ASERA

AUSTRALASIAN SCIENCE EDUCATION RESEARCH ASSOCIATION

The 46th Annual

ASERA Conference

1st – 3rd July 2015

The University of Western Australia, Perth

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 Western Australia, Perth

THE UNIVERSITY OF WESTERN AUSTRALIA

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Welcome to ASERA 2015

It is the tradition of The University of Western Australia to acknowledge that our campus is situated on Noongar land, and that Noongar 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 Perth at The University of Western Australia to be part of the 46th 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 (particularly Martin Swann) at The University of Western Australia who supported us in the various tasks required to convene this conference.

Please enjoy the conference.

Christine Howitt, Grady Venville, Vaille Dawson and Katherine Carson

Co-convenors ASERA 46

Welcome to Perth

We welcome you to Perth, Western Australia and especially to The University of Western Australia situated on the beautiful shores of the Swan River.

The University of Western Australia

The University of Western Australia, affectionately known by locals as UWA, was the state's first university and in 1913 opened its doors to 184 students. Just over 100 years later more than 24,000 students are enrolled at the University in nine Faculties. In 2012 the University adopted a new course model in line with leading international universities, of a broad undergraduate degree followed by a postgraduate professional qualification. This is designed to produce well rounded graduates, as well as allow for different entry opportunities for students. In 2014 UWA was named equal first in the Good Universities Guide, based on measures including student demand, graduate outcomes, getting a full time job and research grants.

UWA is surrounded by beautiful, lush gardens. Take a stroll in a spare moment and you may even spot one of the famous University peacocks.

Perth – In the city

Perth has undergone a revolution and is no longer the quiet city it used to be. As well as the local scenic attractions such as Kings Park and Fremantle, there is a vibrant theatre scene, superb restaurants and high end shopping to experience.

Cultural Centre Precinct: This area takes in the Art Gallery of Western Australia, The Western Australian Museum and the State Library of Western Australia.

Shopping: Perth City boasts the best shopping in Western Australia. For some top end shopping experiences head to King Street which has Gucci, Louis Vuitton and Tiffany and Co as well as some jewellery shops showcasing Western Australian diamonds, opals, gold and pearls.

Kings Park: Just a short walk up the steps known locally as Jacob's Ladder and you are in Kings Park, which boasts the best view of Perth city. Here you can see local flora in abundance (including Gija Jumulu, a boab tree estimated to be 750 years old), as well as the LotteryWest Federation Walkway suspended in the Eucalyptus treetops.

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, Melb) 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

ASERA Executive Board

The members of the ASERA Executive Board are:

Professor Alistair Jones – Managing Director

Dr Stephen Keast - Secretary

Professor Stephen Ritchie - Policy

Professor Deborah Corrigan - RISE

Professor Bronwen Cowie – Emerging Research Support

Professor David Treagust - International

Associate Professor Coral Campbell – Conference Assistance

Dr Kathryn Paige

ASERA 2015 Program Overview

Tuesday 30th June

6.00 pm	Registration desk open
6.00 – 8.00 pm	Welcome reception

Wednesday 1st July

8.00 am – 9.00 am	Registration desk open
8.30am – 8.55 am	Official welcome to ASERA 2015
9.00am – 5.00pm	Paper and poster presentations
5.30pm – 7.00pm	Fireside chat

Thursday 2nd July

8.00 am – 9.00 am	Registration desk open
8.30am – 5.00pm	Paper and poster presentations
7.00pm – 12.00am	Conference dinner

Friday 4th July

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

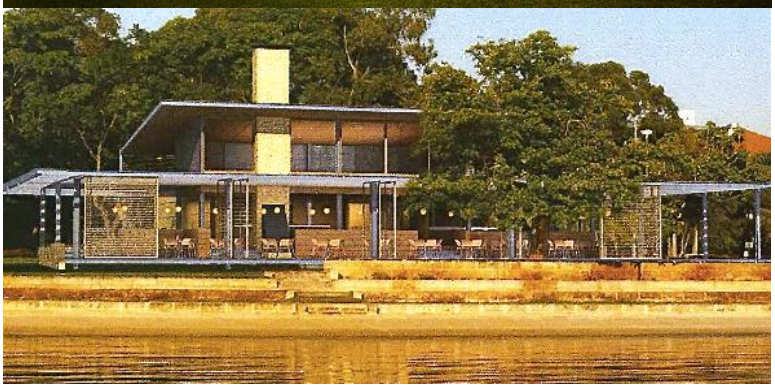
Conference Dinner

Matilda Bay Restaurant

Matilda Bay Restaurant is situated on the banks of the picturesque Swan River and boasts panoramic views of the city, Kings Park and Perth city.

The restaurant is exquisitely designed and offers a magnificent Modern Australian dining experience in a relaxed and friendly atmosphere.

Market fresh seafood and fresh local produce are a feature of the contemporary menu and the extensive wine list offers an impressive selection of wines.



A bus will be available to collect delegates from the following hotels beginning at 6.30pm.

Mounts Bay Waters Apartments Hotel

Rendezvous Studio Hotel Perth Central

Adina Apartment Hotel

A bus will be available to take delegates back to these hotels, leaving from Matilda Bay Restaurant at 11.00pm.

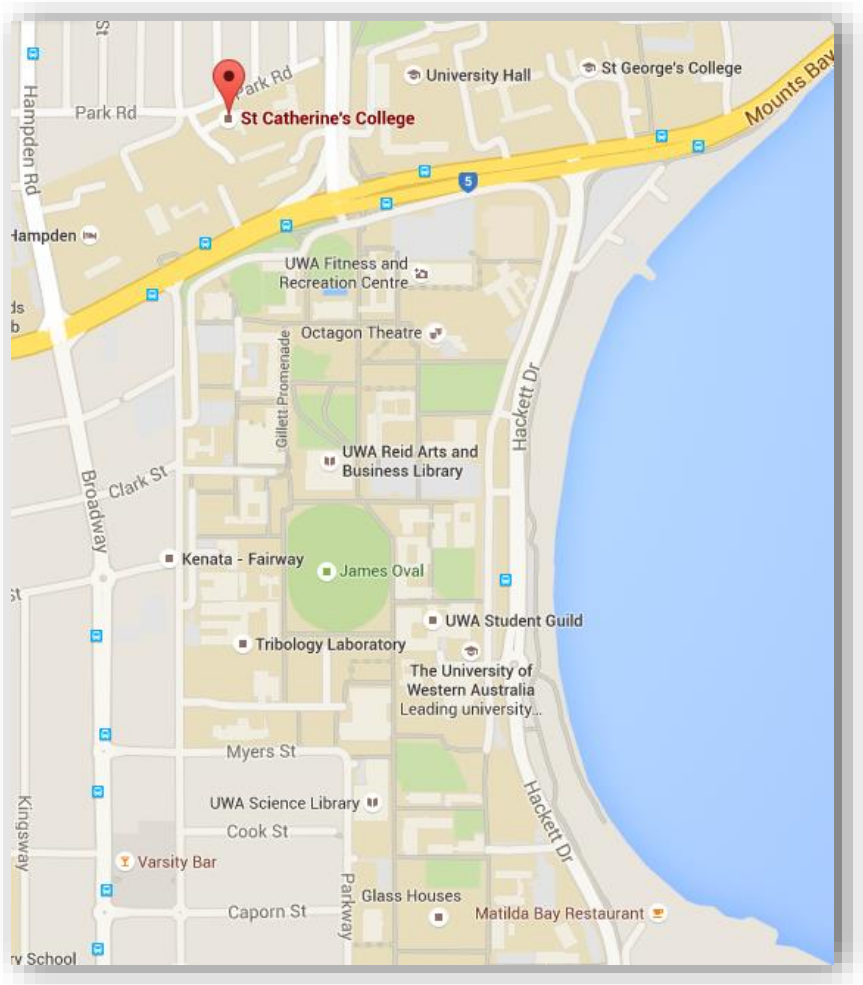
Those delegates wishing to stay can call a taxi from the following companies:

Swan Taxis – 13 13 30

Black and White Cabs – 133 222

13LCab – 135 222

Delegates who are staying at St Catherine's on Park can walk to Matilda Bay Restaurant from this accommodation. This will take approximately 10 minutes.



Catching Public Transport to the University of Western Australia

To travel from the city to the University we recommend using public transport.

The University is conveniently located close to the city of Perth, on the banks of the Swan River.

It is easily accessed by local buses run by Transperth. The following bus routes will take you to the university: **950, 23, 102, and 107.** These buses all leave from the Esplanade Busport every 1 – 5 minutes during peak times and every 5 – 15 minutes at other times. These buses also travel close to the recommended hotels, so ask at reception for the closest bus stop.

Bus timetables for these buses are usually available on the buses. There will also be some available at the conference registration table.

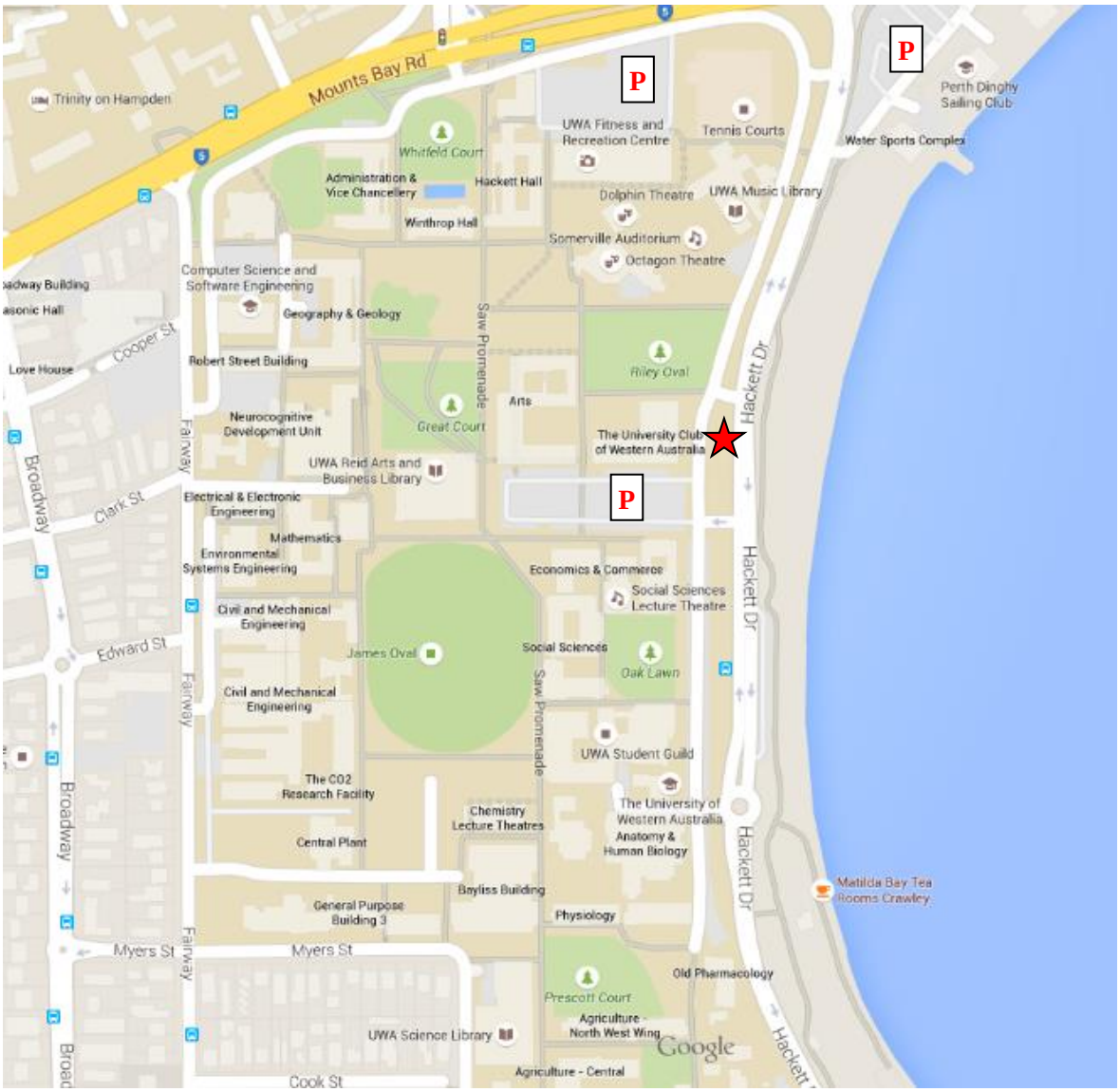
You can purchase your ticket on the bus and it will cost you $2.90 one way. This ticket will last you 2 hours so you will need to purchase another one at the end of the day. You can access more information on these bus services on the Transperth website http://www.transperth.wa.gov.au/

You can also access information on public transport on the official public transport map for UWA here http://www.transport.uwa.edu.au/__data/assets/pdf_file/0006/149253/Pages-from-UWA-Nedlands-TravelSmart-Map-2014-web-public-transport.pdf

The closest bus stop to the University Club is number 10382 on the way to the University.

On the way back into Perth, catch a bus at stop number 26723 (on the opposite side of Stirling Highway).

Parking at the University of Western Australia



We recommend using these parking areas. As it is semester break, parking is free in yellow marked student bays. If parking in a Visitor's bay you must pay. Parking in red staff parking areas is not permitted.

Long term parking is available on a pay and display basis in Car Park No. 23 (corner Hackett Dr and Mounts Bay Rd), and along the University side of Hackett Drive at a charge of $1.50 per hour to a maximum of $10.00. Both of these areas are within a pleasant 5 minute stroll of the Club.

	Theatre/Auditorium	Seminar Room 1	Seminar Room 2	Seminar Room 3	Case Study Room
8.30 – 8.55	**WELCOME TO ASERA 2015 in Theatre/Auditorium**				
Session 1 **9.00 – 9.40**	**Peter Aubusson, Debra Panizzon & Deborah Corrigan** *Science education futures: "Great potential. Could do better. Needs to try harder."* **Chair: Tracey-Ann-Palmer**	**Teukava Finau, Mihye Won, David Treagust & A Chandrasegaran** *Cognitive acceleration through mathematics education in Tonga: Effects on achievements and motivation* **Chair: Liana Aisyah**	**Youngsook Shim & Shinho Jang** *Exploring changes of teachers' science teaching beliefs and instruction strategy through in-service programs for design-based learning* **Chair: Darren Jon Sien Wong**	**Charlotte Pezaro, Tony Wright & Robyn Gillies** *Decision-making of pre-service teachers learning science with argumentation* **Chair: Nina Christenson**	**Mark Hackling & Barbara Sherriff** *Language-based reasoning in primary science* **Chair: Khadeeja Ibrahim Didi**
Session 2 **9.45 – 10.25**	**Tracey-Ann Palmer, Peter Aubusson & Paul Burke** *Fresh minds for science: Why science is a bad buy for a 16 year old* **Chair: Peter Aubusson**	**Liana Aisyah, Missy Morton & Lindsey Conner** *Students with disabilities and science: A story from an Indonesian inclusive high school* **Chair: Teukava Finau**	**Darren Jon Sien Wong & Daniel Poh Yeong Lim** *Design study approach to teacher professional development to support the implementation of a revised science curriculum* **Chair: Youngsok Shim**	**Nina Christenson, Niklas Gericke & Shu-Nu Chang Rundgren** *Science and Swedish language teachers' assessment of upper secondary students' socioscientific argumentation* **Chair: Charlotte Pezaro**	**Khadeeja Ibrahim-Didi** *Scientific reasoning in primary schools: Using bounded rationality to explore reasoning as enacted and embodied* **Chair: Mark Hackling**
10.25 – 10.45	**MORNING TEA**				
10.25 – 11.30	**POSTER SESSION 1 in Lower Colonnade** **(running parallel to paper Session 3)**				
	Chen-Chen Yeh *Underachievers' learning trajectory in prediction-observation-explanation-activities*	**Yulia Burdakova & Jill Aldridge** *Investigating the impact of the learning environment on students' motivation and self-regulation: Motivation-driven learning environments in mathematics and science classes*	**Lin Ya-Hui** *Leading professional learning by implementing an after-school science inquiry program for elementary students*	**Shiho Miyake** *Japanese female students' concepts of sustainable development*	**Tyng-Yu Leu & Ying-Shao Hsu** *Students' attitudes toward socioscientific decision-making*

	Theatre/Auditorium	Seminar Room 1	Seminar Room 2	Seminar Room 3	Case Study Room
Session 3 **10.50 – 11.30**	**Jim Woolnough** *A characterisation of teaching strategies used by expert teachers, based on pedagogical and professional experience repertoires (PaP-eRs)* **Chair: Russell Tytler**	**Derek Cheung** *Student interest in school science: What factors are involved?* **Chair: Yen-Ruey Kuo**	**Abdullah Mamun, Tony Wright & Gwen Lawrie** *Student perceptions in learning science concepts with simulations* **Chair: Frederik Talaue**	**Yuli Rahmawati, Nurbaity, Marheni, Elisabeth Taylor & Peter Taylor** *Engaging Indonesian chemistry students in ethical dilemma story pedagogy* **Chair: Amanda Woods-McConney**	**Ying Tao & Jun Zhang** *Chinese young children's understanding of plants as living things* **Chair: Christine Howitt**
Session 4 **11.35 -12.15**	**Ian Mitchell, Debra Pannizon, Stephen Keast & John Loughran** *Exploring the pedagogical reasoning of expert teachers* **Chair: Jim Woolnough**	**Ching-Hua Hsieh, Hsiao-Lin Tuan, Chi-Chin Chin & Shu-Chen Chen** *An exploratory study of students' motivation, engagement and achievement in learning science* **Chair: Derek Cheung**	**Reece Mills, Louisa Tomas & Brian Lewthwaite** *Representing earth science concepts through slowmation: Preliminary findings on students' alternative conceptions about plate tectonics* **Chair: Abdullah Mamun**	**John Cripps Clark** *Navigating an unmediated information landscape: Teaching digital literacy to science students* **Chair: Yuli Rahmawati**	**Cheryl Jakab & Christine Redman** *Situating children to incorporate science into their habitus: scaffolding cultural development with hinge science concepts* **Chair: Ying Tao**
Session 5 **12.20 – 1.00**	**Russell Tytler, Chao-Ti Hsiung, Karen Murcia & Jörg Ramseger** *Expert teachers coordinating representations in teaching astronomy* **Chair: Ian Mitchell**	**Yen-Ruey Kuo, Hsiao-Lin Tuan, Chi-Chin Chin & Tao-Yu Wu** *Different achievers' motivation and achievement under guided inquiry instruction* **Chair: Ching-Hua Hsieh**	**Aik-Ling Tan, Frederick Talaue & Seng Chee Tan** *The challenges realizing a science as practice classroom discourse: problematizing the curriculum for students' dialogic engagement* **Chair: Reece Mills**	**Amanda Woods-McConney, Mary Oliver & Dorit Maor** *Developing engagement and literacy in science: What do the girls say?* **Chair: John Cripps Clark**	**Christine Howitt & Léonie Rennie** *Using a longitudinal research design to explore the impact of science outreach on parents' perceptions of their role in supporting young children's' learning* **Chair: Cheryl Jakab**
1.00 – 1.45	**LUNCH**				

