and collaborative reflections by the science undergraduates that examined their attitudes and perceptions to science education through a science communication lens.

Lam Hoang Pham & Peter Hubber
Deakin University, Melbourne, Victoria

Representational issues in senior school students learning solution chemistry

Wednesday, 11:35-12:15

Various studies have recently found that when school students were assisted to construct their own representations (graphs, models, images), their learning of science improved (Tytler & Prain, 2010). My PhD research aims to explore how senior school students' construct their own representations impacts their conceptual learning and problem solving skills in solution chemistry.

This presentation critically reviews theoretical frameworks underpinning the representation construction approach (RCA). The presentation also provides a critical analysis of traditional approaches used in teaching and learning solution chemistry (e.g. the molar concentration concept); and explores how RCA is different from traditional use of models in chemistry education. The presentation will describe how the RCA can be used in the research to develop teaching and learning sequences in solution chemistry, utilizing multi modal representation construction and negotiation.

In brief, the chemistry triplet model (Johnstone, 1993) and the representation construction affordances framework (Prain & Tytler, 2012) will be employed as the principal frameworks. Design-based research is used as the research paradigm and ethnographic methodology as the main method. The research will use mixed data generation sources through two phases of the study, including pre- and post-tests and video capture of student collaborative reasoning and learning.

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Prain, V., & Tytler, R. (2012). Learning through constructing representations in science : a framework of representational construction affordances. *International Journal of Science Education*, 34(17), 2751-2773.

Tytler, R., & Prain, V. (2010). A framework for re-thinking learning in science from recent cognitive science perspectives. *International Journal of Science Education*, 32(15), 2055–2078.

Kimberley Pressick-Kilborn, Wan Ng, Tracey-Ann Palmer, Peter Aubusson, Sandy Schuck & Paul Burke
University of Technology, Sydney, NSW

Enablers and barriers to effective primary science and technology teaching

Wednesday, 3:35-4:15

A project on effective science and technology teaching in primary schools was recently implemented. This presentation discusses the case studies that were conducted with six primary teachers to illustrate different ways of planning, implementing and evaluating effective Science and Technology teaching and learning. The studies used a participatory approach and formed one stage of a broader study. The participant teachers were nominated by their respective principals as 'good' practitioners. Over one term, data were gathered from them through a range of methods, including interviews with the teachers, lesson observations, document analysis (including of student work samples), and written reflections from teachers

and students. In this paper, we report research findings on perceived enablers and barriers that impact upon effective teaching. Whether the teachers were generalists or specialists, the emphasis on student inquiry, engagement of students in negotiating the focus of study, and strong content knowledge characterised effective teaching. Support from school leadership and openness to continued professional learning were evident in each case. Different approaches to connecting with community, cross-curricular projects, and variation in organisation and utilisation of specialised and everyday materials and equipment, will be discussed in this paper as strategies that teachers can adopt to overcome common barriers.

Christine Preston
University of Sydney, NSW

But there's more! Further insights into diagrams effects on primary students' understanding about electric circuits

Wednesday, 4:20-5:00

This paper reports on further analysis of the understanding primary students' conveyed about electric circuits from reading a science diagram. Electric circuits are a component of the Australian curriculum: Science for primary students in year 6. Diagrammatic representations of electric circuits are used for teaching and assessment despite absence of research on pedagogical effectiveness with young learners. Individual interviews were used to closely analyse Year 3 and 5 (8–9 and 10–11 year-old) students' explanations about electric circuits. Data was collected from 20 students from the same school providing pre, post and delayed post-test dialogue. Students' thinking about electric circuits and changes in their explanations provide insights into diagram reading skills and resultant understanding of science concepts. Findings indicate the diagram positively enhanced understanding and promoted a scientific model of electric circuits challenging alternative conceptions about electricity flow. This study revealed differences in students' explanations about electric circuits were affected by their prior knowledge, meta-conceptual awareness and a particular feature of the diagram used. A significant implication for teachers of the findings is the usefulness of electric circuit diagrams as a diagnostic tool for informing instruction.

