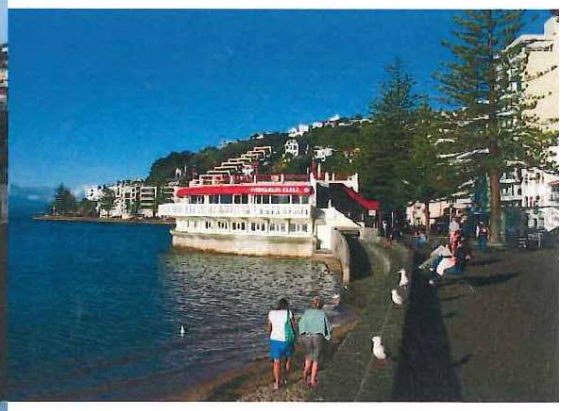
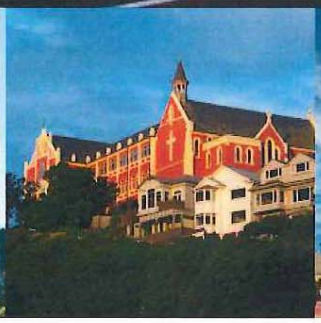
ASERA

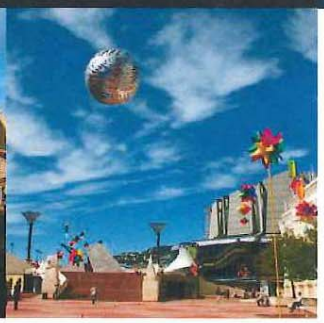
AUSTRALASIAN SCIENCE EDUCATION RESEARCH ASSOCIATION LTD

The 44th Annual
ASERA Conference

2 – 5 July 2013
Te Papa Tongarewa,
Wellington







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 New Zealand Council for Educational Research (NZCER) and Victoria University of Wellington.

ASERA 2013

The 44th Annual Conference of the Australasian Science Education Research Association

www.asera.org.au

July 2nd–July 5th 2013

Te Papa Tongarewa, Wellington, New Zealand

New Zealand Council for Educational Research
Victoria University of Wellington

CONFERENCE PROGRAMME AND ABSTRACTS

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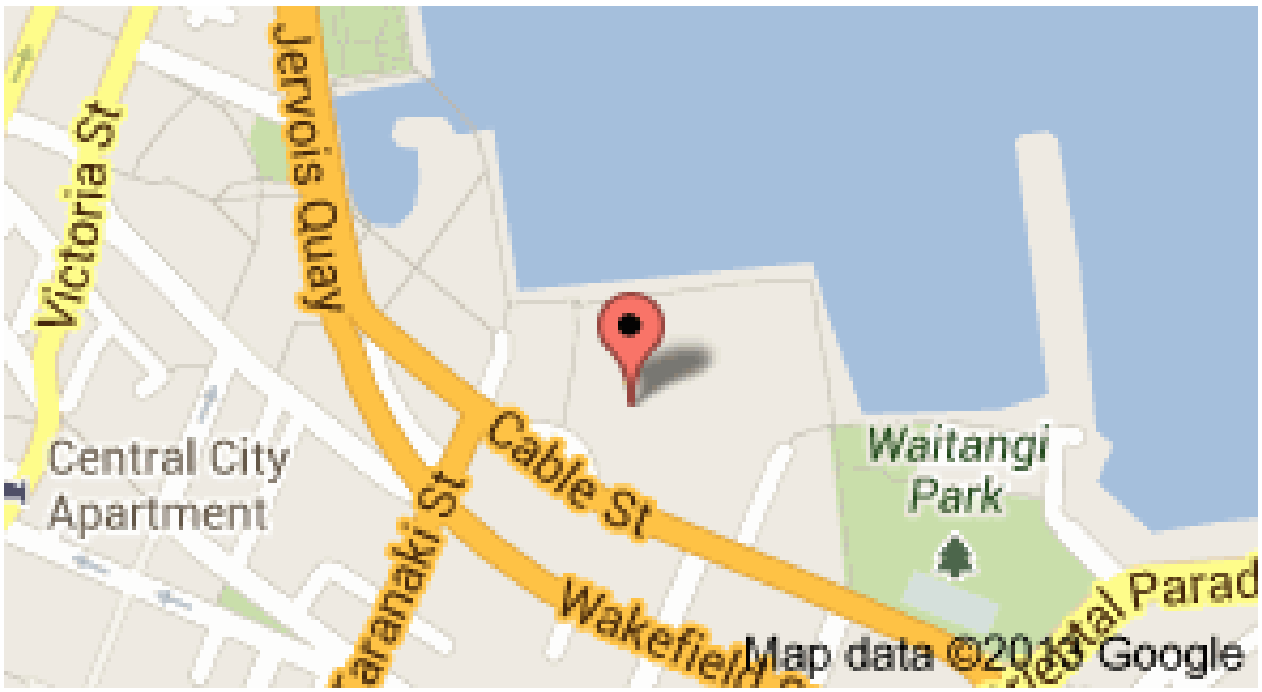
Welcome and Introduction