	Theatre/Auditorium	Seminar Room 1	Seminar Room 2	Seminar Room 3	Case Study Room
Session 6 **1.50 – 2.30**	**Hilary Whitehouse** *Up to date with climate change education research* **Chair: Peta White**	**Saeed Almuntasheri** *The problem with Saudi teachers' assessment: Investigating the ESRU questioning framework* **Chair: S. Ravindran**	**Ya-Chiao Lee, Sharon Hsiao-Lan Chen & Hsung Chao-Ti** *The role of teacher questioning in guided scientific inquiry learning: a cross national comparison of Taiwan and Australia science classrooms* **Chair: Zheng Zhu**		**Rekha Koul, Barry Fraser, David Henderson, Moses Tade, Nicoleta Maynard & Rajinder Sing Attar** *Development and validation of a questionnaire to measure primary school students' learning environment, understanding and attitudes in engineering and technology* **Chair: Christine Preston**
Session 7 **2.35 – 3.15**	**Peta White** *Walking the talk as an intentional, embodied, (co)constructed environmental educator* **Chair: Hilary Whitehouse**	**S. Ravindran & Russell Waugh** *Addressing alternative conceptions in physics learning with the help of a pre-instructional diagnostic tool* **Chair: Saeed Almuntasheri**	**Zheng Zhu, Tony Wright & David Geelan** *The pedagogical issues and misconceptions of Chinese physics teachers in their implementation of inquiry-based teaching and their educational implications* **Chair: Ya-Chiao Lee**		**Christine Preston** *Visual representation use as stimulus in science competition and assessment tests* **Chair: Rekha Koul**
3.15 – 3.30	**AFTERNOON TEA**				
Session 8 **3.35 – 4.15**	**Coral Campbell** *Science learning in 'bush-kinders' in Australia* **Chair: Rowena Scott**	**Judyanto Sirait & Haratua TMS** *Students' representations in physics problem solving* **Chair: Felicity McLure**	**James Davis & Alberto Bellocchi** *Re-theorising analogy in science education: The localised, situated practices of everyday analogical reasoning* **Chair: Alberto Bellocchi**		**Shao-Yun Huang & Hsiao-Lin Tuan** *Using inquiry-based teaching to improve low achievers' learning motivation in science* **Chair: Yu Chen Lee**

	Theatre/Auditorium	Seminar Room 1	Seminar Room 2	Seminar Room 3	Case Study Room
Session 9 **4.20 – 5.00**	**Rowena Scott** *Teaching science outdoors* **Chair: Coral Campbell**	**Felicity McLure, Mihye Won & David Treagust** *Using the thinking frames approach to teach thermal physics* **Chair: Judyanto Sirait**	**Alberto Bellocchi, Kathy Mills & Stephen Ritchie** *Attending to alienation in online science teacher education through social bonds* **Chair: James Davis**		**Yu-Chen Lee** *A project-based science program for promoting elementary school students' performance in science practices* **Chair: Shao-Yun Huang**
5.30 – 7.00	**FIRESIDE CHAT (The Board Room)** **(Informal meeting for early career academics and HDR students)**				

	Theatre/Auditorium	Seminar Room 1	Seminar Room 2	Seminar Room 3	Case Study Room
Session 1 **8.30 – 9.10**	**Dave Palmer** *What was going on in your head during that lecture? Processes of episodic motivation among stem and non-stem undergraduates in formal lectures* **Chair: David Geelan**	**Shu-Fen Cheng, Jer-Ming Hu, Yi-Jung Lin, Zn Chen, Meichun Lydia Wen & Yu-Teh Kirk Lin** *Changes of teaching and learning by using loan box in classrooms* **Chair: Julia Whittaker**	**Ally Bull** *Exploring science capabilities* **Chair: Gillian Kidman**	**Bev France & Sally Birdsall** *Strategies to improve communication about a socioscientific issue: Building a map to identify participants and opinions* **Chair: Chor Yam Lau**	**Muhd Shafiq Shaik Hussain** *Paradigm shifts in methods of teaching primary science: Investigative case-based learning vs direct instruction approach* **Chair: James Deehan**
Session 2 **9.15 – 9.55**	**Stephanie Colby, Mihye Won & David Treagust** *An investigation of the quality of online science education at the tertiary level from the perspectives of students, instructors and university administrators* **Chair: Dave Palmer**	**Timothy Tan, Yew Jin Lee, PeterLee & Choon Kook Sam** *Design based inquiry using the microbial fuel cell* **Chair: Shu-Fen-Cheng**	**Beverly Lowe** *Science Sparks to the rescue: One school's experience* **Chair: Ally Bull**	**Kok-Sing Tang** *Towards a model of supporting language and literacy practices for science teaching and learning* **Chair: Bev France**	**Jeong-Yoon Lee & Shinho Jang** *The effects of design-based learning on elementary students' achievement and attitudes in science class* **Chair: Muhd Shafiq Shaik Hussain**
Session 3 **10.00 – 10.40**	**David Geelan, Adam Palmer & Wendy Loughlin** *Flipping the classroom in undergraduate physics education* **Chair: Stephanie Colby**	**Julia Whittaker, Donna King & Jim Watters** *The gradual release of responsibility: A case study of teaching science inquiry skills* **Chair: Timothy Tan**	**Gillian Kidman** *An enquiry into inquiry in the Australian curriculum: Portrayal of, and leveraging the shared skills* **Chair: Beverly Lowe**	**Chor Yam Lau & Hwee Ting Lim** *Teachers' use of investigative case-based learning to support students' development of scientific literacy in the lower secondary science classroom* **Chair: Kok-Sing Tang**	**James Deehan & David McKinnon** *The implementation of two complex, innovative science subjects in a primary education program: Quantitative findings over an 8 year period (2007-2014)* **Chair: Jeong-Yoon Lee**
10.40 – 11.00	**MORNING TEA**				

	Theatre/Auditorium	Seminar Room 1	Seminar Room 2	Seminar Room 3	Case Study Room
10.40 – 11.45	**POSTER SESSION 2 in Lower Colonnade (running parallel to paper Session 4)**				
	Tzu-Ling Wang, Yi-Kuan Tseng & Mei-Yen Chiu *The effectiveness of blending physical and virtual manipulation on students' understanding of force and motion*	**Yi-Kuan Tseng, Tzu-Ling Wang & Chi-Ru Ku** *Effects of presentation format and spatial ability on students' understanding of heat and temperature*	**Hung-Ming Chen** *Students' use of self-assessment on multimodal writing to learn science tasks*	**Tormi Kotkas, Miia Rannikmäe & Jack Holbrook** *Evaluating science educators´ perception of students´ personal relevance as a key component to enhance scientific literacy*	
Session 4 11.05 – 11.45	**Dave Palmer, Jeanette Dixon & Jennifer Archer** *Using situational interest to enhance individual interest and science-related behaviours* **Chair: Vaille Dawson**	**Karin Thörne & Niklas Gericke** *Genetic determinism in teachers' talk in secondary science classroom* **Chair: Charolotte Pezaro**	**Donna King, Stephen Ritchie, Maryam Sandhu, Senka Henderson & Ben Boland** *Managing emotions: Outcomes of a breathing intervention in year 10 science* **Chair: Stephen Ritchie**	**Rita Hagevik & Hillary Whitehouse** *Educating science teachers for sustainability* **Chair: Hillary Whitehouse**	**Tina Overton & Christopher Randles** *Exploring disciplinary differences in tackling complex problems* **Chair: David Overton**
11.50 – 12.50	**ASERA ANNUAL GENERAL MEETING in Theatre/Auditorium**				
12.50 – 1.35	**LUNCH**				
Session 5 1.40 – 2.20	**George Aranda & Russell Tytler** *Translating across methodologies: neuroscience and education* **Chair: Chris Joyce**		**Kathryn Paige & Graham Hardy** *Science as a human endeavour: A case study of three practitioner projects* **Chair: Dorothy Smith**	**Yi-Fen Yeh & Ying-Shao Hsu** *Synergies between reading strategies and concept mapping in high school students' science text comprehension* **Chair: Yoonjeong Lee**	**Warren Stannard, Tejinder Kaur, John Moschilla, David Blair, Ron Burman & Marjan Zadnik** *Einstein-first: Changing the paradigm of school physics education* **Chair: Michael Fitzgerald**

	Theatre/Auditorium	Seminar Room 1	Seminar Room 2	Seminar Room 3	Case Study Room
Session 6 **2.25 – 3.05**	**Chris Joyce** *Lessons learnt about assessing the hard stuff* **Chair: George Aranda**		**Dorothy Smith, Pamela Mulhall, Christina Hart & Richard Gunstone** *High profile scientists and their interactions with contemporary communities* **Chair: Kathryn Paige**	**Yoonjeong Lee & Shinho Jang** *Examining elementary school students' awareness about socio-scientific issues and solutions by using drawings* **Chair: Yi-Fen Yeh**	**Michael Fitzgerald, Lena Danaia, David McKinnon & James Deehan** *Our solar siblings. A link between the high school classroom and astronomical inquiry* **Chair: Warren Stannard**
3.10 – 3.30	**AFTERNOON TEA**				
Session 7 **3.35 – 4.15**	**Coral Campbell, Russell Tytler & Sandra Herbert** *Sustaining science education through specialist professional learning* **Chair: Linda Hobbs**		**Arpana Dhar, Georgina Fyfe, David Treagust & Rekha Koul** *Student perceptions of co-teaching in higher education: A pilot study* **Chair: Venkat Vishnumolakala**	**Yeseon Park & Shinho Jang** *A comparative analysis on structure of storytelling in Korean, American and Singaporean elementary science textbooks: Focusing on matter area* **Chair: Daniel Poh Yeong Lim**	**Ying-Chun Cho, Ting-Kuang Yeh & Chun-Yen Chang** *The effects of group composition on creativity in groups* **Chair: Peta White**
Session 8 **4.20 – 5.00**	**Linda Hobbs, John Kenny, Mellita Jones, Christine Redman, Sandra Herbert, Gail Chittleborough, Andrew Gilbert & Christopher Speldewinde** *A partnership model from science education: applicability to the higher education sector* **Chair: Coral Campbell**		**Venkat Vishnumolakala, Katherine Bradley, Sheila Qureshi, Daniel Southam, Mauro Mocerino & David Treagust** *Qatar as a gulf regional hub for the organisation and the implementation of student-centred active learning in science at secondary and university levels* **Chair: Arpana Dhar**	**Daniel Poh Yeong Lim, Darren Jon Sien Wong, Chor Yam Lau & Hwee Ting Lim** *Investigative case-based learning in the primary science: Perspectives from pre-service to in-service* **Chair: Yeseon Park**	**Peta White & John Cripps Clark** *Collaboration in science education through self study* **Chair: Ying-Chun Cho**
7.00 – 12.00	**CONFERENCE DINNER at Matilda Bay restaurant**				

	Theatre/Auditorium	Seminar Room 1	Seminar Room 2	Seminar Room 3	Case Study Room
Session 1 **9.15 – 9.55**	**Linda Hobbs, Frances Quinn, Colleen Vale, Christopher Speldewinde, Robert Whannell, Terry Lyons, Russell Tytler & Anna Du Plessis** *A model of teacher learning for out-of-field teachers* **Chair: Russell Tytler**	**Denis Goodrum & Jim Woolnough** *Science by Doing: Impact of an online curriculum program* **Chair: Cathy Buntting**	**Michelle Appleton, Vaille Dawson & Christine Howitt** *Engaging pharmacy students in argumentation: Its impact on thinking skills and understanding of professional practice issues* **Chair: Wendy Nielsen**	**Pei-Ying Tsai** *Enhancing seventh graders' scientific reasoning in comprehensive science news articles* **Chair: Wen-Hua Chang**	**Catherine Milne** *Why materials matter: exploring the role of instruments in learning science* **Chair: William Palmer**
Session 2 **10.00 – 10.40**	**Russell Tytler, John Cripps Clark, Peter Hubber & Gail Chittleborough** *Engaging pre-service teachers in contemporary stem practices* **Chair: Linda Hobbs**	**Cathy Buntting, Alister Jones & Bronwen Cowie** *Ten years on: Reflections on the development of a large-scale, rich online resource for science education* **Chair: Denis Goodrum**	**Wendy Nielsen, Garry Hoban & Chris Hyland** *Digital media construction in pharmacology: Engaging discipline science students with multimodal learning* **Chair: Michelle Appleton**	**Wen-Hua Chang** *Effects of a web-based socioscientific issues instruction on students' conceptual understandings and science inquiry competency* **Chair: Pei-Ying Tsai**	**William Palmer** *Elements of chemistry: The books and their authors (1860-1900)* **Chair: Catherine Milne**
10.45 – 11.05	**MORNING TEA**				
Session 3 **11.10 – 11.50**	**Damien Carter, Euan Lindsay, Marjan Zadnik, Mauro Mocerino, Anthony Lucey & David Treagust** *Identification of student learning processes in classroom and remote laboratory settings* **Chair: James Deehan**	**Alexandra Yeung, Manjula Sharma, Scott Kable, Kieran Lim, Louise Sutherland, Mark Buntine, Vaille Dawson, Daniel Southam & Nicoletta Maynard** *Enhancing student engagement in laboratory learning using inquiry-based activities: The ASELL schools project* **Chair: Tuszie Widhiyanti**	**Tony Wright & Gwen Lawrie** *Chemistry, conceptual understanding and formative assessment* **Chair: Chia-Ju Liu**	**Nathan Curnow, Grady Venville, Mary Oliver & Christine Howitt** *Student and teacher perspectives of Construction Zone activity in the Thinking Science Australia program* **Chair: David Overton**	**Marlécio Maknamara** *Becoming a biology teacher: Memories of school experiences* **Chair: Avory Allen**

	Theatre/Auditorium	Seminar Room 1	Seminar Room 2	Seminar Room 3	Case Study Room
Session 4 **11.55 – 12.35**	**James Deehan** *A longitudinal investigation of the science experiences and beliefs of a cohort of pre-service teachers making their first steps into the teaching profession* **Chair: Damien Carter**	**Tuszie Widhiyanti, Mauro Mocerino, David Treagust & Venkat Vishnumolakala** *Potencies and challenges of content knowledge development in a chemistry teacher preparation program* **Chair: Alexandra Yeung**	**Chia-Ju Liu, Chao-Ming Hung, Chen Hsieh, Chin-Fei Huang, Ming-Chung Ho & Houn-Lin Chiu** *Does the ability of mental rotation affect the learning of chemical structure formulas: The evidence from neuroscience* **Chair: Tony Wright**	**David Overton** *Addressing the learning needs of children, teaching students and teachers in an informal context* **Chair: Nathan Curnow**	**Avory Allen, Miriam Sullivan & Julie Saunders** *Is contraceptive information presented poorly online?* **Chair: Marlécio Maknamara**
12.40 – 1.30	**LUNCH**				
DELEGATES DEPART					

Abstracts – Paper and Poster Presentations

WEDNESDAY: SESSION 1

Science education futures: "Great potential. Could do better. Needs to try harder."

Wednesday, 9.00am: Theatre/Auditorium

Peter Aubusson[1], **Debra Panizzon**[2] **& Deborah Corrigan**[2]
[1]University of Technology Sydney, Australia; [2]Monash University, Australia

Reviews of science education consistently suggest that there is (another) crisis. They express concern with the status quo and suggest directions science education might take. In this context, science educators need to consider the current state of play, the needs of generations in a world to come, and the characteristics of future science education. The research reported in this paper uses a futures methodology informed by Delphi techniques and scenario thinking. Four science education futures scenarios were constructed over an extended period of consultation. These were particularly influenced by discussion arising from an ASERA forum on science education futures. These were presented to a panel of ASERA professors to stimulate consideration of and commentary on the future of science education. The focus in interviews was on identifying and discussing elements of the scenarios that were desirable and likely. Analysis of data indicates divergence on some features of the future and consensus on others. This paper presents the scenarios and findings from interviews with the panel. We highlight key prospects for science education and propose areas for development if we are to produce a future that is both desirable and likely - rather than likely but undesirable.

Cognitive acceleration through mathematics education in Tonga: Effects on achievements and motivation

Wednesday, 9.00am: Seminar Room 1

Teukava Finau, Mihye Won, David Treagust & A L Chandrasegaran
Curtin University, Australia

This study investigated the potential of raising Tongan lower secondary school students' achievement in mathematics through the implementation and evaluation of a cognitive acceleration program. The research also investigated the impact of the program on students' attitudes toward mathematics. By cognitive acceleration we mean the application of some special procedures in students' classes which result in attaining higher levels of cognitive development more quickly than if they had not been presented with these procedures. Cognitive Acceleration through Mathematics Education (CAME) (Adhami, Johnson, & Shayer, 2007) is an innovative teaching approach based on the work of Piaget which also combines with principles of Vygotsky's theories of learning. This study was conducted in Tonga for one year with four lower secondary schools and with students in Form 2 (Year 8) level (n = 338). When comparing groups of students who experienced the intervention and those who did not, the findings showed that significant cognitive gain were made by the groups that received the intervention. Comparing pre-test and post-test scales' means of Students Adaptive Learning Engagement (SALE) revealed there was an improvement on the attitude of the groups that experienced the intervention while the control group does not.

Exploring changes of teachers' science teaching beliefs and instruction strategy through in-service programs for design-based learning

Wednesday, 9.00am: Seminar Room 2

Youngsook Shim & Shinho Jang
Seoul National University of Education, China

The purpose of this study was to describe how teachers have changed their science teaching beliefs and instruction strategy through in-service programs for Design-based Learning (DBL). Subjects were 25 elementary school teachers, 8 middle school teachers and 4 high school teachers. For 15 hours during instruction, teachers experienced to design bio-domes, an electrolyte lamp, structures to withstand earthquake and earth-warm house. They also discussed their own project on DBL and presented the result of team project how to reflect their learning into their classes. After programs teachers reported that they applied and what they designed to their own class within 2 months. We surveyed teachers teaching beliefs in science teaching before and after programs. We analyzed teachers' reports, recorded focus group discussion and interview qualitatively. As a result, teachers have not changed their beliefs on science teaching goals but have changed their beliefs on science teaching efficacy and science teaching strategy. This study has significant implications for proposing effective ways to design in-service program and science teacher professional development.

Decision-making of pre-service teachers learning science with argumentation
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Wednesday, 9.00am: Seminar Room 3

Charlotte Pezaro, Tony Wright & Robyn Gillies
The University of Queensland, Australia

Curriculum documents around the world commonly claim that learning science improves students' decision-making. Empirical evidence that supports this claim is difficult to find. The aim of this study was to investigate the relationship between learning science and decision-making. Particular attention was given to the role that classroom argumentation might play in developing improved reasoning for decision-making. Participants were recruited from a course in science for primary education students. A subsample of participants attended a series of dialogic workshops throughout the semester, which developed these participants' understandings and skills for argumentation about socio-scientific issues. Cognitive characteristics relating to decision-making of participants were measured before and after the course. Semi-structured interviews conducted prior to and following the course probed both argumentation and control condition participants' reasoning for decisions in hypothetical scenarios. Preliminary analysis of results has found no significant difference between the two groups in course achievement, scientific understanding, views of the nature of science, and cognitive reflection. Further analysis of interviews with participants will identify attitudes of doubt, tentativeness, open-mindedness, evidence seeking, and use of informal reasoning for comparing the decision-making of the two groups. As there are methodological issues that limit the generalisability of the study, additional research is recommended.

Language-based reasoning in primary science

Wednesday, 9.00am: Case Study Room

Mark W Hackling & Barbara Sherriff
Edith Cowan University, Australia

Language is critical in the mediation of scientific reasoning, higher order thinking and the development of scientific literacy. This study investigated how an exemplary primary science teacher scaffolds and supports students' reasoning during a Year 4 Materials unit. Lessons captured on video, teacher and student interviews and micro-ethnographic analysis of classroom discourse reveal a sophisticated repertoire of teacher practices focusing on the development of language, conceptual understanding and reasoning within a classroom culture that supports reasoned arguments. The integration of conversation threads supporting language and conceptual development, syntactical and metacognitive scaffolds, prompts and self-regulation strategies extend the opportunities for scientific reasoning.