Christine Preston & Laura Monk
University of Sydney, NSW

The influence of toys on early primary students' conceptions about sound

Wednesday, 1:50-2:30

Toys are an integral part of children's every day, early learning experiences. Scant research exists involving the use of toys as teaching aids in science. This paper reports a project designed to investigate early primary students' conceptions about sound and the effect of a music toy on their understandings about sound. The qualitative research design comprised individual, semi-structured interview with five Year Two children from a large non-government primary school in Sydney. Data was collected using the think-aloud technique and children's drawings, capturing students' initial ideas about sound and any differences due to exposure to and interaction with a music toy. The findings indicate that use of the toy assisted children to demonstrate some advances in their scientific conceptions about sound.

Toys can support children's developing understandings of this mandatory content from the Australian curriculum: Science. The study has implications for teachers through the use of toys to strengthen early primary students' conceptual understandings in science topics.

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[1]Weill Cornell Medicine, Qatar & Curtin University; [2]Curtin University, Perth, WA

Qatari students' perceptions of their process-oriented guided inquiry learning (POGIL) environment

Thursday, 11:05-11:45

The study relates to year 10 science students' perceptions of a culturally relevant POGIL (Process Oriented Guided Inquiry Learning) intervention undertaken at two Arabic independent boys' schools in Qatar. Over a hundred students and four chemistry teachers who participated in this study used POGIL materials according to the curriculum standards of the Ministry of Education in Qatar. The What Is Happening In this Classroom? (WIHIC) questionnaire was administrated to experimental *POGIL classes* and comparison *Non-POGIL classes* to assess students' perceptions of their learning environment. The mean scores for the subscales of WIHIC are generally higher for POGIL classes as compared to Non-POGIL classes, indicating students' positive perceptions of inquiry-based chemistry learning. Significant correlations also existed between student cohesiveness, cooperation, teacher support, equity, and enjoyment of chemistry lessons indicating the congruence of POGIL pedagogical practice in the Qatari context. This research provides an in-depth understanding of implementing western pedagogical practice like POGIL in a high-context culture like Qatar at secondary and college level chemistry courses.

Léonie Rennie[1] & Christine Howitt[2]
[1]Curtin University, Perth; [2]The University of Western Australia, Perth.

Developing and Field-Testing a Framework to Describe Young Children's Interactions with Science Exhibits

Wednesday, 11:35-12:15

As part of the *Small Steps in Science* project (ARC-funded LP110200756) that aimed to explore children's interactions with a science centre's Early Childhood Outreach exhibits, a framework was needed to describe and categorise those interactions. Specifically, two questions needed to be answered.

- What kinds of learning or other behaviours do young children engage in with the outreach exhibits?
- How effective are the exhibits in promoting learning behaviour in young children?

We required a framework that could describe the quality of behaviour, not simply the length of engagement, so it had to include behaviours indicative of cognitive, affective, psychomotor, and social learning. The framework also needed to be generic, applicable to the wide range of exhibits available in a hands-on science program, as well as other kinds of behaviour young children are inclined to invent that are unrelated to the intention of the exhibits. We developed a framework based on the separate works of Chantal Barriault (for

epistemic behaviour) and Corrine Hutt (for ludic behaviour). The Children's Learning Behaviour Framework was field-tested with children under 5 years of age on two very different exhibits during an Outreach visit to a playgroup prior to its successful use in the main research study.

Joël Rioux[1], Bronwyn Ewing[2] & Tom Cooper[2]
[1]Batchelor Institute of Indigenous Tertiary Education, Darwin, Northern Territory; [2]Queensland University of Technology, Brisbane, Queensland

Embedding aboriginal perspectives and knowledge in the biology curriculum: the little porky

Wednesday, 9:00-9:40

This paper reports on an Action Research project that examined the integration of Aboriginal and Western science knowledge into science learning in a Montessori classroom. It drew on the local knowledges of fauna of community members. It explored the teaching of science to twelve Year 8-9 students in an Aboriginal independent high school (Bolinga High School, BHS) in Queensland. The study covered eighty-three (83) lessons that included an initial echidna study. The study applied thematic analysis to data to explore the effect of this integrated approach on students' pride in heritage, cultural knowledge, learning and the Linnaean zoology taxonomy. Results revealed that the contextualisation of Aboriginal and Western science knowledge strengthened students' Aboriginal personal identity as well as identities as science learners and status of local Aboriginal knowledge.