Welcome to Wellington

We welcome you to Wellington and specifically to Te Papa Tongarewa, which means “Our place”.

Te Papa is New Zealand's national museum and a recognised world leader in interactive and visitor-focused museum experiences. New Zealand's geology and natural environment and the stories of New Zealand's indigenous people, the Māori, are celebrated in Te Papa's permanent exhibitions, while Te Papa's Marae is a vibrant contemporary meeting house and a living communal centre, unique in a museum. **Entry to Te Papa’s exhibits is free,** though charges apply to some short-term exhibitions and activities. During ASERA an exhibition of Andy Warhol’s art can be viewed. There is a charge for this special exhibition, but conference attendees are offered a discounted rate of $15.50 per person. You will need to show conference ID when you go to the ticket desk (a name badge will suffice).

Te Papa is conveniently located in the heart of downtown Wellington. It is a short walk to the main shopping areas and cafes. As the map suggests, the harbour-side walkway is also nearby. Look out for the many sculptures and Wellington poems to be found along this walkway. For those with cars parking is offered at a discounted rate of $9 per day. There will be a validation machine at the registration desk. Please bring car park tickets there to get them validated to access this rate. Tickets are then presented as you exit the car park.



Organising ASERA 2013

Lorraine Spiller and Rosemary Hipkins (NZCER) Azra Moeed and Dayle Andersen (Victoria University of Wellington) formed the core organising committee.

We would like to thank all of the other people who have contributed to this conference.

Our particular thanks go to several key NZCER staff: Sarah Boyd (our Communications Manager), Christine Williams and Bev Robinson (administrative support) and Bruce Intemann (IT support).

Sally Birdsall from the University of Auckland gave sterling assistance with the reviewing of abstracts.

We hope you have an enjoyable and stimulating experience at this conference.

Lorraine Spiller, 2013 ASERA Conference Convenor, NZCER, Wellington

A summary of ASERA Conferences to date

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

Venue	Conference Convener(s)
	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, New Zealand	Lorraine Spiller (New Zealand Council for Educational Research)

ASERA Executive Board

The members of the ASERA Executive Board are:

- Professor Alister Jones -Managing Director
- Associate Professor Debra Panizzon - Secretary
- Associate Professor Deborah Corrigan - Editor-in-Chief, RISE
- Dr Coral Campbell
- Associate Professor Bronwen Cowie
- Professor Stephen Richie
- Professor David Treagust

Sponsorship Acknowledgement

Major sponsors: New Zealand Council for Educational Research

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Other Sponsors: Victoria University of Wellington

TE WHARE WĀNANGA O TE ŪPOKO O TE IKA A MĀUI
VICTORIA
UNIVERSITY OF WELLINGTON

Allan Wilson Centre

The Allan Wilson Centre, established in 2002, investigates the evolution and ecology of the biota in New Zealand and the South Pacific using molecular techniques. AWC has researchers spanning five different universities; Auckland, Canterbury, Otago, Victoria University, and the host institution Massey University. Its major projects are: Rates and Modes of Evolution, Biodiversity, Human Settlement of Aotearoa/New Zealand, New Ecological and Evolutionary Models. Victoria University of Wellington is one of five universities participating in the Allan Wilson Centre, and hosts a research group focused on biodiversity. Allan Wilson Centre supports biology teaching in New Zealand schools through educational programmes that are developed in response to teacher request for appropriate resources.