WEDNESDAY: SESSION 2

Fresh minds for science: Why science is a bad buy for a 16 year old

Wednesday, 9.45am: Theatre/Auditorium

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

The supply of scientists and scientifically literate citizens is vital for Australia's prosperity. However, traditional approaches to inspire Australian children to continue with Science into senior school appear to be failing. This study uses a marketing perspective to explore how students' choose their subjects for study in Years 11 and 12 and how the choice of Science is influenced by this choice process. A survey was administered to 379 students to examine career aspirations and perceptions of subject choice. It contained a Best Worst Scaling component to determine the relative importance of 21 factors that students consider when choosing subjects. The findings indicate that students accepted and rejected subjects based on enjoyment, interest and the perceived need for those subjects in their future study or career plans. They saw the principal benefit of studying Science as preparation for a stereotypical career in science. This study suggests redressing students' narrow perceptions of Science by marketing Science as an empowering and achievable 'purchase' that is valuable for a range of occupations and for life generally. It also recommends that students' perceptions of their own abilities in Science be supported during the critical time in Year 10 at which subject choice is made.

Students with disabilities and science: A story from an Indonesian inclusive high school

Wednesday, 9.45am: Seminar Room 1

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

This presentation provides some preliminary findings of an ethnographic study on science education for students with disabilities in Indonesia. In particular, it addresses their interest in and perception of science, memorable science learning experiences as well as issues and

challenges they experience in science classes. Two methods of qualitative data gathering were used to answer the above questions: (1) semi-structured interviews with 5 students with disabilities, all of which are either partially or completely blind (2) 3 sessions of participatory observation in a grade 10 biology class. Most student participants find science less interesting and more difficult than other subjects, a perception shared by their other classmates majoring in social sciences. Their memorable science learning experiences were mostly attributed to hands on/laboratory activities and teachers' delivery, although some of them had difficulty to recall any. In addition to their lack of interest, the lack of accessible media and resources to support their learning in science seem to be the most dominant issues and challenges for them. Findings of this study will contribute to scholarly literature on science education for students with disabilities and inclusive education in Indonesia, which are both very limited. We also expect they can be used to inform policy makers, academic community, and stakeholders.

Design study approach to teacher professional development to support the implementation of a revised science curriculum

Wednesday, 9.45am: Seminar Room 2

Darren Jon Sien Wong[1] **& Daniel Poh Yeong Lim**[2]
[1]Ministry of Education, Singapore; [2]Nanyang Technological University, Singapore

In this study, we investigated how a researcher-teacher collaborative design study approach served as a professional development (PD) model to support teachers in implementing the revised 2013 Singapore lower secondary science curriculum. The investigative case-based learning (ICBL) instructional approach was introduced as the platform for such professional collaboration involving four schools, where a group of teachers from each of the schools participated in the design, implementation and refinement of an ICBL package catered to the context of their particular school and needs of their students. The design study PD model was carried out in four phases in each school: 1) Training and Preparation; 2) Planning and Development; 3) Implementation and Reflection-in-Action; and 4) Evaluation and Consolidation. From the cross-case analysis, we have distilled useful insights and key factors necessary in each phase of our design study PD model to support teachers in translating the goal of the LSS curriculum to develop students' scientific literacy. We hope the knowledge generated will serve to inform other schools on a viable PD model that supports teachers in implementing and addressing the goals of any new curriculum.

Science and Swedish language teachers' assessment of upper secondary students' socioscientific argumentation

Wednesday, 9.45am: Seminar Room 3

Nina Christenson[1]**, Niklas Gericke**[1] **& Shu-Nu Chang Rundgren**[2]
[1]Karlstad University, Sweden; [2]Stockholm University, Sweden

The Swedish curricula, as well as researchers and policy makers worldwide, have recognized the importance of promoting and including sociscientific argumentation in science education to promote scientific literacy. However, to teach socioscientific argumentation in not an easy task for science teachers and among the difficulties is the assessment practice. In this small-scale qualitative study, we have, investigated and compared how science and Swedish language teachers, participating in a SSI-driven project, assess students' written argumentation about Global warming. The Swedish language teachers have a long tradition

of teaching and assessing argumentation and therefore it is of interest to identify possible gaps between these two groups. The results indicate that the science teachers focus on students' ability to reproduce content knowledge within their respective subject that they have been teaching. The Swedish language teachers include students' abilities to select and use content knowledge from trustable reference resources, in addition to the structure of the argumentation and the form of the language used. In fact, the Swedish language teachers' assessment correlates more to previous research about quality in socioscientific argumentation and we suggest that a closer co-operation between these two groups can be beneficial to enhance the quality of assessing students' socioscientific argumentation.

Scientific reasoning in primary schools: Using bounded rationality to explore reasoning as enacted and embodied

Wednesday, 9.45am: Case Study Room

Khadeeja Ibrahim-Didi
Edith Cowan University

Primary students' reasoning is largely different to scientific reasoning on the basis of the scientific concepts available to them, their ability to process and validate scientific findings or reasoning and to communicate such reasoning. This research study utilized a video-based to explore the nature of scientific reasoning evident within a Year 4 science classroom in Western Australia. To illustrate the nature of rationality implicit in multimodal approaches at the primary school level, we used a micro ethnographic approach to focus on the semiotic functions students achieved by using embodied approaches in reasoning; the heuristic approaches used to define the 'problem space'; the processes used to validate their reasoning and the multimodal communication of their conclusions. Findings indicate that students use gestural representational forms such as deictic, iconic, symbolic, beat and tracing, object manipulation and role-play to complement, augment and refine their scientific reasoning in very particular ways. These distinctions demand that we view scientific reasoning in more organic terms within primary school science. A multimodal approach to scientific reasoning interrogates approaches to inductive, deductive and abductive reasoning and may allow developmental approaches to scientific reasoning be understood through a bounded approach to rationality.

WEDNESDAY: POSTER SESSION 1 (Lower Colonnade)

Underachievers' learning trajectory in prediction-observation-explanation-activities

Chen-Chen Yeh
Sanshia Junior High School, Taiwan

Exploring students' learning trajectory would enlighten teachers to adjust pedagogy or provide scaffolds. Prediction-Observation-Explanation activities featured with conceptual conflict events, notable discrepant phenomena, and thought evoking interaction have potential in making explicit students' prior knowledge and reasoning process. In this study, individual and group artifacts about osmosis, afterimages, and respiration from one hundred and fifty-one junior high school students were analyzed by concept mapping to highlight the high achievers' and underachievers' conceptualization and scientific reasoning through the designed POE activities. Analysis reveals that the underachievers tend to overlook the details of the task questions or pay more attention to irrelevant observable phenomena in the

illustrative media. The underachievers would make appropriate corrections about some observable phenomena after within-group or whole-class sharing. However, they were not able to overcome mistakes that involved cross-linked superordinate biological principles. It is suggested that the teacher should allocate time for students to represent their prior understandings in written form, and spend more time in clarifying the focus questions in the given tasks before the students make observations. Moreover, teachers can provide more contradictory statements for groups of students to reexamine and coordinate their observations and conceptual understandings.

Investigating the impact of the learning environment on students' motivation and self-regulation: Motivation-driven learning environments in mathematics and science classes

Yulia Burdakova & Jill Aldridge
Curtin University of Technology, Australia

The overarching aim of our research was to develop a possible model for motivation-driven learning environments in mathematics and science classes. The study involved a mixed-methods approach in which quantitative data were collected from the classes of seven teachers (N=351 year 7-10 students in 19 classes), using two instruments (one to assess students' perceptions of the learning environment and another to assess their motivation and self-regulation). This data were used to identify salient factors within the learning environment that could be enhanced by teachers to improve students' motivation and self-regulation in mathematics and science. Qualitative data were collected during the action research process, including observations and interviews. These data were analysed to identify factors inhibiting and enhancing positive changes in a bid to develop a model for motivation-driven learning environments in mathematics and science classes. Although all of the teachers were involved in the action research component, one teacher (found to be more proactive than the others) was selected as a critical instance case study. The teachers were involved in an action research process that involved critically reflecting on student feedback data and factors that were likely to influence motivation to design interventions to enhance students' motivation.

Leading professional learning by implementing an after-school science inquiry program for elementary students

Lin Ya-Hui
ChungShan Elementary School, Taiwan

Current educational policy in Taiwan regulates schools to provide after-school programs for at-risk students from families with over-time working parents. In this poster we report a group of eight elementary science teachers led by the teacher-head, in co-planning and enacting an after-school science inquiry program for 50 fifth and sixth grade at-risk students. The program lasted for 8 months. The after-school classes met one hour per week and studied science content including birds and plants on campus, reproduction, food for butterflies, and interdependence between animals and plants. Students also practiced inquiry skills including: observing and keeping field logs; determining co-writing topics; searching and organizing information; express and communication; co-writing a report and reflecting; and making an investigation plan for the future. The teacher team offered lectures and activities for students on planning, keeping observation logs, and writing expository texts. Students compiled their learning portfolios and co-wrote project reports for six weeks. At the beginning, the science

teachers were short of confidence due to concerns about their teaching load and students' competencies. However, during enacting the program, the teachers were impressed by the students' enthusiasm in participating in learning activities. They examined student learning artefacts and proposed a revised program.

Japanese female students' concepts of sustainable development

Shiho Miyake
Kobe College, Japan

This paper aims to examine how younger generations, who have been educated in DESD (Decade of Education for Sustainable Development: 2005–2014) principles, typically conceive of sustainable development using the word association method, from 2010 to 2014. The results showed that the term of "solar power generation" was ranked first or second throughout the surveyed period. Specifically, in 2010 the 10 most association words reflect economical concepts, such as "energy", "recycling", "saving", and "refilled items". In 2011, however, students associated the names of specific prominent sustainable development organizations or regions, such as "the Red Cross" or "Sweden" with ESD. The years 2012 and 2013 were significant, because students understood ESD as a community-based or socially cooperative action. This was reflected in the increased appearance of "eco-point", "eco-village" and "partnership". In 2014, "biodiversity", "Red List" and "habitat" became more frequent. This fact suggested that students surveyed in this year were more interested in biologically oriented concerns. Overall, these results suggest that the candidate students 1) consistently associate solar power generation with ESD, 2) believe environmentally friendly actions and the green economy to be closely linked, and 3) associate specific prominent organizations and regions and socially cooperative action with ESD.

Students' attitudes toward socioscientific decision-making

Tyng-Yu Leu & Ying-Shao Hsu
National Taiwan Normal University, Taiwan

In recent decades, socioscientific issues (SSI) education has been used for promoting the idea of "science education for citizenship". However, only a few studies addressed the relationships between students' attitudes and SSI decision-making. The purpose of this empirical study was to investigate how students made trade-offs between different dimensions of attitudes (science and social dimensions) in SSI decision-making process. We designed an SSI learning module which involved students evaluating the sustainability of the nominated twelve community parks for earthquake disaster prevention in Taipei City. During the module, students were required to rank the top three parks based on several criteria, for example safety, and to provide their explanations. The study adopted a one-group pretest-posttest research design. A total of 15 tenth grade students participated in the study. We used questionnaires and drawings to understand the students' attitudes and their perception of scientists and policy makers. During the module, the students' conversations were audiotaped. Discourse analysis was adopted to analyze the changing attitudes during group dialogues. The impact of students' attitudes on their SSI decisions was discussed. It is hoped that this study could contribute to the understanding of the relationships between students' attitudes and SSI decision-making.

WEDNESDAY: SESSION 3

A characterisation of teaching strategies used by expert teachers, based on pedagogical and professional experience repertoires (PaP-eRs)

Wednesday, 10.50am: Theatre/Auditorium

Jim Woolnough
Australian Academy of Science, Australia

What strategies do expert teachers, with well-developed Pedagogical Content Knowledge (PCK), use in the classroom to teach difficult science concepts and ideas? With the current emphasis on 'student-centred' learning, the topic of 'classroom teaching strategies' is often somewhat neglected. A major Australian study of the PCK of expert teachers represented the teachers' PCK through a combination of Content Representations (CoRes) and Pedagogical and Professional Experience Repertoires (PaP-eRs). Each PaP-eR was a narrative account of a teacher's PCK that highlighted a particular aspect of science content to be taught. These included details of teachers' reasoning around the teaching of particular topics as well as their practice, which included a detailed account of particular strategies used by the teachers. This study used the PaP-eRs to identify and characterize the range of classroom strategies used by these expert teachers. They utilized a range of strategies, many familiar in the pre-service teaching literature. Some strategies were notable in their absence but first impressions can be deceptive. The questioning techniques used by these teachers often extended beyond the models usually presented in the literature or in teacher education courses. They exemplify a valuable approach to 'teaching through inquiry' that is often not recognized.

Student interest in school science: What factors are involved?

Wednesday, 10.50am: Seminar Room 1

Derek Cheung
The Chinese University of Hong Kong, Hong Kong

Student interest is an important variable in science education. Although various intervention strategies have been tried by researchers to improve student interest in school science, the results are inconclusive. There are no empirically validated models in science education literature that can be used by stakeholders to analyze the key factors affecting student interest in school science. This study has used qualitative and quantitative methods to develop a model of the factors affecting student interest in school science. In the first phase, qualitative interview data were collected from 60 Hong Kong junior secondary students, who were asked to describe the nature of their interest in school science and the factors to which they attribute this. Teacher interviews, parent interviews, and classroom observations were conducted to triangulate student interview data. The second phase aimed to hypothesize a theoretical model by synthesizing the qualitative data, and the key factors affecting students' individual interest in school science were found to include individual interest in science, situational interest in science lessons, science self-concept, and science self-efficacy. Finally, during the third phase, questionnaire items will be constructed to collect quantitative data from students to test the validity of the hypothesized model by structural equation modeling techniques.

Student perceptions in learning science concepts with simulations

Wednesday, 10.50am: Seminar Room 2

Abdullah Mamun, Tony Wright & Gwen Lawrie
The University of Queensland, Australia

Presented with online self-directed computer simulations, students' learning experiences are very varied. This paper investigates the perceptions of students learning science concepts using PhET and Molecular Workbench simulations. Simulations make abstract or complex scientific processes visible to students through real time interaction at the atomic scale. They provide students with the opportunity to explore abstract science concepts separate from experiencing the physical objects. In these explorations, students experience the simulations differently. Early literature suggests that students' perceptual understanding often affects their conceptual learning. It can be argued that concepts of any scientific learning progresses from simple perceptions to abstract understandings. First year university science students interact with two self-directed online learning modules on 'phase changes' and 'heat'. Preliminary findings of the ongoing research study suggest a threefold effect of student perceptions on learning the concepts. Firstly, the awareness of the virtual environment affects their learning processes and performances. Secondly, previous virtual experiences helping students perceiving the learning environment more effectively. Finally, ongoing perceptual development during the interaction increases the intensity of student's engagement with the module. The implications of these findings that add to our understanding of the use of simulation-based online learning in science topics will be discussed.

Engaging Indonesian chemistry students in ethical dilemma story pedagogy

Wednesday, 10.50am: Seminar Room 3

Yuli Rahmawati[1], Nurbaity[1], Marheni[1], Elisabeth Taylor[2] & Peter Taylor[2]
[1]Universitas Negeri, Jakarta; [2]Murdoch University, Australia

In this paper we present research on an innovative curriculum project conducted at secondary schools in Jakarta, Indonesia during which we employed ethical dilemma story pedagogy to engage chemistry students in values learning. Our study explored how high school chemistry students could be engaged more deeply with ethics and values as part of their chemistry learning. For this purpose, we developed a curriculum package that employed ethical dilemma story pedagogy since previous research had highlighted its potential to enhance students' ethical awareness through critical and dilemma thinking. The subsequent mixed-methods study provided opportunities for deep engagement for both researchers and participants. Methods for generating data included: the Values Learning Environment Survey (VLES), semi-structured interviews, reflective journals, and classroom observations. Through the VLES we investigated perceptions of student engagement with the story, the teacher's supportive role, critical thinking skill development. Furthermore, we gained insights into students' learning of active listening and into their thoughts about chemistry learning. The results indicate that the students and the researchers engaged in critical reflection on their values, on collaboration with others, on their roles in participating in environmental education, on social issues, and on deep chemistry learning.

Chinese young children's understanding of plants as living things

Wednesday, 10.50am: Case Study Room

Ying Tao & Jun Zhang
Nanjing Normal University, China

The purpose of this study was to explore Chinese preschool children's conceptual understandings of plants as living or non-living things. The research was conducted in the interpretive paradigm and was designed to be descriptive with cross-sectional elements. Participants were children aged four to seven from three kindergartens, in Jiangsu Province, east China (*n*=90). In-depth interviews were carried out to explore the criteria children used to classify trees, grass and flowers as living or non-living things. The results showed more than half of the participating young children had an internal framework theory consisting of growth, death and need of water. Four-year-old children tended to use "human analogy" framework and five-year-old children tended to use "movement" framework when they determine the life status of the plants.

WEDNESDAY: SESSION 4

Exploring the pedagogical reasoning of expert teachers

Wednesday, 11.35am: Theatre/Auditorium

Ian Mitchell, Debra Pannizon, Stephen Keast & John Loughran
Monash University, Australia

The notion of capturing and portraying teaching expertise, although attractive, is difficult, partly because of the tacit nature of that knowledge. In this session we draw on an ongoing study, which has so far involved about 50 teachers, that addresses these research challenges. We use and extend the construct of teachers' pedagogical reasoning as a vehicle for identifying crucial, but hitherto tacit knowledge and providing insights into both how teachers enact aspects of skilled practice and why they make the decisions they do. The pedagogical reasoning of these teachers was not linear, but rather a complex, rapid, non-linear interaction (labelled pinball reasoning) between several distinct, but richly connected focal concepts. Each of these focal concepts coheres a substantial body of sophisticated practical knowledge. Exploring these focal concepts and the interactions between them provides routes into identifying and articulating the wisdom that drives skilled teaching and offers a window into pedagogical expertise. In this session we detail the pedagogical reasoning of two pairs of teachers as they each critically interrogate and rework a unit of work and use these data to illustrate how thinking about one focal concept triggers thinking about another as well as how pedagogical reasoning is influenced by factors such as the nature of the content.

An exploratory study of students' motivation, engagement and achievement in learning science

Wednesday, 11.35am: Seminar Room 1

Ching-Hua Hsieh[1], Hsiao-Lin Tuan[1], Chi-Chin Chin[2] & Shu-Chen Chen[3]
[1]National Changhua University of Education, Taiwan; [2]National Taichung University, Taiwan; [3]Pingtung Dong Gang High School, Taiwan

The purpose of this study is to investigate the relations among students' motivation, engagement and achievement in learning science. Using purposive sampling, we selected 258 8th graders in the same junior high school. The instruments used in the study included the Motivation in Learning Science Questionnaire (Wu, Tuan, Hsieh & Chin, 2013), Engagement in Learning Science Questionnaire (Hsieh,Tuan & Chin, 2014) and academic achievement. Data were analyzed using structural equation modeling with the AMOS path analysis. The results of this study revealed that students' motivation was found to affect their engagement directly (direct effects= .82) and academic achievement indirectly (indirect effects= .39). Students' motivation had no significant direct effects on academic achievement. Further, we examined the difference in gender, achievement levels and science preference degree for the relations among students' motivation, engagement and achievement in learning science. The findings revealed the different results that students' motivation only had significant direct effects on their engagement in learning science for low-achievement (direct effects= .77), average- achievement (direct effects= .83) and dislike-science students (direct effects= .79).

Representing earth science concepts through slowmation: Preliminary findings on students' alternative conceptions about plate tectonics

Wednesday, 11.35am: Seminar Room 2

Reece Mills, Louisa Tomas & Brian Lewthwaite
James Cook University, Australia

This paper reports on the the preliminary findings of a classroom-based research project that engaged Year 9 science students in the construction of a slow-motion animation, or 'slowmation', to scientifically represent types of tectonic plate boundaries. To create a slowmation, students manipulated and photographed a range of materials and displayed the photographs in quick succession using an iPad application. While the broader research project aims to investigate students' conceptual development in Earth science through the process of creating a slowmation, this paper reports on the preliminary findings arising from the test construction phase of the study. Data was generated from a two-tiered multiple-choice test instrument developed by the researcher to reveal students' initial conceptions of the topic, and semi-structured student interviews. It was found that students hold many alternative conceptions about plate tectonics, most of which have not been reported in previous research. In particular, students were confused about the formation of landforms at tectonic plate boundaries and the cause of subduction at an oceanic-continental convergent plate boundary. These findings can assist science teachers to diagnose students' alternative conceptions and implement effective conceptual change instructional approaches. The next phase of the research is also discussed.