Sandy Robbins
New Zealand Council for Educational Research

Gathering snapshot data about students' perceptions of their science learning.

Wednesday, 2:35-3:15

The link between engagement and learning is well documented. But how do we know what motivates our students? How can we design engaging opportunities to learn if we don't find out?
Two new surveys that capture student perceptions of, and interest in, their science learning have recently been created by NZCER.
These surveys aim to give schools information about their students' engagement with science and their perceptions of the learning opportunities that have been provided for them. We hope the survey will give teachers the inspiration they need to build a science programme that is responsive to student's interests and needs. The questions are designed to focus teachers on building student capability in science and the survey deliberately provides ideas for experiences and contexts that teachers can use in their programme planning.
Since 2015 over 12,000 students have completed either the year 0-4 or the year 5-10 survey. We are beginning to see some interesting patterns emerging in student responses.
This presentation describes the surveys we have created, selects some interesting trends, and asks questions about how the the data we have collected can be used to enhance teacher expertise in science education.

Emily Rochette
The University of Melbourne, Victoria

A case for the importance of geoscience education

Friday, 9:15-9:55

Lewis and Baker (2010) have suggested building a new research agenda that addresses challenges to Geoscience education. The aim of this paper is to inspire discussion regarding the importance of and possibilities for teaching and researching Geoscience education in the secondary Science classroom. Geoscience is the study of the solid and fluid components of the Earth (King, 2008; Trend, 2005). Internationally, it is becoming increasingly prominent in schools (King, 2008, 2013, 2015) yet continues to occupy a low status among the sciences (Lewis, 2008). This paper explores some of the contentious issues surrounding Geoscience education and reviews various teaching approaches available to educators as presented in the literature.

Saima Salehjee & Mike Watts
Brunel University, London, UK

'Being sciencey': Science identity, inherent inclination and social influence.

Wednesday, 1:50-2:30

An analysis of 123 online questionnaire responses with Brunel university-based STEM and non-STEM students, illustrating their education and career choices after the age of compulsory STEM education in schools. The research argument and analysis is undertaken in the light of previous literature on inherent 'personal proclivities' towards studying science and students' 'science identity'. We have adopted a descriptive data analysis to find out noticeable categories and further utilized narrative approach to compare and contrast the 12 purposively selected stories of STEM and non-STEM university students. Discussion of the results stress on three main categories which includes smooth transition into and out of science, wavering or fluid transition and transformative transition. This case study concludes that inherent inclinations and the self-perceptions of career choices relating to post-secondary subject choices plays a much powerful role in shaping individual science or non-science identity as compared to social influences like parents, peers or teachers.

Manjula Sharma[1], Scott Kable[2] & Alexander Yeung[3]
[1]University of Sydney; [2]University of New South Wales; [3]Curtin University

ASELL Schools: Using science investigations to guide teachers' implementation of inquiry-based teaching in their classrooms

Wednesday, 3:35-4:15

In the current context of intensive scrutiny of science teaching in schools, and several rounds of funding to support this endeavour, partnerships between diverse stakeholders have been forged. ASELL Schools, funded through AMSPP, is one such partnership between scientists, engineers and science educators across Australia. ASELL Schools utilises expertise from the

partnership to create context specific professional learning environments to guide teachers' implementation of inquiry based science teaching with the objective of influencing teachers' professional practices. In this presentation, we report on two research questions:

- What are teachers' reflections on the various aspects of the professional learning context?
- What do teachers say they will take to their practice?

Data in the form of reflections and surveys from 6 workshops with 100 teacher participants has been analysed. Our findings indicate that teachers face particular challenges in implementing inquiry. While teachers are knowledgeable about inquiry based teaching, strategically deciding 'when and how' to implement inquiry with the explicit intent to meet their student needs within the local context is not a trivial task. Hence inquiry in the classroom has many faces which often mask the effectiveness of inquiry espoused in research. The ASELL Schools professional learning environment aids in filling this gap.