ALLAN WILSON CENTRE
FOR MOLECULAR ECOLOGY AND EVOLUTION

Proudly supported by:

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ASERA 2013 Programme Overview

Tuesday 2nd July

4.00 – 6.00pm	Registration desk open – Icon
5.00 – 7.00pm	Welcome Mihi followed by reception

Wednesday 3rd July

8.00 – 8.55am	Registration – Oceania
9.00 – 9.25am	Welcome – Oceania
9.30 – 10.10am	Session 1 – Presentation of papers
10.10 – 10.35	Morning Tea – Oceania
10.35 – 11.15am	Session 2 – Presentations
11.20 – 12.00pm	Session 3 – Presentations
12.00 – 1.00pm	LUNCH – Oceania
1.00 – 1.40pm	Session 4 – Presentations
1.45 – 2.25pm	Session 5 – Presentations
2.30 – 3.10pm	Session 6 – Poster Presentations
3.10 – 3.30pm	Afternoon Tea – Oceania
3.30 – 4.10pm	Session 7 – Presentations
4.15 – 4.55pm	Session 8 – Presentations
5.00pm	Book Launch

Thursday 4th July

9.00 – 9.40am	Session 9 – Presentations
9.45 – 10.25am	Session 10 – Presentations
10.25 – 10.45am	Morning Tea – Oceania
10.45 – 11.25am	Session 11 – Presentations
11.30 – 12.20pm	AGM – Oceania
12.20 – 1.00pm	LUNCH – Oceania
1.00 – 1.40pm	Session 12 – Presentations
1.45 – 2.25pm	Session 13 – Presentations
2.30 – 3.10pm	Session 14 – Poster Presentations
3.10 – 3.30pm	Afternoon Tea – Oceania
3.35 – 4.15pm	Session 15 – Presentations
4.20 – 5.00pm	Session 16 – Presentations
7.00 – 11.00pm	CONFERENCE DINNER – Oceania

Friday 5th July

9.00 – 9.40am	Session 17 – Presentations
9.45 – 10.25am	Session 18 – Poster Presentations
10.25 – 10.45am	Morning Tea – Oceania
10.45 – 11.25am	Session 19 – Presentations
11.30 – 12.10pm	Session 20 – Presentations
12.10 – 1.00pm	LUNCH - Oceania

General Conference Information

Welcome: Mihi and Reception

A welcome mihi will be held in the Icon Room at 5.00pm on Tuesday 2nd July. A mihi can be described as an informal customary welcome of Aotearoa (New Zealand) which originates from the indigenous people. It is a settling process of both the physical and spiritual realms that brings the local people and visitors together. The process is especially appropriate if there are people who are coming into the area for the first time. The mihi is conducted in the indigenous language of Aotearoa, Te Reo Māori, and will be given by Kahu Ropata, a member of the Te Atiawa iwi.

The mihi will be followed by a reception until 7pm. The registration desk will remain open at this time.

Conference Arrival

The registration desk will open at 4pm on Tuesday 2nd July in the Icon Room and at 8am each morning of the conference in the Oceania Room. When delegates first arrive at the conference, they should register at the registration desk. Oceania is on the second floor. Go up the flight of stairs directly ahead of you as you enter, and then up another level again. (The stair risers are currently painted pink to announce the Andy Warhol exhibition.) There are lifts to the right of the entry foyer.

Official Welcome

The Official Welcome will be held from 9.00 – 9.25am on Wednesday morning in the Oceania Room. Please be seated by 8.55am.