Navigating an unmediated information landscape: Teaching digital literacy to science students

Wednesday, 11.35am: Seminar Room 3

John Cripps Clark
Deakin University, Australia

The discrimination of the accuracy and reliability of information is an important skill for science students. Traditionally students have been instructed to use list of criteria but this has been shown to be ineffective and transitory. The *Judging accuracy and reliability of information program* is a teaching and research collaboration between Science Communication academics and Library staff designed to motivate and educate students to judge the accuracy and reliability the science information that they would normally access on the web. Students, in collaboration, developed their own criteria for judging accuracy and reliability. We interviewed students and tutors and collected student work which was used to understand the sequence of representational constructions through which students developed skills of scepticism, collaboration, argumentation, rigorous testing, and the discovery of truth which were resonant with their identity as incipient scientists. By collaboratively constructing their own criteria and using these to critically evaluate scientific websites, science students were not only motivated to develop more sophisticated skills in judging accuracy and reliability but also are being given skills to remain critical interpreters and disseminators in an environment of rapid change of the technologies of information.

Situating children to incorporate science into their *habitus:* scaffolding cultural development with hinge science concepts

Wednesday, 11.35am: Case Study Room

Cheryl Jakab & Christine Redman
The University of Melbourne, Australia

Disengagement with science is a problem for 21st century societies. To what extent might with-holding of key concepts in early science curriculum exacerbate this problem? Given that situational factors, such as past experience and cultural norms, limit and direct what children can know and do (Siegal, 2008), could an earlier offering of key science knowledge open the door to more positive developmental thinking? Might this enable or leverage learner interest towards science? In this paper we present research that indicates that the provision of key scientific language, images, animations and visualisations is able to afford support for young learners, subsequently increasing their engagement with the science concepts. Analysis of classroom and interview discourse using Positioning Theory (Harré, 2002) has highlighted the storylines that young learners may be assisted to focus on in their early explorations of key ideas of science. We show evidence of children's scientific thinking trajectories when abstract ideas were made available for their exploration (Redman, 2004; Jakab, 2013) and what they can do when provided with access to key conceptual tools and begin incorporating these into their *habitus* (Burkitt, 2002). Our research highlights that what is 'developmentally appropriate' science is not fixed and a plausible way ahead.

WEDNESDAY: SESSION 5

Expert teachers coordinating representations in teaching astronomy

Wednesday, 12.20pm: Theatre/Auditorium

Russell Tytler[1], Chao-Ti Hsiung[2], Karen Murcia[3] & Jörg Ramseger[4]
[1]Deakin University, Australia; [2]National Taipei University of Education, Taiwan; [3]Edith Cowan University, Australia; [4]Freie Universität, Germany

There has been increasing recognition of the central role played by multimodal representational practices as part of the disciplinary literacies through which students reason and learn in science. While there is recognition of the need for teachers to use, interpret and coordinate representational work in science classrooms there has been little research into the specific strategies that support quality learning, or how effective representational practices might be situated within different pedagogical traditions. This study draws on close video ethnographic analysis of astronomy lessons in Australia, Germany and Taiwan, to investigate the representation coordination practices of expert teachers. The sequences were supported by significant digital and other representational resources. This representational work occurred within very different classroom organizational contexts, with different presumptions concerning the roles of teacher and students in constructing knowledge, different assessment traditions, and different degrees of openness and collaboration in group representational work. The study aimed to identify whether within this contextual diversity there are transcendent principles governing the way representations and models are established and coordinated. The research demonstrated the strategic ways in which the teachers established representational meaning, and used a range of narrative and embodied devices to establish meaning through coordination of sequences of representations.

Different achievers' motivation and achievement under guided inquiry instruction

Wednesday, 12.20pm: Seminar Room 1

Yen-Ruey Kuo[1], Hsiao-Lin Tuan[1], Chi-Chin Chin[2] & Tao-Yu Wu[3]
[1]National Changhua University of Education, Taiwan; [2]National Taichung University of Education, Taiwan; [3]Lingnan Normal University, Taiwan

This study was conducted on Grade 8 students in Taiwan focusing on their different aspects of motivation to learning and their achievement under totally 90-135 minutes, three units inquiry teaching. The samples were divided to high, average and low achievers in each experimental (n=29) and control (n=32) class. The results show high achievers' scores in the achievement tests benefited from the inquiry teaching in contrast to the fluctuated and declined performance on average and low achievers. Different achievers' motivation to learning seemed decreasing gradually as the inquiry teaching progressing. Possible reason is suggested.

The challenges realizing a science as practice classroom discourse: problematizing the curriculum for students' dialogic engagement

Wednesday, 12.20pm: Seminar Room 2

Aik-Ling Tan, Frederick Talaue & Seng Chee Tan
Nanyang Technological University, Singapore

What would it take for science teachers to shift classroom discourse and interaction from "science-as-knowledge" to "science-as-practice"? It has been argued that realizing this shift could be enabled by change towards a more dialogic or epistemic classroom discourse. In this presentation, we present an analysis of the teaching design and unfolding of General Science lessons by three science-trained teachers in both "Express" and "Normal Academic" classes at a secondary school in Singapore. Our data comes from teacher survey responses, video recordings of lessons, audio recordings of professional development meetings, pre- and post-observations dialogues, and student artifacts. We found that teachers' knowledge of the practices of science does not necessarily translate to a pedagogy that engages students in science practices. In fact, coding the classroom discourse for epistemic operations showed the predominance of describing, defining, and exemplifying science concepts. We attribute this tendency to engage in monologic discourse to, among other influences, teachers' lack of deliberate attention to problematize the curriculum for students. We critique their teaching design and enactment, appropriating Davydof's (1998) analytical scheme for revealing contradictions in the curriculum for productive student engagement: connections to science practices, epistemological dimensions of concepts, and relevance to students' lives.

Developing engagement and literacy in science: What do the girls say?

Wednesday, 12.20pm: Seminar Room 3

Amanda Woods-McConney[1], Mary Oliver[2] & Dorit Maor[1]
[1]Murdoch University, Australia; [2]University of Nottingham, United Kingdom

Despite decades of sustained national focus in several countries (e.g., Australia, Canada, New Zealand, UK, and USA) recent trends in students' course-taking and career choices suggest proportionally fewer students pursuing STEM-related study. Consequently, to address this trend, it is important to better understand factors currently related to students' engagement, literacy and attainment in STEM subjects and vocations. Our own recent research has examined students' science literacy and engagement in association with formal (school-based) and informal (outside of school, home-related) factors, using retrospective analysis of Programme for International Student Assessment (PISA) data. In this study we purposefully recruited several female students enrolled in late-secondary school Physics. This selection meant that all participants were engaged in school science and likely to be considering post-secondary study in STEM, and possibly STEM-related careers. Our purpose was to hear from this select group of female science students, their stories of influences in the development of their engagement and literacy in science. In particular, we were interested in juxtaposing their stories against the explanatory regression models we had previously developed. In this way, our purpose was to test the nomothetic explanations previously offered using idiographic stories of factors related to the engagement of girls in science.

Using a longitudinal research design to explore the impact of science outreach on parents' perceptions of their role in supporting young children's' learning

Wednesday, 12.20pm: Case Study Room

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

This paper explores the impact of an outreach program on parents' role in promoting young children's (3-4 years old) engagement with science, an important aspect of science learning that has received little research attention. We employed a longitudinal research design to study parents' perceptions of the impact of their participation in a science-based outreach program on their understanding of the everyday nature of science, and their understanding, inspiration, and confidence to engage with their children in science. Data were of two kinds: a baseline survey administered immediately after the outreach to 465 parents and interviews at one and seven weeks following the outreach experience to 15 parents. Quantitative and qualitative analyses of this combination of coarse and fine grained data suggested that even though parents were initially interested in science and comfortable supporting their child's play, participation in the science outreach program enhanced their understanding of how their child learned. Parents became more aware of their child's interest in science, the everyday opportunities for learning science through play, and began to seek opportunities to promote science-related experiences with their child. We also provide a critical analysis of the underlying assumptions in our research design for exploring issues of this kind.

WEDNESDAY: SESSION 6

Up to date with climate change education research

Wednesday, 1.50pm: Theatre/Auditorium

Hilary Whitehouse
James Cook University, Australia

Researching climate change education in formal and community settings is a matter of increased and necessary practice in the Anthropocene. Climate change education research sits at the intersection of a number of research field including science and environmental education research The presenter will summarize her findings from a literature review on the types and conclusions of recent research conducted on climate change education in Australia and overseas. The presentation will include a brief summary analysis of the topics of research published and the types of research undertaken in at different educational levels. A summary of major findings on matters of curriculum, pedagogy, and selected social and cultural dimensions of practice (including gender) will be presented. Productive topics for future research will be the subject of group discussion. The purpose of the presentation is informational and generative. The presenter is an executive editor of *The Journal of Environmental Education*.

The problem with Saudi teachers' assessment: Investigating the ESRU questioning framework

Wednesday, 1.50pm: Seminar Room 1

Saeed Almuntasheri
University of Queensland, Australia

This case study is part of a larger project aimed at developing teachers' knowledge of questioning as assessment strategy to support teaching science based inquiry in Saudi Arabia. It is drawn from a wider study examining the questioning practices of six Saudi teachers in six primary schools. By adapting ESRU(Elicits, Student response, Recognises, Uses) questioning framework(Ruiz-Primo & Furtak, 2006), this paper reports on issues with the assessment conversations of one of the primary science teachers. It illustrates how this teacher uses questioning strategies to elicit, recognise, and use student responses. By developing thinking about the use of these questioning strategies to guide student conceptual development of science this study hope to develop insight on how these issues can be addressed in future teacher education programs in Saudi Arabia.

The role of teacher questioning in guided scientific inquiry learning: a cross national comparison of Taiwan and Australia science classrooms

Wednesday, 1.50pm: Seminar Room 2

Ya-Chiao Lee[1], **Sharon Hsiao-Lan Chen**[1] **& Hsung Chao-Ti**[2]
[1]National Taiwan Normal University, Taiwan; [2]National Taipei University of Education, Taiwan

Effective teacher questioning and classroom discourse play important roles in stimulating, scaffolding students' thoughts and developing scientific inquiry skills. However, teachers may encounter challenges when providing guided questions in inquiry-based science classrooms. This study examines how experienced elementary science teachers in Taiwan and Australia use questioning to guide students' learning in their inquiry-based science teaching. Through cross-national comparison, this study aims to understand collective important factors that contribute to effective teacher questioning as well as to explore the impact of cultural and curriculum contexts on the framing of inquiry processes. A framework of questioning in guided scientific inquiry learning was developed, showing different forms of questioning according to its function: confirmation, stimulation, clarification and extension. Preliminary analysis show experienced teachers combine different forms of questions with flexibility to serve as scaffold for guiding students' to explore and learn scientific knowledge. Through video analysis of the "Simple Machine" unit from Taiwan case and the "Flight and Gravity" unit from Australia case, this study not only examines the role of teacher questioning but also investigates related cultural and contextual factors. Based on the analysis, suggestions are provided for using questioning in inquiry-based science classroom to promote more effective scientific inquiry and learning.

Development and validation of a questionnaire to measure primary school students' learning environment, understanding and attitudes in engineering and technology

Wednesday, 1.50pm: Case Study Room

Rekha Koul, Barry Fraser, David Henderson, Moses Tade, Nicoleta Maynard & Rajinder Sing Attar
Curtin University, Australia

This presentation reports the development and validation of a questionnaire to assess primary school students' perceptions of learning environment, attitudes and understanding in Engineering and Technology classes in Perth, Western Australia. 920 students in years 4–6 from 9 schools completed a four-scale questionnaire comprising 20 items with a three-point Likert response scale. Factor analyses supported the *a priori* factor structure and internal consistency of the questionnaire. High alpha coefficients ranging between 0.89 to 0.97 confirmed the reliability of the questionnaire. MANOVA supported the effectiveness of the Engineering and Technology curriculum materials in terms of pretest–posttest improvements of moderate magnitude for learning environment, enjoyment, career interest and understanding scales. In terms of differential effectiveness, the curriculum materials appeared to be of comparable effectiveness for students at different grade levels and for different genders. Following their involvement in the program, students showed improved understanding and interest in engineering and technology.

WEDNESDAY: SESSION 7

Walking the talk as an intentional, embodied, (co)constructed environmental educator

Wednesday, 2.35pm: Theatre/Auditorium

Peta White
Deakin University, Australia

Exploring the question *(how) can I use personal change to inspire educational and social/cultural change*, this work was embodied and action orientated with a thesis that the doing (action) is as important as the thinking and talking about it. As Dewey (1929) stated "theory separated from concrete doing and making is empty and futile" (p. 281). A critical poststructural ecofeminist frame undergirded an autoethnographic self-study where I changed my living practices to become more sustainable while living within Western society, and used this as a platform for how I could become a better environmental educator and activist. *Personal change* was researched via autoethnographic means where I learned to read the discourses operating on me, which constantly disciplines my choices. I reduced my ecological footprint (Wackernagel & Rees, 1996) from 16.4HA (hectares) to 1.8HA. *Transformational education* was researched via self-study as I taught a pre-service teacher unit in environmental education. Using self-reflection, critical friends, and student focus groups I explored student resistances, power and relationships, a critique of curriculum, and personal change. *Social/cultural change* was researched via narrative meta-reflection and I used this work as an opportunity to undertake environmental education activism. The conclusions reveal how difficult the journey was/is and that a destination is (relatively) unknow(n)/able. It is the doing, the intention, the embodied action, that led/leads to a transformational understanding of how to live more sustainably, and how to teach/encourage others to (re)consider their own actions/choices.

Addressing alternative conceptions in physics learning with the help of a pre-instructional diagnostic tool

Wednesday, 2.35pm: Seminar Room 1

S Ravindran[1] **& Russell Waugh**[2]
[1]Ministry of Education, Singapore; [2]Edith Cowan University, Australia

The personal response system (clickers) appears to provide a solution for the efficient determination of students' alternative conceptions in a typically large physics class in mainstream Singapore secondary schools. But can its use also help improve students' conceptual understanding and motivation in physics learning? This research was part of a larger study that examined how the use of a pre-instructional diagnostic tool during physics lessons affected the conceptual understanding and motivation of students. Two reliable linear scales for measuring physics conceptual understanding and motivation were created using the Rasch Unidimensional Measurement Model computer program (RUMM2030) (Andrich, Sheridan & Luo, 2010) from a sample of 480 secondary-three (Year 9) physics students in three mainstream schools. These Rasch measures were then used in the analysis of variance and covariance to determine the effectiveness of using the diagnostic tool to enhance physics learning in the classroom. The results indicated improvements in students' conceptual understanding and motivation when the personal response system was used but not significantly greater compared to classes where it was not used. They also highlighted the importance of high quality items in the diagnostic tool that tested students' understanding, rather than how these items were administered.

The pedagogical issues and misconceptions of Chinese physics teachers in their implementation of inquiry-based teaching and their educational implications

Wednesday, 2.35pm: Seminar Room 2

Zheng Zhu[1]**, Tony Wright**[1] **& David Geelan**[2]
[1]University of Queensland, Australia; University of Griffith, Australia

Literature review shows that science teachers all over the world struggle to implement inquiry-based changes to their teaching practices. With an aim of addressing the barriers to the effective enactment of inquiry-based teaching (IBT), a mixed-methods study was conducted to explore five Chinese physics teachers' perceptions and enactment of IBT in their unique teaching contexts. This paper presents the results from the case studies. It was found that these teachers generally adopted guided approaches to student inquiry, meanwhile demonstrating some common and individual pedagogical issues and misconceptions in their implementation of IBT. They seemed to provide a high level of structure to student inquiry to keep students' learning under control, generally used whole-class activities to engage all students in learning, and often employed questions and observation to check student progress. In addition, they had individual pedagogical issues in using questioning strategies. Furthermore, their instruction was often distorted by their misconceptions and lack of pedagogical knowledge about inquiry.
Noting the pedagogical issues and misconceptions that teachers demonstrated in their implementation of IBT, this study implies that science teachers need to be provided with appropriate, sustained, system, and contextualised professional development, in order to improve their success in implementing IBT.

Visual representation use as stimulus in science competition and assessment tests

Wednesday, 2.35pm: Case Study Room

Christine Preston
University of Sydney,

This study investigated the use of visual representations as stimulus material in science competition and assessment tests designed for primary school students. Research indicates that visual representations, particularly science diagrams can be problematic for students to understand. Further, little time is spent at school teaching students how to read science visual representations. The aim of the research was to determine the types of visual representations used as stimulus, how this compared across science disciplines and what students were asked to do with the visual stimulus. Content analysis was conducted on a four year sample of competition and assessment papers designed for primary school years 3-6 (n=16). Findings from the study indicate several types of visual representations are used as stimulus for test questions. Visual representations are used across all four science disciplines (biology, chemistry, geology and physics) with some subject areas featuring more than others. Primary age children are expected to use visual representations in a variety of ways to answer the test questions. Implications for teachers and researchers of these findings will be discussed.

WEDNESDAY: SESSION 8

Science learning in 'bush-kinders' in Australia

Wednesday, 3.35pm: Theatre/Auditorium

Coral Campbell
Deakin University

The Forest kindergarten movement of Europe has translated into the recent 'bush kinder' approach in some Australian kindergartens. There are many learning benefits of children playing in natural settings, such as improved appreciation for the natural environment, greater motivation and risk-taking behaviour. Much of this has been documented in earlier research. However, cognitive development, in particular in relation to the science learnt through play in 'bush settings', has not been investigated. This pilot project followed a number of kindergartens in Australia which were using either a bush or beach kindergarten approach. Three science education researchers were involved in documenting the 'science through play' observed. Using three separate video-stimulated interviews, educators were asked to comment on their perceptions of the science that was part of the children's play in the bush settings. The findings revealed that the educators expected children to learn about the environment and some biological science ideas. As a consequence, scaffolding of learning was focussed on these areas. Other science learning relating to the physical sciences was less well supported, although equally prominent in the children's experiences in the natural setting.

Students' representations in physics problem solving

Wednesday, 3.35pm: Seminar Room 1

Judyanto Sirait & Haratua TMS
Tanjungpura University, Indonesia

Physicists use multiple representations such as sketches, motion diagrams, force diagrams, graphs, and mathematical equations to represent concepts. This study probed the effect of utilizing multiple representations while learning physics and solve physics problem. The samples of this study are senior high school students in West Kalimantan. Qualitative and quantitative research methods were applied to analyze students' score and the effect of multiple representations while students learn the material. The result shows that students who employed more than one representation such as motion diagram, force diagram while solving the problem achieved higher score than students did not. This indicates that multiple representations can be helpful to enhance students' understanding of physics concept.

Re-theorising analogy in science education: The localised, situated practices of *everyday analogical reasoning*

Wednesday, 3.35pm: Seminar Room 2

James Davis & Alberto Bellocchi
Queensland University of Technology, Australia

Science education literature tends to link pedagogical analogies to the cognitive sciences via theories such as structure-mapping. Although making these links, the literature highlights situated dimensions of analogical reasoning that are not captured by these theories. These absent, situated dimensions suggest contemporary theory to be teacher centric and decontextualized from the experiences of science classrooms. Both cognitive scientists and science educators suggest there is 'something more' to be known about analogical reasoning. Yet this 'something more' has not been addressed in science education research. The present study is important as it suspends the *a priori*, teacher centric perspective of analogical reasoning and adopts a methodology that accesses the essence of analogical reasoning as a situated social phenomenon in the science classroom. The aim of this paper is to present an alternative theoretical approach to analogical reasoning, to reflect the reality of the localized, situated context of science classrooms.This study draws on a conceptual framework informed by ethnomethodology that gives access to the 'something more' that is missing from contemporary theory. That 'something more' arises as an accomplishment of the localized, situated practices of members of the science classroom and is presented in this paper as *everyday analogical reasoning*.