Yen-Hung Shen, Pin-Yin Liao & Wen-Gin Yang

National Taiwan Normal University, Taiwan

The Identification of Specific Difficulties with the Logical Semantic Meanings of "or" in Science among Senior High School Students and College Students: A comparison of English and Mandarin

Wednesday, 3:35-4:15

The study is a cross-linguistic investigation of both senior high school and college students' interpretation of logical connective "or" (English *or*, Mandarin *huo*) in sentences selected from "Conceptual Physics." We prepared 9 test items (7 Eng-or translated to Man-huo, and 2 Eng-and translated to Man-huo) to explore 73 senior high school students' and 50 college students' comprehension of logical semantic meanings of "or/huo." After using repertory grid analysis, we identified at least four different semantic dimensions with five meanings (inclusive-, exclusive-, both-, identical-, and whole-or) were distinguished. Moreover, on the basis of the result of the paired–samples t-test, in Eng-or translated to Man-huo items, we found that subjects' stronger tendency to assign more than one meaning to Man-huo than Eng-or sentence. Likewise, in Eng-and translated to Man-huo items, we found there are more tolerance of ambiguity in Man-huo than Eng-and. Strategies and suggestions for teaching logical connectives and topics for further investigations are proposed.

Dorothy Smith[1], Richard Gunstone[2] & Pamela Mulhall[2]
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Articulate Science: openness and open-mindedness in relationships between scientists and society.

Wednesday, 9:00-9:40

We report broad outcomes of a research project that discovered and documented the variety of ways in which Australian research scientists interacted with their communities, in order to provide a variety of fresh approaches to educating future scientists. A key goal of the research was to explore the extent to which scientists whose work brought them into contact with the community might be said to have adopted a post-patrimonial stance when dealing with

members of the public. Our participants regarded the development of productive relationships between scientists and their communities as an essential facet of their work. They spoke of the need to be open to the views and the values of the people with whom they interact and many expressed views indicative of a stance that acknowledged non-scientists as partners in a two-way conversation. We explore the extent to which such a stance might be said to indicate a post-patrimonial relationship between scientists and society.

Kathy Smith
Monash University, Melbourne, Victoria

Positioning teachers as self-directed learners – the challenge of passive disconnection

Wednesday, 12:20-1:00

This study conceptualized professional learning as what professionals do and as a result learn about their own knowledge of practice and therefore assumed that such learning must be situated as an individual experience. To this end, research was undertaken to strategize the conditions that position teachers as self-directed learners within a professional learning program. The program involved eleven science teachers and aimed to build teacher capacity to become an effective school-based leader in science education. Data analysis suggested that being a self-directed learner relied on supportive learning experiences and also upon a willingness of the learner; to 'buy into a new role'. Some teachers actively utilised the range of learning experiences and made active decisions about their learning, others struggled to find direction and, in particular, how to please the facilitator by delivering a product that might be viewed as successful. For these teachers a sense of uncertainty prevailed, producing two main challenges: teachers sometimes demonstrated a passive disconnection with learning experiences; and, also an unwillingness to completely recognise and take ownership of their own professional expertise. These challenges appeared to be connected. This paper will explore 'passive disconnection' and the challenge this disposition present for teacher professional learning.

Enny Susiyawati, David Treagust & Mihye Won

Curtin University, Perth, Western Australia

Difficulties in learning plant anatomy: A study of undergraduates' interpretations of leaf photographs

Wednesday, 10:50-11:30

The interpretation of visual representations is at the heart of learning plant anatomy. However, how successfully do biology undergraduates accomplish this task? This study investigated how biology students interpret visual representations using the CRM model suggested by Schönborn and Anderson (2009). About 80 second-year university biology students participated in this study. The data from observations, a diagnostic test, semi-structured interviews, and document reviews were collected and triangulated. It was found

that the majority of biology undergraduates experienced difficulty in interpreting the plant anatomy photographs. This interpretation difficulty was primarily caused by their limited ability to transfer and integrate the knowledge that they had learned. This finding suggests that teachers and university lecturers need to actively support the development of students' interpretive skills of plant anatomy representations.

Carrie Swanson
Waikato University, New Zealand

"We had first hand experiences": Shifting conceptual understandings through the drama-based inquiry approach Mantle of the Expert

Thursday, 2:35-3:15

This paper examines the use of the drama-based inquiry pedagogy Mantle of the Expert (Heathcote & Bolton, 1995) to shift students' conceptual understandings of buoyancy and stability. It is widely acknowledged that shifting students' conceptual understandings to those closer to the scientific norm is difficult and takes time. Buoyancy is recognised as a difficult concept for Year 7/8 students to understand.