Annual General Meeting

The ASERA Annual General Meeting will be held on Thursday 4th July, from 11.15am to 12.15pm. Again the venue is the Oceania room. All members are welcome to attend.

Chairing Sessions

If you are presenting a paper, then you have probably been assigned to chair a session for someone else. Please check the Programme of presentations. If you are not presenting any paper then you have not been assigned to chair a session.

Each session lasts 40 minutes. This allows 20 minutes for paper presentation and 20 minutes for questions. The Chairperson should introduce the speaker, monitor the time for the speaker and assist in managing any questions.

If you are unable to chair a session for which you have been assigned, please arrange to swap with someone else

Poster Information

On the day of your presentation, your poster needs to be taken to the Oceania Room before the poster session begins and placed on one of the available panels. Please hang your poster with the materials provided. At the time allocated for poster presentations, you will have the opportunity to speak to the whole group for 3-5 minutes (to present one or two key points) then explain your poster to conference participants as they visit the posters on display. At the end of the day's sessions, please remove your poster. Thank you for participating in the poster presentation.

Internet access

Te Papa is fully wireless. Internet access is free in all parts of the building. Bring your own device if you wish to use this. There is no login or password required.

Meals

Lunches, morning and afternoon teas will be served in the Oceania Room.

Conference Dinner

The 2013 conference dinner will be held in the Oceania Room.

The dinner will include a 3-course meal, wine on the tables and live music. A cash bar will operate for other alcohol purchases. Bring your dancing shoes.

Please present your dinner ticket upon arrival.

Transport from the airport

Taxis are freely available outside the main doors at Wellington Airport. You do not need to book. Prices vary as there are a number of competing operators. Expect to pay about $40 – $50 for a trip into the city, depending on traffic density.

The 'Airport Flyer' shuttle bus is a cheaper option. The stand is to the right as you exit the main arrival doors and there is generally a service every 20 minutes or so.

Local train and buses

Wellington's trains do not service the airport or the inner suburbs but will be a good option if you want to go further afield (e.g. the Kapiti Coast, Johnsonville, or the Hutt Valley). There is one central Railway Station. As you leave Te Papa keep the sea on your right and you'll find in near the end of the harbour side walkway. Tickets are purchased on the station and clipped by a guard on the train.

Parking

Parking is available at Te Papa for a cost of $9.00 per day. There will be a validation machine at the registrations desk so that delegates can bring their car park tickets to get this rate.

Important contacts:

Lorraine Spiller, Researcher, New Zealand Council for Educational Research

Email: Lorraine.Spiller@nzcer.org.nz

In New Zealand, for extreme emergencies, you can dial 000 from any phone for free.

- Dialling this number will have police, fire *and* ambulance sent to your location immediately.
- Please only call this number in case of a serious emergency.
- If the situation is deemed not to be a serious emergency by authorities, the person who called will be fined.

AUSTRALASIAN SCIENCE EDUCATION RESEARCH ASSOCIATION LTD

Programme of Presentations

ASERA Conference 2013

TUESDAY 2 JULY	
4.00-6.00pm	**Registrations**
5.00-7.00pm	**Welcome Mihi followed by Reception – ICON TE PAPA**

WEDNESDAY 3 JULY							
	Rangimarie 1	**Rangimarie 2**	**Rangimarie 3**	**Angus 1**	**Angus 2**	***Oceania 1***	Oceania 2
8.00-8.55am	**REGISTRATIONS – OCEANIA ROOM**						
9.00-9.25am	**Welcome in Oceania**						
9.30-10.10am Session 1	**Georgina Stewart** *Teaching and learning science in Māori: Language, knowledge and identity.*	**Debra Panizzon, Rebecca Cooper & Greg Lancaster** *Teaching in the Virtual School of Emerging Sciences: Why must my pedagogy change?*	**Russell Tytler, Peter Hubber & George Aranda** *Teachers supporting reasoning in primary science in three countries.*	**Kirsty Farrant** *Polishing up my critical lens: how conversations with students have changed my practice.*	**Tang Wee Teo, Kim Chwee, Daniel Tan, Yaw Kai Yan & Yong Chua Teo** *Using Flip Teaching to Address the Limitations of Undergraduate Chemistry Practical Curriculum.*		
	Chair: Christine Preston	**Chair: Peter Fensham**	**Chair: John Kenny**	**Chair: Linda Hobbs**	**Chair: Anne Hume**		
10.10-10.35am	**MORNING TEA – OCEANIA**						
10.35-11.15am Session 2	**Christine Howitt, Fiona Mayne & Leonie Rennie** *Parents' role in*	**Jacquie Bay, Helen Mora, Mark Vickers, Deborah**	**Venkat Vishnumolakala, David Treagust, Mauro Mocerino**	**Gregory Smith & Michael Michie** *The elusive indigenous*	**Judy Moreland & Bronwen Cowie** *Igniting children's interest and*		