Using inquiry-based teaching to improve low achievers' learning motivation in science

Wednesday, 3.35pm: Case Study Room

Shao-Yun Huang & Hsiao-Lin Tuan
National Changhua University of Education, Taiwan

The purpose of this study is to investigate the influence of inquiry-based teaching on low achievers' learning motivation in science. The combination of qualitative and quantitative research design was used in this study. One 8th grader science class was chosen and inquiry-based teaching was implemented for one semester. Using purposive sampling, we selected 12

low-achievement students in the class. The collected data includes teacher's interviews, students' interviews, classroom observation and the Motivation in Learning Science Questionnaire (MILS) (Wu, Tuan, Hsieh, & Chin, 2013) before and after the study period. Findings revealed that, in MILS, scales of "Negative learning strategy" were significantly decreased; on the contrary, the scales of "self-efficacy", "Learning strategy", "Science learning value", "Performance goal", "Achievement goal", "Learning environment stimulation", and "Examination" did not show a significant increase, though appeared positive. For qualitative data, low achievers take active learning strategies in learning science. Reasons for low achievers' involvement are receiving rewards and recognition. The results revealed that low achievers' motivation to learn science is stimulated by a range of different factors, with autonomy, relatedness and belonging apparently. Finally, inquiry-based teaching approach can improve low achievers' learning motivation, enhance them to participate in inquiry curriculum, and promote the confidence for science learning.

WEDNESDAY: SESSION 9

Teaching science outdoors

Wednesday, 4.20pm: Theatre/Auditorium

Rowena Scott
Curtin University

We have become indoor people! As technology use increases and risk management becomes forefront in the minds of parents and teachers, children are playing and learning outdoors less often than in previous generations. Outdoor learning spaces are noted as a feature of Australian learning environments in the Early Years Learning Framework fostering an appreciation of the natural environment and inviting exploration and discovery which are integral to learning science. There is a trend for early childhood centres and primary schools to grow gardens and the Stephanie Alexander Kitchen Garden program is successful nationally. A review of recent literature on formal and informal teaching and learning outdoors as part of school curriculum provided the framework for teaching pre-service teachers outdoors for the first seven weeks of semester in their *Engaging Children in Science* class. This presentation poses and answers questions that arise from that teaching.

Using the thinking frames approach to teach thermal physics

Wednesday, 4.20pm: Seminar Room 1

Felicity McLure, Mihye Won & David Treagust
Curtin University, Australia

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) 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 Year 9 Science teacher, the first author developed a sequence of lessons based on the TFA in order to study its impact on students' conceptual understanding and written explanations. One of the topics was thermal physics. In order to challenge common alternative conceptions about this topic (Clough & Driver, 1985; Lewis,

1994), demonstrations, questioning and small group discussions were used to encourage them to develop scientific explanations through representing verbally, pictorially and in a written form. Thermal Concept Evaluation (Yeo & Zadnik, 2001) results indicated that students had developed quite sophisticated scientific understanding on the topic. Interviews with students revealed that students recognised the benefits of the TFA in understanding concepts and writing scientific explanations. Establishing effective small groups to support learning for all students was one of the challenges we will discuss along with other benefits of implementing the TFA for school science.

Attending to alienation in online science teacher education through social bonds

Wednesday, 4.20pm: Seminar Room 2

Alberto Bellocchi[1], **Kathy Mills**[1] **& Stephen Ritchie**[2]
[1]Queensland University of Technology, Australia; [2]Murdoch University, Australia

Online learning for pre-service science teachers can be an alienating experience. Practitioners and researchers who are interested in delivering high quality online learning are interested in addressing the feelings of alienation documented commonly in the literature. We report on the amelioration of alienation experienced initially by online learners by focusing on the status of social bonds. The study took place in the second author's science education methods course. Instruction and learning resources were delivered through a web-based content management system that included discussion boards and web-logs. Online students also accessed video recordings of the weekly lectures for the face-to-face group. Data sources consisted of online learners' emotional accounts reported through an e-motion diary. We interpreted students' emotions and the status of social bonds through sociological perspectives. Outcomes included feelings of inclusion for online students that were facilitated by the video recordings of classroom transactions and science demonstrations. Blogging about emotional experiences provided opportunities for students to share their emotional experiences and this led to the formation of social bonds and the alleviation of initial emotions, such as fear, about becoming science teachers. Implications are presented for improving online learning experiences and future directions for research on online learning.

A project-based science program for promoting elementary school students' performance in science practices

Wednesday 4.20pm: Case Study Room

Yu-Chen Lee
National Taiwan Normal University, Taiwan

In the new 12-year curriculum in Taiwan, the emphasis about core literacy requires teachers to cultivate students with autonomous action, communication and interaction by applying various tools, and societal participation. The elementary school teachers face challenges about educating students in exploring problems, making and enacting plans, developing fundamental language and science literacy, collaborating in group works, and engaging in issues. In this study, we developed a project-based science club program for grade 5-6 students. In the whole-school year program, the 4 groups of students (9 Boys, 8 Girls) learn through appreciating accomplished science fair projects, practicing basic and advanced science investigation skills, framing and evaluating research questions, planning and carrying out investigations, self-monitoring work progress, writing a project report, and presenting in a conference. Teaching plans and logs, students learning portfolios, and project products were

analyzed by the constant comparative method to generate thematic findings. It is concluded that the program is effective in enhancing students' competencies in clarifying problems and searching for possible evidence-based solutions.

THURSDAY: SESSION 1

What was going on in your head during that lecture? Processes of episodic motivation among stem and non-stem undergraduates in formal lectures

Thursday, 8.30am: Theatre/Auditorium

Dave Palmer
University of Newcastle, Australia

When a student enters a formal learning situation there might be a number of personal and situational factors that could potentially influence how motivated that student is at that particular point in time. However, we still have very little understanding of the processes involved. The purpose of this study was to identify processes involved in instances of motivation in formal lectures. Forty-seven STEM and non-STEM students were individually interviewed immediately after one of their normal lectures, and were asked to describe their feelings of wanting to learn or not wanting to learn that occurred during that lecture. It was found that a wide range of internal and external factors can influence wanting to learn, and adaptive learning behaviours are closely tied to the relative strength of that feeling.

Changes of teaching and learning by using loan box in classrooms

Thursday, 8.30am: Seminar Room 1

Shu-Fen Cheng[1], Jer-Ming Hu[1], Yi-Jung Lin[1], Zn Chen[2], Meichun Lydia Wen[2] & Yu-Teh Kirk Lin[1]
National Taiwan University, Taiwan; 2National Changhua University of Education, Taiwan

Four loan boxes have been created using mostly museum specimens that targets 5th- to 7th-grade students. We have finished the design of lesson plans, expert review, and pilot lease & loan, and held workshops for teachers. We collected data on teachers' instructional representations, and the change of students' learning motivation in the classrooms. The Loan Boxes of "The Bone Stories" and "Understanding Breadfruit Tree" were evaluated by school teachers in 2013 and 2014 when they were loaned 36 times by 13 junior high schools, 10 elementary schools and one museum, and used on 4500 students. For teachers' instructional representations studies, there were totally five evaluation stages in this study including preparation, discussion, teaching, interviewing, and analysis. Data collection and analysis were conducted using instructional representations checklist, learning sheet, students' motivation toward science learning (SMTSL) questionnaire, classroom observation, and interview record. The teachers performed more than 30 forms of instructional representations using loan boxes. Through the loan boxes, the teachers' instructional representations tended to become student-centered and significantly ($p < .05$) increased students' learning motivation in results of SMTSL questionnaire from 136 elementary/junior-high students were collected and analyzed before & after the lesson.

Exploring science capabilities

Thursday, 8.30am: Seminar Room 2

Ally Bull
New Zealand Council for Educational Research, New Zealand

In recent years NZCER has been exploring what a "capabilities approach" to science education might involve. By a "capabilities approach" we mean a view of curriculum that focuses on dispositions – what students are able to *be* and do, not just on what they know. This approach is widely promoted as necessary for future-oriented education but at the same time challenges many tacit assumptions about education. In NZ, many schools have picked up the idea of "science capabilities" but there is a need to find out more about the conditions and contexts that support teachers to refocus their teaching to foreground these capabilities. NZCER is carrying out a small research project that involves working with primary and junior secondary students, and recording and analysing their responses to tasks that focus on science capabilities. The intent of the project is to support teachers by providing a sense of what "progress" in the development of capabilities might look like. Student responses are currently being developed into annotated exemplars that highlight both the range of capabilities displayed by students and the sorts of questions teachers can ask to encourage the development of these capabilities.

Strategies to improve communication about a socioscientific issue: Building a map to identify participants and opinions

Thursday, 8.30am: Seminar Room 3

Bev France & Sally Birdsall
The University of Auckland, New Zealand

One of the issues when framing a discussion about SocioScientific Issues (SSIs) in classrooms is to provide an opportunity for students to gain an appreciation of the dimensions of the issue. Bruno Latour's Actor-Network-Theory (ANT) (Latour, 2007) is used to theorise and analyse the identification and categorisation of participants-actants (material and semiotic) that could be involved. Aerial drops of 1080 (sodium fluoroacetate) to control mammalian pests in the New Zealand forest ecosystem is the SSI under analysis. It is predicted that the variety of viewpoints can be nuanced using ANT so that a map can be constructed in order to reveal the complexity and the range of diverse voices. Two strategies have been used to unravel the complexity of 'voices' that contribute to this issue. First websites (23) are analysed to reveal the stance of different groups, the actants involved and their group reasoning. Second human actants (15) who are involved professionally or personally are asked their opinion through a Delphi investigation. ANT provides a theoretical tool to identify and analyse multiple perspectives of this SSI that will inform students' position during discussion and the taking of appropriate action if they decide to become actors in such a network.

Paradigm shifts in methods of teaching primary science: Investigative case-based learning vs direct instruction approach

Thursday, 8.30am: Case Study Room

Muhd Shafiq Shaik Hussain
Ministry of Education, Singapore

This study investigates the use of investigative case-based learning pedagogy and compares its effectiveness with the traditional direct instruction method in the teaching of Interactions in Primary 6 pupils. As part of this study, there is a need to provide learners with problem-solving opportunities and stimulate higher-order thinking. Lessons must not only emphasize teaching of knowledge but also provide platforms for pupils to be engaged in discussion of scientific concepts. A pre-test was administered to two classes of the same ability before providing the necessary intervention methods before a post-test was administered to both classes to determine the pupils' understanding of the topics taught using both teaching methods with the two classes. A survey was also given to the experimental group at the end of the lessons to measure their perception on the use of investigative case-based learning method in their lessons. Interviews were conducted and recorded on selected pupils who took part in the survey for closer analysis. Sessions of the investigative case-based lessons were recorded for observation. From the post-test results, the standardised mean difference (SMD) and Hake's normalised gain <g> indicated that the investigative case-based learning pedagogy had the same effect in helping pupils to improve their understanding of Interactions as compared to the direct instruction method. Case-by-case analyses revealed some interesting findings that might have implications for future studies. Finally, limitations and recommendations for future studies are discussed.

THURSDAY: SESSION 2

An investigation of the quality of online science education at the tertiary level from the perspectives of students, instructors and university administrators

Thursday, 9.15am: Theatre/Auditorium

Stephanie Colby, Mihye Won & David Treagust
Curtin University, Australia

This study investigates the effectiveness of online science education at the university level from the perspectives of university administrators, instructors, and students. Despite recent studies on the effectiveness of online learning, educators still do not seem convinced with the quality of online education. Why do we perceive online learning is not as effective as the face-to-face education? What do we look for as quality indicators for effective science education? In this multiple-case study utilizing one-on-one interviews, we have investigated the perception of quality education for three stakeholder groups of online university science education—administrators, instructors, and students—and documented the source of incongruity in the perception of quality. Fifty participants from five different universities in the Midwestern United States shared their perceptions. Initial results confirm a discrepancy between participant perceptions regarding online science education, primarily based upon their understanding of online learning tools and workload expectations. Perceived effectiveness appears to be hindered critically by the inclusion of hands-on laboratories and their ability to be conducted online. This study provides a comprehensive resource for

gauging effectiveness of online science education and suggests the sources of current scepticism of the quality of online science education.

Design based inquiry using the microbial fuel cell

Thursday, 9.15am: Seminar Room 1

Timothy Tan, Yew Jin Lee, Peter Lee & Choon Kook Sam
Nanyang Technological University, Singapore

Microbial fuel cells (MFC) generate an electric current through the biochemical processes of living microbes. Understanding how it works requires integration of concepts across chemistry, biology and physics. MFCs have many functional parameters and is thus an ideal device for design-based inquiry (DBI) lessons where students are challenged to construct improvised MFCs to meet specific goals. Significance: Such tasks push students to apply their acquired scientific knowledge and skills while fostering deep understanding. The inherent STEM integration features of the task provide a platform for students of diverse abilities and aptitudes to work collaboratively. Aim/Methodology: A key aim was to establish the extent to which students inform or base their experimentation and decisions for the development of their prototype on 'science', as opposed to trial-and-error or capricious choices. High-ability grade 8-10 students were given an introduction to MFCs and then facilitated during experimentation and build phases. Video recordings were analysed for evidence-based explanations (EBE) and argumentative reasoning. Findings: Students were able to formulate and conduct investigations to determine optimum parameters for MFC function, then cooperatively design and construct working MFCs with novel features. They were able to apply 'science' to experimental-design tasks, engineering-design tasks, and to solve complex inter-disciplinary problems.

Science Sparks to the rescue: One school's experience

Thursday, 9.15am: Seminar Room 2

Beverly Lowe
University of the Sunshine Coast, Australia

Science is often viewed as the 'ugly stepchild' curriculum area. It is considered to be less valuable and therefore often has less priority on the state education agendas and the school agendas. However, as recently as 2009, after the "Shaping the Nation" report by Geoff Masters, a mini science revival was initiated. Masters announced the Australian standings compared with many of the world's nations. This report also identified Queensland students as being one of the lowest in the nation in literacy, numeracy and science. One of Master's many recommendations suggested that the state government provide teacher support in the form of specialist science teachers to work in schools. The Queensland State Government took heed of this recommendation and enlisted high school science teachers as 'Science Spark' teachers who provided science training associated with the introduction of the new Australian Curriculum. Through the use of surveys, interviews and observations, teachers from one state school revealed their story of the Science Spark teacher-training program in their school. The results include improved confidence, science avoidance, and minimal change in teaching strategies. This again demonstrates how the nature of teacher professional development in primary science is crucial in facilitating change in science teaching practices.

Towards a model of supporting language and literacy practices for science teaching and learning

Thursday, 9.15am: Seminar Room 3

Kok-Sing Tang
Nanyang Technological University, Singapore

There is wide consensus that language and literacy play an important role in the learning of science. Thus, students need to be given more support to develop science literacy skills in interpreting and communicating information, constructing explanations, and engaging in evidence-based argumentations as they learn science content. Yet, there is little research to inform science educators on how to enact these literacy practices in the classrooms. In this paper, I present findings from an intervention research aimed to develop a pedagogical model to support students' development of disciplinary-specific literacy skills. Based on video observations of ninth-grade physics and chemistry teachers, the characteristics of literacy practices in their classrooms before and after the intervention were compared. Specifically, discourse analysis was used to analyze the oral and written language used in the classroom. Two pertinent findings from the analysis will be presented. First, it was observed that classroom talk became more dialogic as students were given more opportunities to explore phenomena and communicate their observations and ideas among themselves. Second, more emphasis was given to the construction of scientific explanations when an explicit language support was taught to the students. Finally, the implications and tensions surfaced from the research will be discussed.

The effects of design-based learning on elementary students' achievement and attitudes in science class

Thursday, 9.15am: Case Study Room

Jeong-yoon Lee & Shinho Jang
Seoul National University of Education, South Korea

Engineering design can promote interest and be used a method of scientific problem solving in science class. However, engineering design is not a required subject in science class in most elementary school. The purpose of this study was to develop design-based learning program for sixth graders in elementary school and identify effects of the program. The program is Electromagnet crane, in which engineering design is used to teach students electromagnet concepts such as the method of making strong electromagnet. Subjects were sixth graders of elementary school in Seoul (27 students). This study examined pre-post changes about students' achievement and attitudes in science class. The first result is that in the DBL program, several features are represented when compared to a traditional science class. For example, students discuss actively and share their ideas. They acquire concepts through this discussion and product electromagnet crane. Second, This program is effect on acquirement of knowledge. Students participated this program improve their grades. Third, this program was helpful to increase students' attitudes in science class. This study has significant implications for proposing effective ways to teach science using design.

THURSDAY: SESSION 3

Flipping the classroom in undergraduate physics education

Thursday, 10.00am: Theatre/Auditorium

David Geelan, **Adam Palmer & Wendy Loughlin**
Griffith University, Australia

New mixed mode pedagogical approaches in university physics pedagogy blend the affordances of online and multimedia materials with those of face-to-face teaching and tutoring to enhance student learning. This paper is a case study and evaluation of the implementation of a novel teaching approach in a first year, semester 2 Physics course in a Queensland university that included video mini-lectures, assigned readings and practice problems and face-to-face tutoring. Some features of the chosen approach were effective and flexible for learners while others were modified or abandoned. Students achieved scores comparable with those in earlier, more traditional iterations of the course and reported enjoyment and engagement. Exploring the potential of non-traditional pedagogical approaches contributes to the body of knowledge informed physics pedagogy for undergraduate education. Similar approaches are likely to be applicable in other tertiary and secondary physics education contexts, and experiences and lessons learned will be of interest to ASERA members with interests in physics education.

The gradual release of responsibility: A case study of teaching science inquiry skills

Thursday, 10.00am: Seminar Room 1

Julia Whittaker, Donna King & Jim Watters
Queensland University of Technology, Australia

Research suggests that the current form of science education fails to engage contemporary youth in advanced societies. Despite many initiatives to improve science teaching in the primary years, the quality of science teaching remains a challenge. This case study focuses on a pedagogical approach for teaching scientific inquiry skills in a year-4 primary classroom. The approach adopted the gradual release of responsibility (GRR) strategy widely used in literacy education. Data were sourced from classroom observations, interviews and student performance. Data were analysed using a modified SOLO-taxonomy model and student performance was monitored using the ACER PatScience test. The findings reveal that a learning environment was established in which students discussed their ideas, designed experiments using fair testing procedures, made accurate observations and measurements, analysed and offered justifications for results, questioned the limitations of their ideas, and negotiated knowledge claims in ways similar to some of those in the scientific community. Furthermore, student-student and teacher-student discourse were fundamental for scaffolding students' learning and application of Science Inquiry Skills. Through the Gradual Release of Responsibility (GRR) model of instruction, the year 4 teacher guided students to develop an understanding about Scientific Inquiry leading to the foundations of scientific literacy.

An enquiry into inquiry in the Australian curriculum: Portrayal of, and leveraging the shared skills

Thursday, 10.00am: Seminar Room 2

Gillian Kidman
Monash University, Australia

In many ways, Australia was built upon an Inquiry foundation. This presentation will provide a brief historical overview of how Inquiry has featured in Australia's educational history. The presentation will then analyse the portrayal of inquiry as it is presented in the inquiry skills sections of the Australian Curriculum. As inquiry learning and teaching originated in the scientific domain, the 'Science Inquiry Skills' strand of the Australian Curriculum will be used as a base for overlaying the Humanities Inquiry strands. This overlay will highlight the types of activities, cognitive tasks and data sources that are shared between the learning areas. This identification of shared inquiry skills is important for primary school teachers as they have the advantage of whole-of-curriculum responsibility. They have an aerial view of the Australian Curriculum across all learning areas and in some cases across year levels.