The year 7/8 students in this study were positioned as 'expert' scientists re-investigating the science behind the sinking of the Wahine, a major maritime disaster in NZ in 1968. Data generated from the pre and post-unit assessments, dialogue from four sign-posted classroom episodes, student and teacher interviews and classroom artefacts will be used to explore shifts in students' conceptual understandings over the duration of the study. Findings indicate that the Mantle of the Expert approach, which included both drama and hands-on experiments, has many of the characteristics noted in the literature as advantageous for conceptual change. Findings indicate it would be a valuable addition to teachers' pedagogical repertoires.

Heathcote, D., & Bolton, G. (1995). *Drama for learning: Dorothy Heathcote's mantle of the expert approach to education.* Portsmouth, United Kingdom: Heinemann.

David Treagust & Mihye Won
Curtin University, Perth, Western Australia

STEM education: What does it mean and where are we headed?

Thursday, 11:50-12:30

Implementing STEM education has been gaining popularity in educational discourse and policy documents in recent years. The Chief Scientist (2013, 2015) and the Department of Education and Training (2015) insist that STEM education should be the new focus in both primary and secondary school education, because STEM education will help build real-world problem solving skills to prepare our students for future challenges. However, if we look closely at what is suggested and implemented as STEM education, we get to wonder what actually STEM education is. Is this just a synonym for science education and mathematics education, or is it meant to refer to an integrated curriculum? Where does 'E' go when planning and actually implementing STEM education? How does and how can our school curriculum support an integrated STEM education? Where do we find the 'evidence' that STEM supports the development of students' real-world problem solving skills and scientific attitudes that it promises? In this presentation, we examine the current status and critiques of STEM education.

Michael Tynan
CSIRO, Canberra, ACT

Evaluating the CSIRO Indigenous STEM Education Project

Wednesday, 9:45-10:25

The CSIRO, supported by BHP Billiton Foundation, are implementing a new five-year $28m Indigenous STEM Education Project aimed at increasing participation and achievement of Indigenous students in STEM subjects and careers. There are six program elements, working with school clusters across Australia, catering to the diversity of Indigenous students across metropolitan, regional and remote settings as they progress through primary, secondary and tertiary education.
The project constitutes a major investment which will reach over 4,500 Indigenous students a year. Dedicated resources are going into a longitudinal evaluation of the Project that will utilise mixed methods to capture the program elements' diversity and interconnectivity. Central to the project's 'Theory of Change' is that culture, identity and connection to place, as well as a rigorous academic focus, are essential for success. This presentation will describe the project's holistic longitudinal monitoring and evaluation approach.
Individual program logics for each of the program elements uniquely integrate the diverse elements of the theory of change, as well as demonstrate their interconnectivity and contribution to the Indigenous STEM Education Project as a whole. They lead to the identification of key indicators that will be longitudinally measured to determine the impact of the project.

M. Vermeulen & F. Janssen
University of Leiden, Holland

The why, what and how of making inquiry-based teaching practical. **POSTER**

Teaching science as inquiry is a recurring feature in science education reforms. Despite all implementation efforts in many science classrooms, of both beginning and more experienced science teachers, lab activities are separated from knowledge development (Crawford, 2014). Science teachers often first present the theory, after which students gather data to illustrate or confirm the theory. Students are seldom involved in practices like developing research questions, methods and interpreting results. Following practicality theory we argue that teachers will only adopt complex teaching practices, like inquiry-based teaching, if they consider it to be practical (Janssen, Westbroek, Doyle, 2015).
Teachers consider a change proposal practical if: (1) efficient procedures (heuristics) are available to translate innovative ideals into concrete instruction (instrumentality); (2) the proposed change sufficiently fits the teacher's current practice and goals (congruence); (3) implementation will take limited investment but the expected benefits are substantial (low cost). We will present a bridging framework for making inquiry based teaching practical. We will also present results of a case study in which a beginning biology teacher used this bridging framework to convert stepwise regular theory lessons and lab work into inquiry based teaching.