WEDNESDAY 3 JULY							
	Rangimarie 1	**Rangimarie 2**	**Rangimarie 3**	**Angus 1**	**Angus 2**	***Oceania 1***	Oceania 2
	supporting 4-year-old children's exploratory play at an interactive science exhibit in a playgroup setting.	**Sloboda, Susan Morton & Peter Gluckman** *Learning Together: Exploring the translational potential of the classroom within the science cycle and the role of engagement in science within the development of scientific literacy.*	**& Daniel Southam** *First year chemistry students' understanding of stereochemistry concepts and their perception of modified Process Oriented Guided Inquiry Learning.*	*perspective through science education student teachers' eyes.*	*understanding in science: Experimenting, constructing and presenting.*		
	Chair: Kathy Saunders	**Chair: Rosemary Hipkins**	**Chair: Azra Moeed**	**Chair: Georgina Stewart**	**Chair: Rebecca Cooper**		
11.20-12.00pm Session 3	**Fiona Mayne & Christine Howitt** *Gaining meaningful informed consent with 3-year-old children using science stories.*	**Michelle Tewskesbury** *A comparative analysis of the NCEA and IB Diploma courses in chemistry: Curriculum, pedagogy and assessment.*	**Keith Skamp, Eddie Boyes, Martin Stainisstreet, Manuel Rodriguez, Georgios Malamdrakis, Roseanne Fortner, Ahmet Kilinc, Neil Taylor, Kiran Choker, Shweta Dua, Abdullah Ambusaidi, Irene Cheong, Mijung Kim & Hye-Gyoung Yoon**	**Craig Rofe** *Indigenous Knowledge of Science Teachers – A Case Study.*	**Pojchana Khumwong, Kusalin Musikul, Benjawan Hanpipat, Wanchai Noiwong & Sanikan Saneewong** *Development of primary students' scientific process skills after the second year of implementation of new science learning materials.*	**Kirupanithi Pooranavelu & Mageswary Karpudewan** *Science Writing Heuristic (SWH) as a means to improve undergraduate students attitude in the topic of stoichiometry in chemistry.*	

WEDNESDAY 3 JULY							
	Rangimarie 1	**Rangimarie 2**	**Rangimarie 3**	**Angus 1**	**Angus 2**	***Oceania 1***	Oceania 2
			Power generation and sustainability options: An international study of students' beliefs about, and willingness to act, in relation to two energy production scenarios.				
	Chair: **Stephen Ritchie**	**Chair:** **Maryam Sandhu**	**Chair:** **Peter Fensham**	**Chair:** **Louisa Thomas Engel**	**Chair:** **Rekha Koul**	**Chair:** **Karen Murcia**	
12.00-1.00pm	**LUNCH – OCEANIA**						
1.00-1.40pm Session 4	**Dennis Fitzgerald** *The Use of Spatial Thinking in the Teaching of Secondary Science.*	**Bill MacIntyre** *Are we preparing primary science educators for a science leadership role in the primary classroom?*	**Gerry Healy** *The Real versus Simulations in Science Teaching: Where is the balance?*	**Thomas Owen & Brian Lewthwaite** *Culturally Responsive Science Teaching in Indigenous Settings: What Does it Look and Think Like and What is its Influence?*	**Frederick Toralballa Talaue & Aik-Ling Tan** *Positioning to teach science through inquiry.*		
	Chair: **James Watters**	**Chair:** **Debra Panizzon**	**Chair:** **Christine Howitt**	**Chair:** **Leonie Rennie**	**Chair:** **David Treagust**		
1.45-2.25pm Session 5	**Joseph Ferguson** *"Reasoning through Digital Modelling about Natural Selection as a Complex System*	**Dayle Anderson** *Back at school: common factors in primary schools where Primary Science Teacher Fellows successfully raise*	**John Kenny, Coral Campbell, Linda Hobbs, Jeffrey King, Sandra Herbert, Gail Chittleborough, Mellita Jones &**	**David Paterson** *Science education research really does make a difference.*	**Azra Moeed & Mike Taylor** *Initial Classroom Shockwaves Subsequent to the Darfield (Canterbury) Earthquake 2010*		