Teachers' use of investigative case-based learning to support students' development of scientific literacy in the lower secondary science classroom

Thursday, 10.00am: Seminar Room 3

Chor Yam Lau[1] **& Hwee Ting Lim**[2]
[1]Ministry of Education, Singapore; [2]Science Centre, Singapore

A major goal of twenty-first century school science is increasingly viewed by education systems around the world to be the development of students' scientific literacy. In line with this emphasis, the revised 2013 Singapore lower secondary science curriculum gives emphasis not only to the development of students' basic understanding of the knowledge and processes in science, but also their understanding of the applications of science in real-world contexts. This study investigated how teachers used an investigative case-based learning approach (ICBL) to make a shift in their practice to support the intended student learning outcomes of the new curriculum. Teacher teams in each of four selected secondary schools represented the cases examined. Multiple data sources from teacher interviews, lesson observations, discussion notes and student surveys were used to provide insights into how teachers from the four schools implemented and adapted their ICBL lessons to scaffold their students' learning. Findings from this study may serve to inform classroom practitioners, educators and policy makers on the feasibility and implications of using ICBL to enhance students' engagement and understanding of the processes and applications of science.

The implementation of two complex, innovative science subjects in a primary education program: Quantitative findings over an 8 year period (2007-2014)

Thursday, 10.00am: Case Study Room

James Deehan[1] **& David McKinnon**[2]
[1]Charles Sturt University, Australia; [2]Edith Cowan University, Australia

There has been a steady decline in science interest and performance permeating through all levels of science education in Australia (e.g. Tytler, 2007). It is imperative that quality science experiences are delivered by confident primary teachers during formative years of

education. This paper reports on the long-term implementation of two complementary, innovative tertiary science subjects that intended to develop the confidence and competence of pre-service primary teachers at a rural Australian university. The research aims is to assess the changes in the science teaching efficacy beliefs of multiple cohorts of pre-service elementary teachers (2007-2014) as they completed two separate science curriculum subjects. The combined effect of the two subjects is also considered. Data were collected through multiple iterations of single cohort, pre-post test quasi experimental designs. Repeated measures designs were afforded by the collection of data from the same participants across the two science subjects. Quantitative data was collected via the administration of the Science Teaching Efficacy Belief Instrument B (STEBI-B) to 923 pre-services teachers over 8-years. The results indicated that the science subjects had the intended complementary effect as the pre-service teachers' personal and general STEBs both showed 1-sigma effect size growth. Broader implications are discussed within the paper.

THURSDAY: POSTER SESSION 2 (Lower Colonnade)

The effectiveness of blending physical and virtual manipulation on students' understanding of force and motion

Tzu-Ling Wang[1], Yi-Kuan Tseng[2], Mei-Yen Chiu[3]

[1]National Hsinchu University of Education, Taiwan; [2]National Central University, Taiwan; [3]Hsin-nan Elementary School, Taiwan

This study aims to explore the effectiveness of blending physical and virtual manipulation on students' science achievement and conceptual understanding in the domain of force and motion. A pretest-posttest quasi-experimental design was used that involved 199 fifth grade students assigned to three learning conditions: only physical, only virtual, blending physical and virtual manipulation. A science achievement test and an open-ended questionnaire were administered to students before and after a teaching intervention. The results showed that the use of a blend of physical and virtual manipulation enhanced students' science achievement more than the use of virtual manipulation alone. Moreover, the results showed that the use of a blend of physical and virtual manipulation promoted students' conceptual understanding most efficiently compared to the use of either physical or virtual manipulation alone. The use of virtual manipulation alone was least influential for students' conceptual understanding compared to any other learning condition. The use of physical manipulation was identified as the cause of this differentiation.

Effects of presentation format and spatial ability on students' understanding of heat and temperature

Yi-Kuan Tseng[1], Tzu-Ling Wang[2], Chi-Ru Ku[3]

[1]National Central University, Taiwan; [2]National Hsinchu University of Education, Taiwan; [3]Ping Sing Elementary School, Taiwan

The purpose of this study was to investigate the impact of presentation format and spatial ability on students' science achievement and conceptual understanding related to the topic of heat and temperature. A quasi-experimental design was used in this study. The participants were 495 sixth grade students from eighteen science classes assigned to three learning environments: only static, only dynamic, and combining static and dynamic visualizations. A

science achievement test, a two-tier conceptual test, and the PMA Spatial Relations Test were used to collect data. The results showed that the use of combining static and dynamic visualizations facilitated students' science achievement more than the use of only static or only dynamic visualizations. In addition, the results showed the use of combining static and dynamic visualizations promoted students' conceptual understanding most efficiently compared to the use of either only static or only dynamic visualizations. Moreover, the use of combining static and dynamic visualizations is conducive to low spatial ability students' science achievement.

Students' use of self-assessment on multimodal writing to learn science tasks

Hung-Ming Chen
Shi-Yuan High School, Taiwan

Literature indicates that simple inquiry activities in school science differ from authentic science inquiry in several aspects, such as generating research questions, designing studies, making observations, explaining results, developing theories, and studying research reports. Writing-to-learn activities have potential to enhance learners' conceptual understandings and science practices. In this study, we applied backward design principles to develop a series of lessons for preparing students with basic and advanced investigation skills through multimodal writing tasks as well as self-assessment skills. The lessons included Science inquiry, Observing microorganisms, Respiration of plants, Osmosis, Phototropism, Making pickles, Simulating natural selection, and The mark-recapture method. The lessons were integrated within the lessons in the textbook. In order to explore the effectiveness of the lessons, one hundred and forty-seven seventh graders from five classes in a high school participated in a trial study. The students' examination scores and artifacts were collected. The students in the experimental group improved significantly in test score (α<.001). Moreover, they out-performed their peers in the control group in terms of their competencies in identifying variables, designing an experimental study, and providing scientific explanations. In the poster, the lessons and student artifacts will be used to illustrate how students self-assess their written tasks.

Evaluating science educators´ perception of students´ personal relevance as a key component to enhance scientific literacy

Tormi Kotkas, Miia Rannikmäe & Jack Holbrook
University of Tartu, Estonia

Many countries indicate that the goal of science teaching is to enhance scientific literacy among students. In Europe, this is promoted through competence-based curricula (Eurydice, 2002, 2012), which sees the goal as preparing students for a responsible and successful life after school. However, students do not see science as a field of interest (Osborne, Collins, Simon, 2003). One perceived issue is the lack of relevance of the science teaching in the eyes of students, although there is uncertainty about students' actual perception of relevance. This poster addresses science educators´ perception of relevance through develop procedures for examining titles and initial scenarios of teacher prepared context-based, science teaching modules. The goal is to match this with actual students´ perception of relevance by determining their reactions to the same module titles and initial scenarios. In this poster, the titles and scenarios created by science educators are analyzed to establish how science educators introduce science education learning material, considered by them to be relevant for students from a first impression.

THURSDAY: SESSION 4

Using situational interest to enhance individual interest and science-related behaviours

Thursday, 11.05pm: Theatre/Auditorium

Dave Palmer, **Jeanette Dixon** & **Jennifer Archer**
University of Newcastle, Australia

Situational interest is a transient reaction to highly stimulating factors in the immediate environment, whereas individual interest is a long-term preference for a particular subject or activity. It has been proposed that regular experiences of situational interest in a particular subject may eventually lead to the development of individual interest in that subject. Importantly, this should also result in an increase in related behaviours. For example, a student who develops an individual interest in science would be expected to spend more time on science-related activities such as reading about science, talking with other people about science, or watching science shows on TV. However, the extent to which this does happen has not yet been established. The purposes of this study were to find out whether regular experiences of situational interest can enhance individual interest, and whether there is an associated increase in related activities. The participants were primary teacher education students who were enrolled in a semester-long science course. Data were collected using a survey, an interest inventory, open-ended questionnaires and interviews. It was found that regular experiences of situational interest during the course were associated with positive changes in individual interest in science and increased participation in science-related activities.

Genetic determinism in teachers' talk in secondary science classroom

Thursday, 11.05pm: Seminar Room 1

Karin Thörne & Niklas Gericke
Karlstad University, Sweden

Genetic determinism is known to be a problematic conception, since a simplified understanding of the genotype-phenotype relationship in genetics can lead to a view where the sociocultural aspects are neglected. Such a view can be used for the rationalizing of discrimination based on gender, race etc. Previous research have found that genetic deterministic representations still exists in textbooks as well as in students and even teacher views in the form of following models: nature *versus* nurture or nature *and* nurture. A more contemporary model is the integrated model where genes are described as constantly interacting with the environment to result in a phenotype. This is in line with recent biological discoveries, for example within the field of epigenetics. The aim with our study is to investigate if and how genetic determinism is realized in teachers talk during lessons and how teachers relate nature to nurture in their teaching. Four secondary school teachers were observed and recorded during their entire genetics course at lower secondary school (age 15-16 years). The analysis is still ongoing, but our preliminary analysis suggests that teachers communicate a partly deterministic view and mainly reproduce the old models of nature *versus* nurture or nature *and* nurture.

Managing emotions: Outcomes of a breathing intervention in year 10 science

Thursday, 11.05pm: Seminar Room 2

Donna King[1]**, Stephen Ritchie**[2]**, Maryam Sandhu**[1]**, Senka Henderson**[1] **& Ben Boland**[3]
[1]Queensland University of Technology, Australia; [2]Murdoch University, Australia; [3]Isis District State High School, Australia

Learning science can be an emotional experience. Recent research reveals that middle years students experience negative emotions such as frustration and anxiety while learning science. Strategies to help students manage their emotions in science classes are emerging but require further investigations. In this study, an intervention that adopted short deep-breathing exercises was trialled in a Year 10 science class. The aim of the study was to determine students' emotional responses as well as the practicalities for implementing such an intervention. Through an ethnographic case study method over a seven-week term, we collected and analysed data including video and audio files, field notes, students' emotion diaries, and interviews. Five themes emerged. First, students who experienced the negative emotions of frustration/anxiety reported that the breathing exercises changed their emotions. Second, students reported that the breathing exercises improved their focus. Third, time to adapt to the breathing exercises and experience its effectiveness varied for individual students. Fourth, students reported that they used the breathing techniques voluntarily beyond the science classroom. Fifth, the teacher's role in the implementation of the breathing exercises was paramount. Finally, we suggest a methodology for implementing deep-breathing exercises in middle school science classes.

Educating science teachers for sustainability

Thursday, 11.05pm: Seminar Room 3

Rita Hagevik[1] **& Hillary Whitehouse**[2]
[1] The University of North Carolina at Pembroke, United States: [2] James Cook University, Australia

We propose to present a summary of our findings from the edited book in press by Springer Publishing called *Educating Science Teachers for Sustainability*. The book focuses on education for sustainability content and pedagogy in science teacher preparation as it applies to instructional practices in PreK-12 science classrooms and beyond. The contributors to the book chapters, whom are from North America, Europe, and Australia, explore these issues from an international perspective. The book is part of a series of research compilations sponsored by the Association for Science Teacher Education (ASTE), which is an international organization of science teacher educators. In this paper presentation, we will summarize the research presented by the twenty-three research chapters in the book. One of the editors and an author of the book's chapters will present their research in Australia and the US. We will then discuss the ideas presented in the book and ways to address the urgent need of bringing sustainability education more purposefully into educational systems throughout the world. In addition, the presenters will explore the differences by the authors in this book as well as conclusions drawn as a result and relate these meanings to possible implications for future research.

Exploring disciplinary differences in tackling complex problems

Thursday, 11.05pm: Case Study Room

Tina Overton[1] **& Christopher Randles**[2]
[1]Monash University, Australia; [2]University of Hull, United Kingdom

Problem solving is one of the skills prized by employers of science graduates but the type of problem solving developed through traditional teaching approaches rarely develops the ability to solve the complex, real-life problems. 'Real' problems are rarely algorithmic, rarely provide a complete data set and rarely lead to a single 'correct' answer. This paper describes the results of a qualitative study that investigated different approaches used by science undergraduates to tackle these complex problems. The study involved undergraduates from chemistry, physics, pharmacy, psychology and students on an integrated science programme delivered by problem-based learning. Students individually answered complex problems using a think aloud protocol. Complex problems are defined here as problems where not all the required data is given, where there is no single possible strategy and no single correct answer to the problem. The qualitative data identified a limited number of different approaches used to solve these problems. The relative quality of solutions developed by each group was also analysed. Analysis identified the characteristic profiles for each group of students. This paper will describe the disciplinary variations exhibited in approaches and the varying levels of success and will explore some of the possible reasons for these disciplinary differences.

THURSDAY: SESSION 5

Translating across methodologies: neuroscience and education

Thursday, 1.40pm: Theatre/Auditorium

George Aranda & Russell Tytler
Deakin University, Australia

Educational Neuroscience is an emerging scientific field that seeks to bring together a number of different disciplines with the aim to explore the interactions between biological processes and education. The focus of the ARC-funded program, *The Science of Learning Research Centre*, already in its second year, has brought together a range of psychology, education and neuroscience specialists. With ongoing professional development seminars and symposiums the research groups have sought to bring together these disparate research methodologies and theoretical perspectives, spanning experimental to ethnographic methods, and neuroscience to socio-cultural. As part of this project, we have sought to examine student learning behaviours and interactions from a sociocultural perspective that foregrounds student construction of language and representations. We have sought to align our research protocols with findings from the literature on the biological processes that underlie the act of construction. This has required us to closely interrogate the biological processes underlying construction, drawing on literature from art, psychology, education and neuroscience. This presentation will explore the links between socio cultural and neuroscience perspectives, findings on learning, and describe a program of research that is attempting to better understand how they can fruitfully interrelate to raise new and productive question.

Science as a human endeavour: A case study of three practitioner projects

Thursday, 1.40pm: Seminar Room 2

Kathryn Paige & Graham Hardy
University of South Australia, Australia

Science as a Human Endeavour (SHE) is an important and innovative strand of the Australian Science Curriculum. The introduction of such a potentially radical element to the curriculum, however well intentioned and welcomed, was always bound to provoke real and significant challenges to the repertories and pedagogical approaches for both newly qualified and experienced teachers alike. This study reports on how three early career teachers of science, all teaching in low SES areas and/or schools in challenging circumstances, found ways to engage with the demands of the Australian Curriculum and redesign pedagogy for incorporating the SHE strand into their practice. These early career teachers participated in a year-long teacher professional learning program using an action research methodology as a way to engage them critically with their own pedagogical practices. This was partly driven as an attempt to raise their aspirations, confidence and competence in teaching science in the middle years of schooling. An evaluation of the teachers' cases will provide an analysis of their professional journey in implementing aspects of SHE curriculum and highlight issues relating to the teachers' understandings, practices and priorities.

Synergies between reading strategies and concept mapping in high school students' science text comprehension

Thursday, 1.40pm: Seminar Room 3

Yi-Fen Yeh & Ying-Shao Hsu
National Taiwan Normal University, Taiwan

Science text offers a good source to build up students' scientific literacy, not only in terms of science text comprehension but also in scientific thinking development. Considering that science texts are usually overloaded with information or concepts, it is necessary to enhance their reading strategies and help them to better organize the information that is embedded in texts. Important reading strategies for science texts include setting goals, finding clues and claims, making inferences and predictions, etc. Concept maps can be a good learning tool for readers to organize information of complex concepts. In this study, the researchers investigated how students constructed concept maps and used their reading strategies to help them comprehend popular science texts. Participants were two classes of grade-10 students in Taiwan. Our data includes students' written responses to reading comprehension questions and two concept maps, classroom videotapes and teacher interviews. Results showed that they used more of network diagrams and tree diagrams in information organization. They tended to construct nodes by summarizing key events, instead of connecting single phrases as nodes. Positive correlations were found between students' abilities to make predictions and summaries and the quality of their concept maps.

Einstein-first: Changing the paradigm of school physics education

Thursday, 1.40pm: Case Study Room

Warren Stannard, Tejinder Kaur, John Moschilla, David Blair, Ron Burman & Marjan Zadnik
University of Western Australia, Australia

The Australian high school Physics curriculum is focused mainly on Newtonian physics and there is minimal mention of new ideas developed in the 20th century by scientists such as Einstein and others. This new physics, referred to here as Einsteinian Physics, encapsulates our best understanding of space, time, gravity, energy and matter, superseding the ideas of Newton. For example, modern electronic devices, new medical instruments and astronomy can only be understood in the context of Einsteinian Physics. Important concepts such as special relativity, general relativity and quantum mechanics are seldom encountered by students except maybe in their final year or as extension material. This research program investigates the possibility and benefits of introducing Einsteinian Physics to the curriculum at a stage where it is the student's first exposure to Physics. Ideas such as curved space, warped time, photons, quantum effects and uncertainty are introduced to students in the early years of high school. Simple hands on activities have been developed, often based on analogies and models, which make the various concepts interesting and understandable to young minds. Results show that young students can be successfully introduced to our best scientific understanding of the universe, the world of Einsteinian Physics.

THURSDAY: SESSION 6

Lessons learnt about assessing the hard stuff

Thursday, 2.25pm: Theatre/Auditorium

Chris Joyce
New Zealand Council for Educational Research, New Zealand

In The New Zealand Curriculum (NZC) the core strand of the science learning area up until Year 10 is Nature of Science. NZC is a framework document that allows schools to develop a science curriculum that is relevant to their students, but which provides little direction about the details of what they should or could be teaching. Over a number of years, NZCER has drawn on international, national and our own research to think about the focus for science education at different stages of schooling including consideration of what should be assessed. It is well documented that, once you move from a traditional concept of science education, assessment becomes a challenge because it is not contained as "fact" or "process". Questions we have been asking include: What is most important to be assessing? and; How do we assess that? The overall research programme could be considered as a series of iterative design experiments. Drawing on several very different assessment projects, the challenges, successes and failures are discussed.

High profile scientists and their interactions with contemporary communities

Thursday, 2.25pm: Seminar Room 2

Dorothy Smith[1], Pamela Mulhall[2], Christina Hart[3] & Richard Gunstone[2]
[1]La Trobe University, Australia; [2]Monash University, Australia; [3]The University of Melbourne, Australia

Research scientists who interact with sectors of the broader community do so in a variety of ways and for a variety of reasons. Some of these research scientists, by choice or by circumstance, develop a high public profile. We report on interviews with ten high profile scientists from varied fields of science and locations in Australia. The research questions that guided this study were: (1) What qualities, characteristics and knowledge support successful interactions between scientists and non-scientists? (2) What obstacles inhibit successful interactions between scientists and non-scientists? In this presentation we report on the extent to which the characteristics and knowledge associated with being a good scientist assists our participants in their interactions with the public and the particular skills and approaches they have developed in order to deal with the public media. We also discuss the knowledge, skills and attitudes on the part of the general public that these scientists consider might assist productive public engagement with science. The professional experiences of these scientists foreground the need for science curricula to better acknowledge the changed context of research science.

Examining elementary school students' awareness about socio-scientific issues and solutions by using drawings

Thursday, 2.25pm: Seminar Room 3

Yoonjeong Lee & Shinho Jang
Seoul National University of Education, China

Recently science educators in Korea have had special attention to socio-scientific issues in science education because socio-scientific issues can make possible to deal with moral education in science class. The purpose of this study was to investigate elementary school students' awareness about socio-scientific issues and solutions by using their drawings. The sample population for this study was 489 students at 4 elementary schools in In-cheon, Po-hang and Dang-jin in Korea. The students participated in a drawing activity about their ideas of the socio-scientific issues and solutions related to 'environmental problem'. Also the students wrote some sentences for explaining their drawings. After collecting data, students drawing and writing were analyzed using a checklist. The first result is that pollution such as air pollution, water pollution and trash problem are the most awareness in socio-scientific issues. But global environmental problem area such as global warming, climate change was perceived very low. Second, 80.85% drawings were related to personal context to solve the socio-scientific issues. For example, the most awareness about socio-scientific issues solution is to reduce trash. Third, in socio-scientific issues the students looked at relationship of human and nature from a biased point of view.