Crawford, B (2014). From Inquiry to Scientific practices in the Science Classroom. In N. Lederman & S. Abell Handbook of Research on Science education Vol. 2, (p.515-544) New York: Routledge.
Janssen, F.J.J.M., Westbroek, H.B. & W. Doyle (2015). Practicality studies: How to move from what works in principle to what works in practice. Journal of the Learning Sciences, 24(1), 176-186

Lynn Walker & Leah Moore
University of Canberra

Fostering Pedagogical Content Knowledge (PCK) in preservice STEM teachers.

Thursday, 10:00-10:40

Ensuring a steady pipeline of talented STEM teachers is essential for engaging students in STEM. Resources and approaches developed as part of the AMSPP *National Mentoring in Mathematics and Science Teaching Project* project (see Walker et al. paper, this meeting) are being trialed with preservice *Masters of Teaching* students at the University of Canberra. The first workshop focused on addressing misconceptions in the teaching of *force*, while the second workshop used an *inquiry approach* in the teaching of science. Both workshops aimed to draw students' attention to the opportunities of making explicit links between mathematics and science in their teaching. All participating students recorded an improvement in their level of confidence as a result of the workshop and indicated that the workshop had been useful or very useful.

Lynn Walker, Janet Smith, Mike Gaffney
University of Canberra

Mentoring in science and mathematics teaching — leveraging technology across Australia

Thursday, 9:15-9:55

The quality, confidence and retention of mathematics and science teachers is a national priority. The Commonwealth through the Australian Mathematics and Science Partnership Program (AMSPP) is funding the *National Mentoring in Mathematics and Science Teaching Project.* The project is a collaborative research partnership between the University of Canberra; Centre for the Public Awareness of Science – ANU; Questacon; Australian Association of Mathematics Teachers (AAMT), Australian Science Teachers Association (ASTA) and the New Teacher Center, California, USA. The project aims to improve the quality of science and mathematics teaching in early career teachers and those teaching mathematics or science "out of area" by providing quality mentoring and developing participants' pedagogical and content knowledge. This professional development is being delivered through a combination of intensive face-to-face and online modes of delivery for teachers in dispersed locations across metropolitan, regional, and remote areas of Australia.

This session will outline the design and discuss the process and the findings to this point of the research. Evaluations show that the program is highly effective in supporting and improving teachers' confidence, skills, and efficacy. Participants are also developing their understanding about mentoring and professional development processes and supporting technologies.

Pei-Ying Wu, Yu-Hsuan Chang, Yan-Yu Lin, Yu-Ting Tsai, Sheng-Ju, Chu & Meng-Tzu Cheng
National Changhua University of Education, Changhua City, Taiwan

Developing an inquiry-based instructional module for improving 9th grade low achievers' scientific understanding and learning interest

POSTER

This study aimed to develop an inquiry-based instructional module for middle school low-achievers to learn about biology. The instructional module employs adaptive learning activities, explicit teaching themes, and diversifying learning strategies with an attempt in reflecting a sound and effective teaching. It is hoped that student biology learning can be improved because of the implementation of this instructional module, and the purpose of this study was to investigate its effectiveness on students' scientific understanding and learning interest. A total of 26 9th grade low-achievers participated in this study. Students were required to take the knowledge assessment and learning interest questionnaire as a pretest before receiving the instructional module. The module was composed of twelve sessions that focused on the confusing and important biological concepts taught in Junior High School. The learning activities included observing characteristics of different organisms, generating a hypothesis about classification based on the relevant information, and discussing the results with peers. While the module was completed, a posttest including the identical knowledge assessment with different order and learning interest questionnaire was conducted. The results indicated that student learning outcomes ($p<0.05$) and learning interest ($p<0.01$) were significantly enhanced after receiving the instructional module.