WEDNESDAY 3 JULY							
	Rangimarie 1	**Rangimarie 2**	**Rangimarie 3**	**Angus 1**	**Angus 2**	***Oceania 1***	Oceania 2
	Phenomenon."	*the profile of science.*	**Christine Redman** *Science Teacher Education in Partnership with Schools.*				
	Chair: Jerry Healy	**Chair: Keith Skamp**	**Chair: Margaret Marshman**	**Chair: Brian Lewthwaite**	**Chair: Kathryn Garthwaite**		
2.30-3.10pm Session 6	**Poster Session 1 – Oceania 1** **Chris McIntyre, Azra Moeed & Mike Taylor** *The response of secondary school geography and science teachers to Canterbury earthquakes* **Amani Al-hussan** *Evaluating the Level of learning of scientific concepts from developed science books in the 1st year of primary school.* **Janjira Saisang & Chokchai Yuenyong** *Infusing Ethical and Moral Issues in a Grade 12 Biology Laboratory* **Carrie VanderZwaag** *Explorations of ideas about water transport in plants—a cross-age survey*				**Poster Session 2- Oceania 2** **Hsiu-Ping Huang, Chih-Hung Wang, Ying-Yao Cheng & Yueh-Suey Shiao** *A Study of Elementary School Science Teachers' Attitudes toward Multicultural Education Issues.* **Yueh-Suey Shiao, Huey-Lien Kao & Hsiu-Ping Huang** *A study of elementary school students' knowledge of energy-saving and carbon reduction in Taitung.* **Chokchai Yuenyong, Khanittha Patho & Suthida Chamrat** *Elementary school science teachers' reflections on the Nature of Science during a force and motion learning activity.* **Huey-Lien Kao, Yueh-Suey Shiao, Ming-Chou Su, Ching-Yi Chang, Wei-Min Hsu, Chih-Lung Lin & Chi-Liang Chang** *A Case Study of One Taiwan's Paiwan Elementary School Implementing Culturally Responsive Teachings in Science and Mathematics.*		
	Chair: Russell Tytler				**Chair: Peter Hubber**		
3.10-3.30pm	**AFTERNOON TEA – OCEANIA**						