Our solar siblings. A link between the high school classroom and astronomical inquiry

Thursday, 2.25pm: Case Study Room

Michael Fitzgerald[1], **Lena Danaia**[2], **David McKinnon**[1] **& James Deehan**[2]
[1]Edith Cowan University, Australia; [2]Charles Sturt University, Australia

Calls for scientific inquiry to be significantly embedded in high school education have been ubiquitous over the last two decades. Actual on-the-ground successes in realistic school environments lag dramatically behind the power of this philosophical wanting. Astronomy, even more so than most sciences, suffers from a variety of blocking factors not least that inquiry in this science requires the use of expensive equipment in remote locations in the dark (translation: outside of school hours). In this paper, we present a new project linking high school classrooms to scientific grade telescopes available over the internet via Las Cumbres Observatory Global Telescope Network. The project design is outlined but more importantly, the theoretical and empirical basis is made clear based on experience and data from previous projects. This is supported on deep interviews with teachers and on a, now published, large-scale global review of similar attempts at connecting high school students to the night-sky through the use of real telescopes.

THURSDAY: SESSION 7

Sustaining science education through specialist professional learning

Thursday, 3.35pm: Theatre/Auditorium

Coral Campbell, Russell Tytler & Sandra Herbert
Deakin University, Australia

There is significant concern in Australia and internationally about the level of participation of students in Science, Technology, Engineering and Mathematics (STEM). Students' interest in science and mathematics is often determined in their primary schooling years, so the effective development of a teacher's science pedagogical content knowledge is crucial to student engagement and learning in science. This paper reports on the findings in the third year of a 4 year investigation into the conditions of sustainability of a major professional learning innovation which trained generalist primary school teachers to undertake the role of a science specialist support teacher within their school. Modules relating to leading change in schools, development of whole-school science curriculum and training of other classroom teachers were included within the professional learning provision. The research has been developing in-depth case studies of schools explicitly focussing on conditions of growth and sustainability over a four year period. Results suggest that the investment in this model leads to significant change in schools. The research is significant in providing insight into the conditions of sustainability leading to improved quantity and quality of science taught in primary schools.

Student perceptions of co-teaching in higher education: A pilot study

Thursday, 3.35pm: Seminar Room 2

Arpana Dhar, Georgina Fyfe, David Treagust, Rekha Koul
Curtin University, Australia

Context: In response to changes in higher education, Australian universities are transforming the design and delivery of education to a more student-centred teaching and learning approaches. Curtin's flipped classroom strategy coupled with face to face workshop has led to large enrolment inter-professional units. These are taught through co-teaching involving two tutors who may have strengths in different fields teaching together the students enrolled in 1st year health sciences common core units. Significance: The study aim was to develop a valid and reliable survey instrument to measure expectations and experiences of students in a co-teaching classroom. Research questions: The aim was to record student responses to experiences and challenges and also suggestions to improve co-teaching strategy. Methodology: Review of existing literature and many focus group interviews with experts were considered before developing *Health Science Co-teaching Instrument (*HSCTI), measuring Teacher Support, Student Satisfaction, Collaboration, Equity, Involvement and Innovation. The survey was administered to 528 students across 3 units. Results: The data was analysed using SPSS statistical software and a refined form was created.

Investigative case-based learning in the primary science: Perspectives from pre-service to in-service

Thursday, 3.35pm: Seminar Room 3

Daniel Poh Yeong Lim[1], Darren Jon Sien Wong[2], Chor Yam Lau[2], Hwee Ting Lim[3]
[1]Nanyang Technological University, Singapore; [2]Ministry of Education, Singapore; [3]Science Centre, Singapore

This study reports on the key takeaways of pre-service primary school teachers on Investigative Case-based Learning (ICBL) approach to Science Teaching and Learning and how they perceive this approach as an alternative instruction to inquiry for their future classrooms. More than 80% of the pre-service primary school teachers (N=159) from the post-graduate diploma (PGDE) and degree BSc (Education) programs agreed that the ICBL provides a meaningful context in bringing about the learning of science and its inquiry process, although only 61% is confident in using it. The study extends further to follow up on 2 teachers who eventually graduated and using the ICBL in in their own classrooms. Both used ICBL to serve different learning outcomes and have reported positive learning experiences in students' inquiry and learning through scientific investigations however, not without new challenges. Case-crafting is said to be a challenge for both teachers and the implementation of the 3P's (Problem posing, Problem solving and Peer Persuasion) may take more than the required teaching periods. The findings in this study will hope to inform classroom practitioners, educators and policy makers on the feasibility and implications of using ICBL to further stimulate new interest in this area of research.

The effects of group composition on creativity in groups

Thursday, 3.35pm: Case Study Room

Ying-Chun Cho, Ting-Kuang Yeh & Chun-Yen Chang
National Taiwan Normal University, Taiwan

Previous studies suggested that the amount of information available to the individuals plays a crucial role in group performance. But rare studies have examined the effects of the diversity of members' ideas on group creativity. The current study attempted to investigate the correlation between the diversity of members' opinions and the amount of group new ideas after collaborative interaction. Totally forty-three undergraduate students were recruited. Students were asked to give their thoughts about an unfamiliar organism picture in the domain of Life Science. They have tried to generate ideas related to the possible living environments of the organism and provide the reasons. After collaborative discussion, we counted the number of innovative ideas within a group. The results showed that the diversity of individual primary thoughts was significantly associated with new idea creation. The more diverse of the original thoughts, the more innovative ideas were generated after grouping (Pearson r = .721, p = .028). In addition, we found that the number of members in each group was negatively associated with new idea generation.

THURSDAY: SESSION 8

A partnership model from science education: applicability to the higher education sector

Thursday, 4.20pm: Theatre/Auditorium

Linda Hobbs[1], John Kenny[2], Mellita Jones[3], Christine Redman[4], Sandra Herbert[1], Gail Chittleborough[1], Andrew Gilbert[5] & Christopher Speldewinde
[1]Deakin University, Australia; [2]University of Tasmania, Australia; [3]Australian Catholic University, Australia; [4]University of Melbourne, Australia; [5]RMIT University, Australia

This paper presents a multi-dimensional partnership model, arising out of science education, and applied to the tertiary sector. Australian universities are adopting the language of partnerships in various ways, such as to frame the pedagogical contract, and to describe their interactions with various partners. Partnerships can be powerful mechanisms that underpin the core business of many universities—education and research—and are especially vital in preparing the next generation of teachers. While partnership theory contributes to many of these discussions, few theories are complex enough to encompass the range of partnerships, and the related principles, practices, and processes that underpin them. The Science Teacher Education Partnerships with Schools (STEPS) partnership model emerges from the analysis of school-based models of teacher education, where pre-service primary science teachers undertake science lessons in partnership schools during their science education units. The resultant "Interpretive Framework" is a partnership model describing: processes required to initiate, maintain and evaluate partnerships; partnerships can be connective, generative or transformative depending the 'embeddedness', and the attributes of each; principles underpinning the practices that emerge as a result of partnerships; and principles necessary to achieve effective partnerships. The science education and more generalist models will be juxtaposed, and illustrate the applicability of the STEPS model to different contexts.

Qatar as a gulf regional hub for the organisation and the implementation of student-centred active learning in science at secondary and university levels

Thursday, 4.20pm: Seminar Room 2

Venkat Vishnumolakala[1]**, Katherine Bradley**[2]**, Sheila Qureshi**[2]**, Daniel Southam**[1]**, Mauro Mocerino**[1] **& David Treagust**[1]
[1]Curtin University, Australia; [2]Weill Cornell Medical College, Qatar

The Qatari government has made significant changes in the organization and staffing of schools over the past decade in an effort to improve the academic performance of school-aged citizens. Qatar's National Vision 2030 and Education for New Era emphasise the need to encourage teachers to move from a didactic teacher-led mode of instruction to one that is more student-centred, but also teacher-guided, which encourages the development of critical thinking, problem solving, inquiry, and investigative skills. In this presentation, we discuss past and current educational changes and developments in Qatar at both the secondary and university levels. With an emphasis on an initiative in chemistry, we describe a project that brings together educators from Qatar and Australia to explore the utility and cultural transferability of student inquiry learning approaches that involves improving student conceptual understanding as well as their attitudes and self-efficacy. Based on the current activities we argue how Qatar can be a regional hub for the organisation and implementation of student-active learning at the secondary and university levels.

A comparative analysis on structure of storytelling in Korean, American and Singaporean elementary science textbooks: Focusing on matter area

Thursday, 4.20pm: Seminar Room 3

Yeseon Park & Shinho Jang
Seoul National University of Education, South Korea

The purpose of this study was to propose better understanding of elementary school science textbook with storytelling. This study performed a comparative analysis of 3rd and 4th grade science textbook(1st and 2nd semester) in Korea, America, Singapore and divided into storytelling type, content and format especially focusing on Matter area. Setting the standard of analysis about storytelling element by reconstitution of organization. Four types of storytelling was "real life linked type", "science history inquiry type", "science fairy tale type" and "academic fusion type". And each story was analyzed according to Flanders interaction analysis system. As a result, most storytelling structure type was "real life linked type" and most textbook format was "story introduction - problem presentation – conception – inquiry activity". Science textbook based on storytelling has been developed to help students learn science meaningful and with interest. These results of the study would form the worthwhile base information for the development and the implementation of science textbooks based on storytelling.

Collaboration in science education through self study

Thursday, 4.20pm: Case Study Room

Peta White & John Cripps Clark
Deakin University, Australia

Reviews into teacher education such as the Teacher Education Ministerial Advisory Group (TEMAG) call for more rigorous evidence based research to ensure quality preparation for teachers. In this time of turbulence and change in teacher education, methodologies such as

self-study are working to find space in the conversation, which can provide useful input and application to science education. Although collaboration is always represented as crucial there is little research into the nature of collaboration between science education and other disciplines. Our collaboration involved a journey of eight education academics from a variety of disciplines coming together through an interest in using self-study methodologies to improve our teaching practice through research and scholarship. We investigated the development of the values, communicative structures, identity and reflection within and between the group members. Data was drawn from interviews with members, audiorecordings of meetings and electronic communication to reveal the ways in which the exchange of reasons, playful talk, articulation of values and the personal facilitated or inhibited the collaboration and thus the development of our teaching and research practice.

FRIDAY: SESSION 1

A model of teacher learning for out-of-field teachers

Friday, 9.15am: Theatre/Auditorium

Linda Hobbs[1], **Frances Quinn**[2], **Colleen Vale**[1], **Christopher Speldewinde**[1], **Robert Whannell**[2], **Terry Lyons**[3], **Russell Tytler**[1] **& Anna Du Plessis**[3]
[1]Deakin University, [2]University of New England, [3]Queensland University of Technology; Australia

Shortages of appropriately qualified teachers mean that Science and Mathematics in Australian schools, particularly in rural areas, is often taught by teachers teaching out-of-field; that is, teaching across subject boundaries. This can impact negatively on teacher wellbeing and attrition, and learning outcomes, hence there is a need for research on the kinds of knowledges a teacher needs when teaching a new subject, and the development of appropriate teacher-learning models. Our presentation therefore aims to discuss what can be drawn from existing models that frame teacher knowledge and teacher learning, and what is missing from them, with the ultimate aim of developing a model that can inform research exploring the shifts in understandings and identity as beginning teachers in a specialization cross the boundaries between their in-field and out-of-field teaching. Our methodology has involved scrutinising existing models and frameworks, including Shulman's PCK framework, Clarke and Hollingsworth's (2002) model of teacher growth, Federal and State quality teaching frameworks, along with self-efficacy, identity theory and 'craft knowledge'. Initial findings highlight the breadth and range of different but related constructs and elements comprising the range of available models and the importance of the 'beliefs and 'identity' constructs represented in some models.

Science by Doing: Impact of an online curriculum program

Friday, 9.15am: Seminar Room 1

Denis Goodrum & Jim Woolnough
Australian Academy of Science, Australia

On July 2013 the *Science by Doing* website went live. Through this website teachers and students could access, without cost, innovative science units for years 7 to 10. Initially eight units were available with the complete suite to be completed in 2015. This was the first comprehensive online science program made available for Australian schools. The curriculum units are based on an inquiry approach and include a rich array of hands-on

investigations, film clips and interactive activities to engage students. Each unit consists of an e-book student guide, a student digital platform and a teachers guide with relevant activity sheets. There are also embedded diagnostic, formative and summative assessment activities and items. The website also contains award winning professional learning modules suitable for pre-service teachers that can be streamed and downloaded. What has been the impact of this program? The paper will explore this question and examine the nature of the people using the program and level of use. The provision of online curriculum resources provide an opportunity to collect data on classroom activity in a way that was previously unavailable. The challenges and potential value to schools will also be outlined.

Engaging pharmacy students in argumentation: Its impact on thinking skills and understanding of professional practice issues

Friday, 9.15am: Seminar Room 2

Michelle Appleton, Vaille Dawson & Christine Howitt
University of Western Australia, Australia

Argumentation skills are essential generic attributes required by the pharmacy profession in Australia. The teaching of these skills, like many other generic attributes in tertiary education, may not always be explicit in pharmacy courses partly due to the problematic inclusion of these skills within traditional assessment methods. Using case study methodology and a before-after quasi-experimental design, this study investigated the impact of teaching third year pharmacy students Toulmin's Argumentation Pattern (TAP). Students were asked to construct an argument that would convince a colleague on their response to a professional practice scenario. Results indicate that student arguments improved in terms of argument structure and complexity after introduction of TAP. In addition, the number of student arguments that aligned with expert responses to the scenarios increased. Feedback from students indicated they found TAP helpful and all students responded that they believed the method had improved their argument. Pharmacists operate within a complex framework of not only clinical issues but also ethical, moral and legal obligations. These results indicate that the teaching of argumentation skills may positively influence the development of critical thinking skills and conceptual understanding of practice issues and improve professional decision-making.

Enhancing seventh graders' scientific reasoning in comprehensive science news articles

Friday, 9.15am: Seminar Room 3

Pei-Ying Tsai
Shun-Tien Junior High School, Taiwan

Practicing scientific reasoning to coordinate data and claims is critical in learning science meaningfully. Literature indicates that systematically selecting and utilizing science news articles in science classes would lead to better conceptual understanding and inference performance. Students in middle schools tend to comprehending and evaluating science statements based on personal experiences, rather than activating related conceptual or procedural knowledge to make judgments. In this study we applied the teaching sequence Think-Read-Analyze-Self-evaluate to facilitate students' activation of prior conceptual and procedural knowledge, and performing of induction, deduction, and judging credibility of statements. One hundred and nine seventh graders from four classes participated in this study. Data sources included measures of the Cornell Critical Thinking Test, measures of the Views about Science News, and student artifacts. Data analysis indicates that students with lower

critical thinking ability were inadequate in making connections with prior conceptual and procedural knowledge as well as distinguishing their position against or for the statements in the articles. Moreover, students' views about science news need to be further prompted. Implications for educational practice are discussed.

Why materials matter: exploring the role of instruments in learning science

Friday, 9.15am: Case Study Room

Catherine Milne
New York University, United States of America

In this paper presentation I explore the blackboxing (Latour, 1994) of scientific instruments as elements of material culture and the implications this might hold for developments in national standards and curricula that focus on scientific practice. In the presentation I investigate the nature of scientific instruments, their role in material culture, and scientific practice from a social studies of science and feminist theory perspective (e.g. Barad, 2007). Case studies from the development of the thermometer and the discovery of the ribosome illustrate these arguments. I also explore how I have begun to address my concerns through curriculum development of a natural science Liberal Arts course for non-science majors called Science in the Community that has a citizen science component. Using artifacts from the course, I demonstrate how a focus on scientific practices and instruments can support learners to value specific scientific practices beginning with observing. Through these studies I explore the implications for science education of attending to the nature of scientific instruments with respect to complex relationship between instrument and human that engenders different questions and practices, the moral power of instruments in the science classroom, and the role of instruments in constructionist approaches to science curriculum.

FRIDAY: SESSION 2

Engaging pre-service teachers in contemporary stem practices

Friday, 10.00am: Theatre/Auditorium

Russell Tytler, John Cripps Clark, Peter Hubber & Gail Chittleborough
Deakin University, Australia

Concerns about STEM participation in Australia has led to promoting the representation within school science and mathematics of contemporary STEM practices as a means to better engage students in these subjects. REMSTEP is an initiative shared between four Victorian Universities that aims at introducing contemporary STEM research practices into pre-service teacher education in order to engage these future teachers in inquiry pedagogies that will translate into their curriculum practices. At Deakin we have developed processes to link PSTs with research scientists to a) develop curriculum resources, b) experience resources developed by the team, and c) trial these resources in schools, sometimes alongside scientists and teachers. The Geelong based Skilling the Bay project will draw on REMSTEP activities, local industry and university staff and students to improve engagement and retention of students in STEM through capacity building of teachers. The presentation focuses on the development of a framework to describe a variety of productive interactions between pre-service teachers, science educators, and scientists/engineers, and the learning that arises from these. The educators and scientists include museum educators and scientists, specialist science centre staff, and researchers at high profile science and engineering institutes. The

research draws on field notes, interviews, and surveys.

Ten years on: Reflections on the development of a large-scale, rich online resource for science education

Friday, 10.00am: Seminar Room 1

Cathy Buntting, Alister Jones & Bronwen Cowie
The University of Waikato, New Zealand

The growth of the Internet has led to a proliferation of online resources to support science teaching and learning. In New Zealand, the Biotechnology Learning Hub (www.biotechlearn.org.nz) was launched in NZ in 2005 specifically to make biotechnology research more accessible to New Zealand school teachers and students. Its sister-site, the Science Learning Hub (www.sciencelearn.org.nz) was launched in 2007. Funded by the New Zealand Government, the emphasis of these resources is to use multimedia formats to tell the stories of contemporary science research, with teaching and learning ideas that demonstrate how these science stories can be used to contextualise the learning of science concepts as well as unpack aspects of the nature of science. Ten years on, the programme directors report on the challenges involved in navigating a changing digital, economic and socio-political landscape, and the viability of moving to online teacher support infrastructures.

Digital media construction in pharmacology: Engaging discipline science students with multimodal learning

Friday, 10.00am: Seminar Room 2

Wendy Nielsen, Garry Hoban & Chris Hyland
University of Wollongong, Australia

This paper reports two case studies of students studying Pharmacology in a Bachelor of Science degree program who constructed a digital media product about a disease pathway and/or therapeutic approaches to treatment. Students reviewed a specified journal article and conducted a wider literature review as a preliminary task before preparing a digital media product to explain the topic to a non-specialist audience. The research question driving this study was: *What are students' perceptions of creating digital media and how does this contribute to their understanding of third year Pharmacology?* The first case study conducted in 2014 was of four students to ascertain their perceptions of creating the digital media as an assignment using interviews and artefact analysis. The second case study conducted in 2015 focused on students' understanding of science topics using interviews at three points of the semester, concept maps and artefacts. Findings suggest that students found the media making to be engaging and supported them in representing key topics. Interestingly, for both cohorts this was the first time they had made a media product in the three- year degree. Media making can enhance student engagement and understanding of science topics, which can also be shared with other students.

Effects of a web-based socioscientific issues instruction on students' conceptual understandings and science inquiry competency

Friday, 10.00am: Seminar Room 3

Wen-Hua Chang
National Taiwan Normal University, Taiwan

New advances in science and technology closely impact the natural environment, policy and society. Recently, issues about genetic engineering, genetic diseases and counseling, and environmental pollution, among many others, are explicitly addressed in formal science curriculum. These socio-scientific issues (SSIs) could urge the students to reflect upon the connections among their daily life, community, and science. In this study, we developed a web-based SSI instruction module and enacted on one hundred and thirty-two students from four junior high schools. In the instruction, the students were required to explore their prior conceptual understandings, read science journal articles, comment on science news reports, interpret authentic science research data, and finally, make their decisions. Measures about students' conceptual understandings and science inquiry competency were collected before and after the instruction. Results of paired-t tests show a significantly improved scores of conceptual understandings ($p < .001$, effect size Cohen's $d = 0.9$) and science inquiry competency ($p < .001$, effect size Cohen's $d = 0.8$). The analysis of online responses reveals that the students paid more attention on content which provoked their emotional reactions and moral considerations. Educational implications will be discussed.