Lihua Xu, Wanty Widjaja & Joseph Ferguson
Deakin University, Melbourne, Victoria

Seeing through the eyes of the teacher: investigating primary school teachers' professional noticing in science through a video-based methodology

Friday, 10:00-10:40

Digital video technology has been increasingly employed to investigate aspects of teaching expertise such as teacher professional vision. While extensive research has been undertaken to unpack the specialised knowledge base underlying this professional vision, little has been done to examine the various methods and methodologies in accessing this professional vision and to consider the methodological consequences for understanding the very nature of professional vision. This paper draws upon a recent study that investigated primary school teachers' professional noticing of student mathematics and science reasoning to discuss some of the issues, challenges, and opportunities emerged in relation to accessing and understanding professional vision of primary school teachers. In this study, latest video technology was harnessed to "empower" primary school teachers to take active roles in both selecting and discussing significant classroom events in their own classroom. By drawing upon some examples from this Professional Noticing project, this paper highlights the tension between the dual priorities of empowering the teacher participants in research and enabling valid interpretations by the researchers. It also illustrates the methodological challenges in capturing and understanding in-the-moment noticing in real time through such a video-based methodological approach.

Zhijun Xu & Maurice Cheng
University of Hong Kong

Investigating high school students' Chemistry Representation Competences (CRC) – Understanding properties and structures of covalent substances

Friday, 11:10-11:50

Concepts related to "chemical bonding, properties and structure of substances" have known to be difficult to secondary students. Success in learning entails interpreting, translating, and selecting various representations, inventing new representations, and identifying differences between representations and their referents. These skills are called Chemistry Representational Competence (CRC) in this study. However, little is known about CRC among secondary students. This study investigates high school students' CRC in the context of understanding properties and structure of covalent substances. This qualitative study consists of two parts. Firstly, two written instruments, one on water and the other on graphite and diamond, were administered to two Year 11 classes in a secondary school. Then, from each class, a low-, medium- and high- achieving student from the instrument, were invited for a 45-min clinical interview respectively to explain their answers both verbally and by drawing.
In this presentation, we will explicate the CRC framework, and its relevance to the learning of properties and structures of covalent substances. Findings from multimodal analysis through the CRC framework will be reported. We observed that students had different problems in interpreting representations and using representation(s) to solve problems. Furthermore, students could learn new representations without any instruction.

Yi-Fen Yeh
National Taiwan Normal University

Uses of graphical representations in high school textbooks

Friday, 10:00-10:40

Graphical literacy is important to science learning, because it facilitates learners' understanding of science reports and active presentation of research findings. Representations can be viewed as information carriers; consequently, uses of representations can be dependent upon disciplinary differences. Graphics Analysis Protocol (GAP) was used to analyze the content of representations, texts where the representations were located, and integration of representations and texts. The data were comprised of 24 science textbooks currently in use in tenth grade courses in biology, chemistry, earth science, and physics in Taiwan. The results showed disciplinary differences in the use of these representations. Hybrids were the main category across all disciplines. Further investigation found tables and graphs to be common in physics and earth science textbooks. For semantic relations, representations were found not playing a decorative role; instead, they added concreteness to a reference or coherence within a greater scheme beyond the texts. A good link between representations and texts would be if the information the representations added was easy to interpret, but the findings indicated that a significant portion of the representations demanded that a reader have background knowledge to derive their meaning.

Jennifer Yeo[1] & John Gilbert[2]
[1]Nanyang Technological University, Singapore; [2]King's College, London, UK

What It Takes to Produce a Scientific Explanation in Dynamics, and the Challenges Students Face

Thursday, 9:15-9:55

The paper aims to identify the reasoning behaviors and challenges of producing a scientific explanation in Dynamics by examining the *form* (structural organization) (Yeo & Gilbert, 2014) of a scientific explanation produced by high school students. In a think-aloud setting, the form of a verbal explanation produced is representative of a child's reasoning (Vygotsky, 1986). The analysis of 74 explanations of a phenomenon on Dynamics uncovers reasoning behaviors associated with explanations deemed successful (by school standards) – (1) qualitative: identification of key states/aspects of the phenomenon; transformation of key states/aspects into abstract entities; inferring their quantitative properties, justified by scientific laws, rules and knowledge; and (2) quantitative: identification of a mathematical model that applies to the phenomenon, and contextualizing the model to arrive at a conclusion. We found that unsuccessful explanations tend to have problems identifying spatial properties of bodies and their motion as key aspects of the phenomenon, resulting in the failure to make crucial inferences about the forces acting on the bodies. We consider the challenges with qualitative reasoning to be associated with to make connection between every day and scientific conceptions (Vygotsky, 1986), and suggest that more attention needs to be put into the process of abstraction during instruction.