WEDNESDAY 3 JULY							
	Rangimarie 1	**Rangimarie 2**	**Rangimarie 3**	**Angus 1**	**Angus 2**	***Oceania 1***	Oceania 2
3.30-4.10pm Session 7	**Eunhee Kang, Shinyoung Lee & Heui-Baik Kim** *Does meaningful cognitive cooperation occur in a collective problem solving activity on Mendelian genetics?*	**Brian Lewthwaite, Tanya Doyle & Thomas Owen** *"Did something happen to you over the summer?" Tensions in Intentions for Chemistry Education.*	**Alberto Bellocchi, Stephen Ritchie & Maryam Sandhu** *Experiences of Pride and Triumph in Learning Science*	**Sheryl Maher** *Does feedback help?*	**Louisa Thomas Engel, Cliff Jackson & Karen Carlisle** *The Transformative Potential of Engaging in Science Inquiry and Design-based Challenges: The ATSE Wonder of Science Challenge.*		
	Chair: **Donna King**	**Chair:** **Anne Forbes**	**Chair:** **Deb Corrigan**	**Chair:** **Adam Betram**	**Chair:** **Joseph Ferguson**		
4.15-4.55pm Session 8	**Rekha Koul** *Co-Teaching and Co-Generative Dialogue: Case Studies in Science Classrooms with Academically Talented Students.*	**Karen Murcia** *Secondary school students' attitudes to nanotechnology: What are the implications for science curriculum development?*	**Donna King, Stephen Ritchie, Alberto Bellocchi & Maryam Sandhu** *Activity makes a difference: discrete emotions of year 8 science students.*	**Margaret Marshman & Michael Christie** *The rhetoric and reality of University engagement: a case study.*	**Sheila Qureshi** *Reflections of POGIL Implementation in Foundation Chemistry in Qatar.*		
	Chair: **Vaughan Prain**	**Chair:** **Alicia Richardson**	**Chair:** **Katherine Swalf**	**Chair:** **Jennifer Hubber**	**Chair:** **Michael Forret**		
Book Launch: **Constructing representations to learn in science** Russell Tytler, Vaughan Prain, Peter Hubber, Bruce Waldrip (Eds.) Launch by Professor Bronwen Cowie in the display area. Drinks and nibbles provided.							

THURSDAY 4 JULY							
	Rangimarie 1	**Rangimarie 2**	**Rangimarie 3**	**Angus 1**	**Angus 2**	***Oceania 1***	Oceania 2
9.00-9.40am Session 9	**WP Palmer** *Elements of chemistry: the books and their authors (1820-1850)*	**Christine Preston** *Primary students' explanations from interaction with a magnets science diagram.*	**Rosemary Hipkins** *Translating NOS into the taught curriculum as "science capabilities."*	**Matthew Hill & Manjula Sharma** *Teaching communication or concepts in flip-lecture science instruction: The impact of teaching multiple representations across a semester of 1st year university physics.*	**David Warren** *The influence of an extended outreach Programme on the attitude of year 8 pupils towards science.*	**Mihye Won, Siv Ling Ley & David Treagust** *Concept maps as a diagnostic tool for teaching and learning physics.*	
	Chair: **Sally Birdsall**	**Chair:** **Dennis Fitzgerald**	**Chair:** **Cathy Buntting**	**Chair:** **Judy Moreland**	**Chair:** **Pru Smith**	**Chair:** **Kate Rice**	
9.45-10.25am Session 10	**Nhung Nguyen, John Williams & Michael Forret** *Integrating Information and Communication Technology into Teaching Physics – a Pedagogic Model.*	**Melanie Isaacs & Deb Corrigan** *Moving beyond good intentions: Explicit Science as a Human Endeavour content in senior secondary.*	**Ally Bull** *Strengthening engagements between schools and the science community.*	**Karen Marangio** *Progression of learning within the Victorian Certificate of Education (VCE) Psychology Study Design.*	**Syeda Tahmina Akhter** *Curriculum emphases in junior secondary science textbooks in Bangladesh and their relationship with real life situations.*		
	Chair: **Bill MacIntyre**	**Chair:** **Gregory Smith**	**Chair:** **Simon Taylor**	**Chair:** **Kathy Paige**	**Chair:** **Melissa Slarp**		
10.25-10.45am	**MORNING TEA – OCEANIA**						