Elements of chemistry: The books and their authors (1860-1900)

Friday, 10.00am: Case Study Room

Dr William P. Palmer
Curtin University, Australia

This is the fourth 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. This paper is the fourth in the series and covers the books entitled *Elements of chemistry* approximately 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 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 1860 to 1900.

FRIDAY: SESSION 3

Identification of student learning processes in classroom and remote laboratory settings

Friday, 11.10am: Theatre/Auditorium

Damien Carter[1], Euan Lindsay[2], Marjan Zadnik[1], Mauro Mocerino[1], Anthony Lucey[1] & David F. Treagust[1]
[1]Curtin University, Australia; [2]Central Queensland University, Australia

Existing literature of both classroom and remote laboratories has focused upon the learning outcomes but not on the learning processes. Studies have also shown different learning outcomes for the different access modes, however the reasons for these differences are yet to be fully investigated. For example students in remote labs are reported as more reflective, but there has not been a study identifying what it is about the remote mode that makes them that way. This project aims to determine the mechanisms through which students learn in a laboratory setting and answer key questions such as: With whom and with what do students interact, and what is the purpose of these interactions?; How do the patterns of these interactions correlate to the students' learning and assessment outcomes? and Which of these interactions must be preserved in a shift to the remote access mode? These questions will be answered by observing, recording and analysing students in physical laboratory classes, and by using this analysis to guide the development of the next generation of remote laboratory interfaces. The presentation will provide a summary of the background literature and update of progress to-date in the research project, which is supported by the ARC.

Enhancing student engagement in laboratory learning using inquiry-based activities: The ASELL schools project

Friday, 11.10am: Seminar Room 1

Alexandra Yeung[1], Manjula Sharma[2], Scott Kable[2], Kieran Lim[3], Louise Sutherland[2], Mark Buntine[1], Vaille Dawson[4], Daniel Southam[1], Nicoletta Maynard[1]
[1]Curtin University, Australia; [2]The University of Sydney, Australia; [3]The University of New South Wales, Australia; [4]The University of Western Australia, Australia

Laboratory programs, regardless of their quality, will play a major role in influencing student learning and performance. It can define a student's experience in the sciences, and if done poorly, can be a major contributing factor in causing disengagement from the subject area. Studies of the nature of the laboratories show that they vary immensely, from open-ended inquiry, guided inquiry to recipe based practical activities or learning specific skills and techniques. The challenge remains to provide students with laboratories that are relevant, engaging and offer effective learning. The Advancing Science by Enhancing Learning in the Laboratory (ASELL) project has developed over the last 10 years with the aim of improving the quality of learning in undergraduate laboratories and providing effective professional development for science academics. With the onset of the new Australian Curriculum and an increased emphasis on science inquiry and hands-on learning, ASELL expanded to secondary schools with the aim of helping teachers improve school students' experience of experiments, particularly through an inquiry-based framework. This presentation will discuss the process of moving the ASELL project into schools, describe the ASELL Schools workshops held to date, and present some feedback from teachers and students who attended the workshops.

Chemistry, conceptual understanding and formative assessment

Friday, 11.10am: Seminar Room 2

Tony Wright & Gwen Lawrie
The University of Queensland, Australia

The rapid pace of change in chemistry makes it important for students to acquire useful conceptual knowledge that will help them make sense of the change. One of the major tools with which we can equip students is a useful grab-bag of concepts that students can apply to contexts they encounter. This paper describes results from two chemistry concept inventories that call into question the way we often think about conceptual learning. Our analysis of results from the inventories indicates that students often deal with individual concepts rather than thinking about networks of related concepts. A model that has multiple concepts contributing the chemistry behind particular applications can be is a much more useful guide for students. In the early work on the Force Concept Inventory, Hestenes and Halloun (Hestenes & Halloun, 1995) suggested that when assessing results of the inventory it is better to look for consistency of response to multiple questions rather than judge individual right/wrong responses. This paper will report results from the two inventories, the Molecular Life Science Concept Inventory (Wright & Hamilton, 2010)and a newly assembled chemistry concept inventory. It will also provide suggestions for the use of these and related inventories in providing feedback for formative assessment.

Student and teacher perspectives of Construction Zone activity in the Thinking Science Australia program

Friday, 11.10am: Seminar Room 3

Nathan Curnow[1], Grady Venville[1], Mary Oliver[2] & Christine Howitt[1]
[1]University of Western Australia, Australia; [2]The University of Nottingham, United Kingdom

Thinking Science Australia (TSA) is a cognitive acceleration intervention program currently being implemented in Australian high schools and based upon the Cognitive Acceleration through Science Education (CASE) program (also referred to as Thinking Science). Previous empirical research into CASE has concentrated on the effectiveness of this program and its implementation in schools, with comparatively little addressing how student and teacher participants perceive the program and their involvement. This study uses qualitative methods to explore student and teacher perspectives of the program's episodes of 'Construction Zone Activity' (CZA), considered to be the driving force of the cognitive gains experienced by participants, wherein students engage in small group activity, experimentation and discussion. An embedded case study research design was used within one Western Australian high school, with data collected from interviews with teachers and student focus groups, triangulated against classroom observations of a TSA lesson. Findings from data collected contribute to our understanding of how students and teachers operate within this zone and provide data on how both groups respond to the Thinking Science pedagogy. Results also stimulate reflection on how Thinking Science impacts on teaching practice and learning outcomes and have the potential to influence implementation of cognitive acceleration programs such as TSA within schools.

Becoming a biology teacher: Memories of school experiences

Friday, 11.10am: Case Study Room

Marlécio Maknamara
Federal University of Rio Grande do Norte, Brazil

This paper presentation is a compact of an autoethnographic inquiry on my trajectory as biology teacher. Currently I am a university biology teacher educator from Brazil and coordinate investigations about memories of school experiences and needs of future science teachers. In this short paper I present narratives of key autobiographical moments of my journey as a student at school, also motivated by the Paulo Freire's call on the need for teachers to take curious epistemologically. The goal was to evoke and reflect critically on some of my past experiences at school and connect this to my trajectory of teaching. I got inspiration with three focus paradigms (interpretativism, criticalism and postmodernism) and designed a critical autoethnography applying arts-based research elements. Presented in teasers, the results reveal that I was a restless student and experienced a multitude of subject teaching positions. This enabled a mindful, sensitive and responsible practice facing my students' demands. I conclude that autoethnography enables to perceive and create ways of thinking and acting in biology teaching, ways that arise from such school experiences.

FRIDAY: SESSION 4

A longitudinal investigation of the science experiences and beliefs of a cohort of pre-service teachers making their first steps into the teaching profession

Friday, 11.55am: Theatre/Auditorium

James Deehan
Charles Sturt University, Australia

Science achievement of primary students is declining for many nations, including Australia (e.g. Hackling, 2014). The quality and frequency of science teaching at the primary-school level is insufficient to address such declines (e.g., Goodrum, Hackling & Rennie, 2001). This paper assesses the relationship between participation in two tertiary science subjects and the science teaching efficacy beliefs (STEBs) of one cohort of pre-service primary teachers over a four-year period. In addition, this research makes a meaningful contribution to the literature by assessing the durability of their' STEBs for two years after formal science education finishes. Participants attended a rural university (2010-2013). Two Type II case studies with repeated measures were conducted within the two subjects. Quantitative data were collected via 26 administrations of the Science Teaching Efficacy Belief Instrument B (STEBI-B) (Enochs & Riggs, 1990) over the 4-year period. Qualitative data sources included semi-structured interviews, Harvard one-minute papers and subject evaluations. Results showed that participation in the two science subjects covaried with statistically significant increases in the participants' STEBs. These increases in STEB remained durable for two-years after the completion of the science subjects. The implications for these findings are discussed within the paper.

Potencies and challenges of content knowledge development in a chemistry teacher preparation program

Friday, 11.55am: Seminar Room 1

Tuszie Widhiyanti[1,2], Mauro Mocerino[1], David Treagust[1] & Venkat Vishnumolakala[1]
[1]Curtin University, Australia; [2]Indonesia University of Education, Indonesia

The development of the teachers' content knowledge is one of the essential facets in teacher education program (Corrigan, 2009; Koballa, Graber, Coleman, & Kemp, 1999; Shulman, 1986, 1987), and as suggested by Jong et al. (2002), the study to analyse the process of content knowledge development is necessary. This research attempted to evaluate the existing program of developing pre-service teachers' content knowledge, especially in the topic about the particulate nature of matter. The curriculum of content knowledge development was examined using an analysis of the forms of the curriculum evaluation (Akker, 1998; Goodlad & Associates, 1979; Treagust, 1987). Within this framework, the curriculum was evaluated in several aspects including the vision and intention of the curriculum as mentioned in the curriculum documents (intended curriculum), the users' interpretation and perception about the curriculum (perceived curriculum), the actual process of curriculum implementation (implemented curriculum), and the outcomes of the curriculum (achieved curriculum). According to the framework used for this study, the research combined qualitative and quantitative methods of data collection and the interpretation including document analysis, classroom observation, interviews, and two-tier diagnostic test. Through this research we examined the coherence among those aspects. The results provide basic information about the effectiveness of the program including the challenges and the potencies for a reconsideration of the program in the future.

Does the ability of mental rotation affect the learning of chemical structure formulas: The evidence from neuroscience

Friday, 11.55am: Seminar Room 2

Chia-Ju Liu, Chao-Ming Hung, Chen Hsieh, Chin-Fei Huang, Ming-Chung Ho & Houn-Lin Chiu
National Kaohsiung Normal University, Taiwan

The previous studies present two points of view regarding the influences of mental rotation on learning chemical structure formulas. One is that the ability of mental rotation affects the learning of chemical structure formulas, while the other argues otherwise. The purpose of this study was to conduct neuroscience technology-event-related potentials (ERPs) to try to clarify this research question. A total of 24 university students majoring in chemistry were recruited. In the ERP experiments, the participants were required to identify 2D figures, 2D chemical structural formulas, 3D objects and 3D chemical structural formulas. The results showed that all students used similar strategies of mental rotation when identifying 2D figures, 3D objects and 3D chemical structural formulas. However, the high-achieving students used different strategies for identifying 2D figures and chemical structural formulas, while the low-achieving students tended to use similar strategies of mental rotation for identifying both 2D figures and chemical structural formulas. The results indicate that due to the low-achieving students' inappropriate strategies of mental rotation, they encountered some difficulties when identifying 2D chemical structural formulas.

Addressing the learning needs of children, teaching students and teachers in an informal context

Friday, 11.55am: Seminar Room 3

Dr David Overton
Monash University, Australia

There are over ninety local Children's Universities (CUs) throughout the United Kingdom (UK) and throughout the World including in Australia. CUs aim to meet the learning needs of children through extracurricular provision. This paper describes a detailed exploration of the factors underpinning the needs of stakeholders, including children, teachers, teacher education students and Higher Education (HE) tutors, during the formation of a local CU. This qualitative study used unstructured interviews employing a constructivist grounded theory approach. The research identified a common need for science education across all stakeholders and that the unique approach adopted by this CU benefited all stakeholders by providing a context within which children, teachers, teacher education students and HE tutors could learn science in an informal way. There was simultaneous acquisition of scientific knowledge and skills by children, their teachers and by teacher education students, at point of delivery by the tutor. Teachers considered the tutor as a trusted expert supporting their professional development through modelling what they described as innovative pedagogy. Tutor credibility was enhanced in the eyes of the teacher education students. The implications for science teacher education, teacher professional development and the role of specialist science teachers in primary schools will be explored.

Is contraceptive information presented poorly online?

Friday, 11.55am: Case Study Room

Avory Allen, Miriam Sullivan & Julie Saunders
The University of Western Australia, Australia

Young people often use the Internet for sexual and reproductive health information however little is known about the accuracy or bias of online health messages. This talk will present the early findings of a study attempting to understand whether some methods of contraception are presented more accurately online than others, and whether certain formats of online information are more accurate than other formats. Content analysis was employed to measure the levels of accuracy and bias presented in text online. Results of this study will help educators to understand where their students may be struggling with sex education and what misconceptions should be addressed in class.

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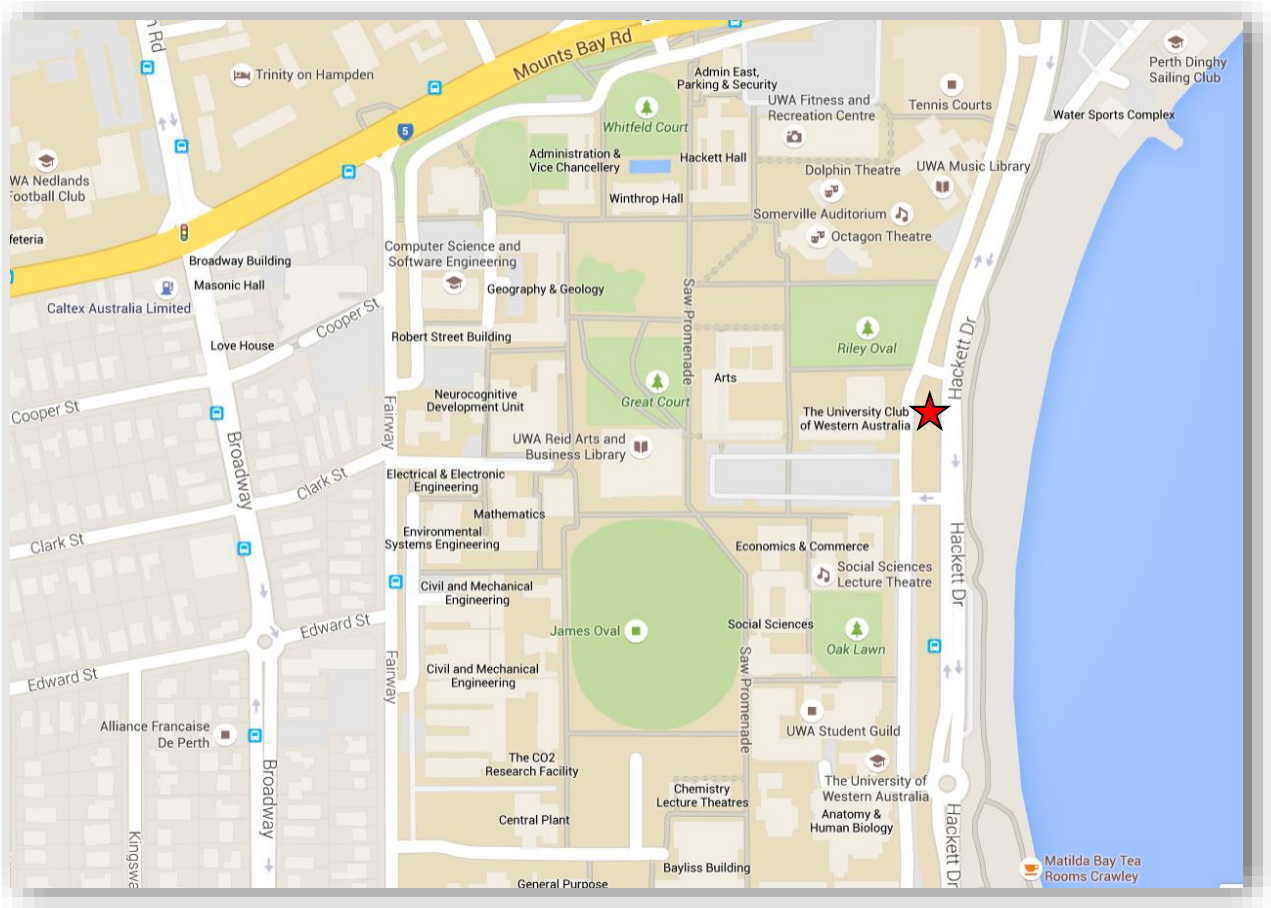
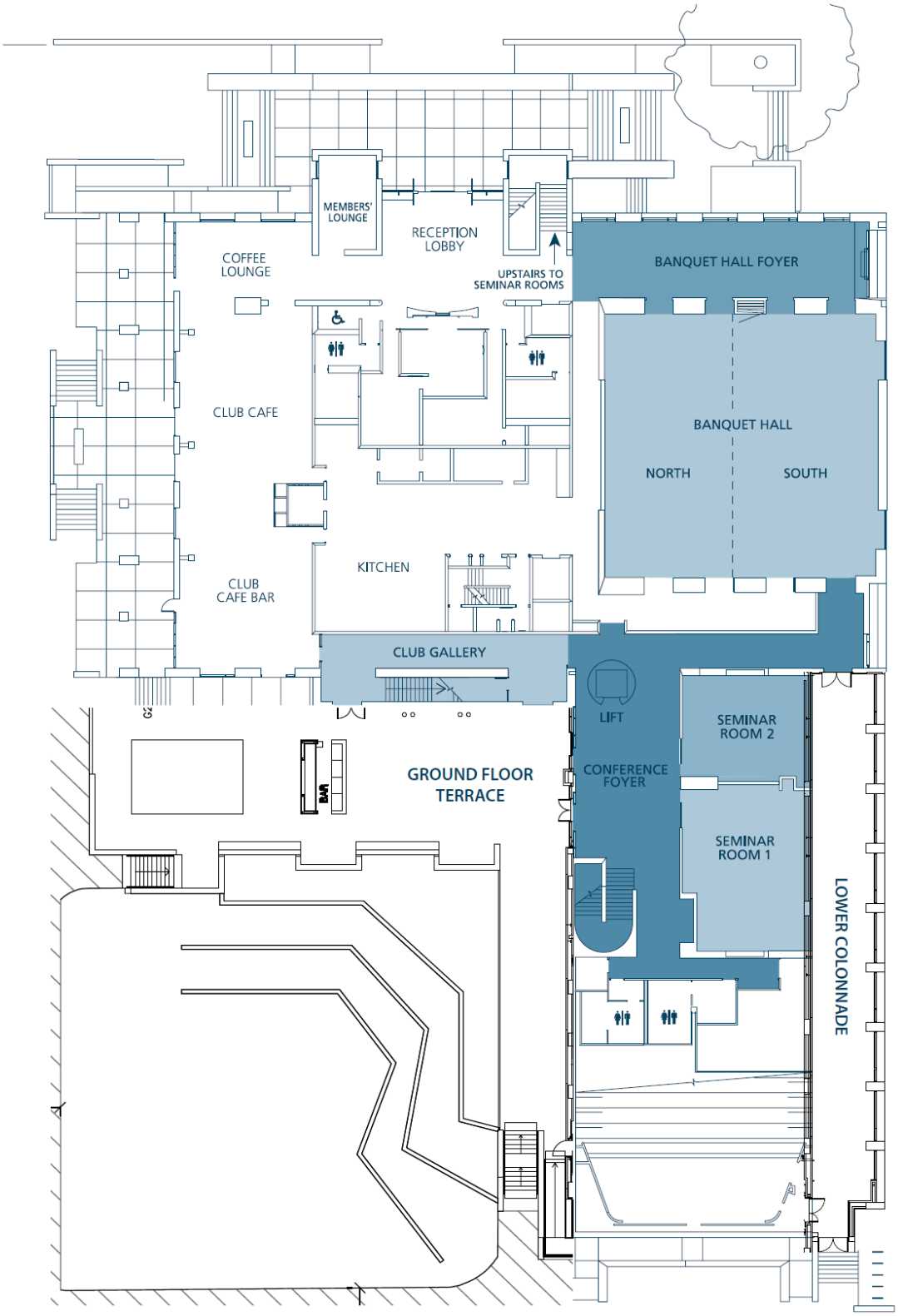


The University Club of Western Australia Interior Map

On the **Ground Floor** is the Seminar Room 1, Seminar Room 2 and the Lower Colonnade where the poster sessions will be held.



The University Club of Western Australia Interior Map

On the **First Floor** is Seminar Room 3, the Case Study Room and the Theatre/Auditorium.
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