Vygotsky, L. S. (1986). Thought and language. Cambridge, Massachusetts: The MIT Press.
Yeo, J., & Gilbert, J. K. (2014). Constructing a scientific explanation—A narrative account. *International Journal of Science Education, 36*,(11), 1902-1935.

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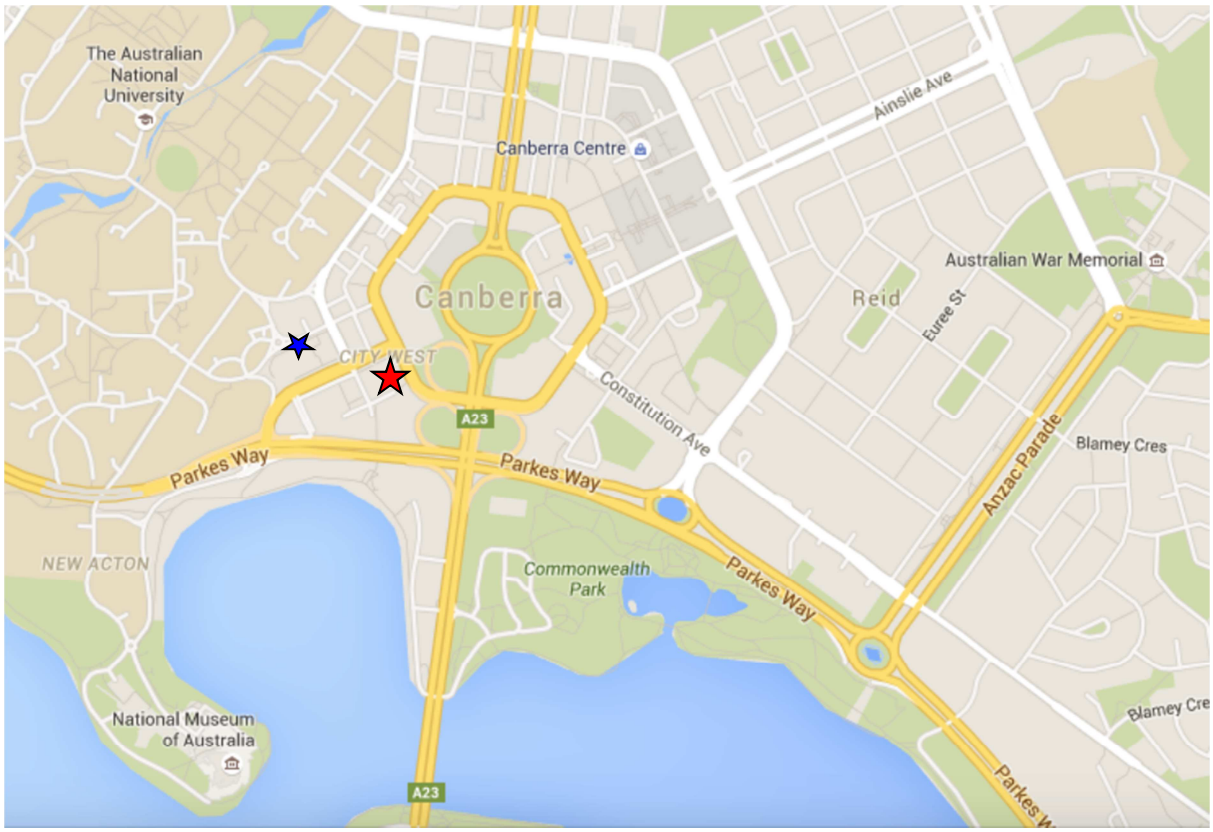
Central Canberra



QT Hotel: off London Circuit

Shine Dome: SbD pre-conference workshop (off Gordon Street)

The Conference Dinner is at the National Museum of Australia. There is a footbridge crossing Parks Way accessible from the rear of the hotel.

Restaurants are spread throughout the city but many can be found at the western end of the Canberra Centre. Some can also be found nearby at New Acton.

The QT Conference Centre is located on the first floor of the QT Hotel: directly up the stairs.