THURSDAY 4 JULY							
	Rangimarie 1	**Rangimarie 2**	**Rangimarie 3**	**Angus 1**	**Angus 2**	***Oceania 1***	Oceania 2
10.45-11.25am Session 11	**Kate Rice** *Using Design-Based Research (DBR) to develop a professional development programme to build Nature of Science (NoS) understanding of a group of New Zealand teachers.*	**Peter Fensham** *Which Child(ren) left Behind? Assessment of science learning and equity.*	**David Symington & John Cripps Clark** *Toward a better understanding of school/community collaboration in school science.*	**Jennifer Yeo & John Gilbert** *Producing scientific explanations: What it takes.*	**Rana El Farra & Tarik Rashid** *Assessing Learning, Teaching and Thinking Levels in Y7-13 Science, Biology and Chemistry at one New Zealand high school.*		
	Chair: Dayle Anderson	**Chair: Rosemary Hipkins**	**Chair: Michael Michie**	**Chair: Bev France**	**Chair: Karen Marangio**		
11.30-12.20pm	**AGM - OCEANIA**						
12.20-1.00pm	**LUNCH – OCEANIA**						
1.00-1.40pm Session 12	**Lorraine Spiller & Rosemary Hipkins** *"It's too hard": Supporting secondary science teachers to change their practice.*	**Kathy Paige** *Socio- Scientific Issues- A reflective glance.*	**Anne Hume & Amanda Berry** *Professional learning partnerships: PCK development as an outcome of pre-service and associate teacher collaboration in CoRe design.*	**Vaille Dawson & Katherine Carson** *Western Australian High School Students' Understanding of Climate Change*	**Jessie McKenzie, Azra Moeed, Dayle Anderson & Rex Bartholomew** *Using strengths: collaboration between organisations to support primary science.*	**Belinda Cridge & Bev France** *Organisational culture and its role in developing a sustainable science communication platform.*	
	Chair: Ally Bull	**Chair: David Symington**	**Chair: Karen Murcia**	**Chair: George Aranda**	**Chair: Foez Mojumder**	**Chair: Venkat Vishnumolakala**	

THURSDAY 4 JULY							
	Rangimarie 1	**Rangimarie 2**	**Rangimarie 3**	**Angus 1**	**Angus 2**	***Oceania 1***	Oceania 2
1.45-2.25pm Session 13	**John Williams, Kathy Saunders, Elaine Khoo & Bronwen Cowie** *Networked Inquiry Learning in Secondary Science classrooms.*	**Pru Smith** *Developing teachers' capacity to manage classroom discourse in primary science classrooms.*	**Leonie Rennie** *Learning Science Outside of School: Community Links.*	**Karen Murcia, Mark Hackling & Khadeeja Ibrahim-Didi** *Multimodal reasoning in a Western Australian primary science classroom.*	**Kongsak Thathong** *An Application of the Philosophy of Sufficiency Economy in Conserving the Environment and Generating Income for Local Youths through Growing Golden Teaks at Home.*	**Dermot Donnelly, & Anne Hume** *Pre-service teachers' perceptions of a wiki to support Content Representation (CoRe) design.*	
	Chair: **Linda Hobbs**	**Chair:** **Jessie McKenzie**	**Chair:** **Chris Joyce**	**Chair:** **David Warren**	**Chair:** **Lorraine Spiller**	**Chair:** **Katrina Elliott**	
2.30-3.10pm Session 14	**Poster Session 1- Oceania 1** **Jirakan Yuenyong** *Preservice Science Teachers' Awareness of Knowledge and Skills for Inquiry Teaching during Their Teaching Practices in Schools.* **Napaphan Iamsam-ang** *Enhancing Grade 12 Thai Students' Creative Thinking in Learning about Ecosystem through Inquiry Cycle*. **Kuo Hua Wang & Ching Sheng Yang** *Professional Development Needs on Argumentation-based Inquiry Teaching for Math and Science Teachers in Taiwan.* **Shu-Ching Wang & Kuo-Hua Wang** *Professional development in nanoscience education for science teachers of junior high school in Taiwan.*				**Poster Session 2- Oceania 2** **Adam Bertram, Anthony Vella & Bruce Waldrip** *The impact of a physics teacher's PCK in developing his students' critical thinking and reasoning skills.* **Chokchai Yuenyong & Gegory Thomas** *Argumentation and Metacognition of Physics classroom in Thai context.* **Shih Wen Chen, Wei Ying Lan & Wen Gin Yang** *The affordances of multimodalities on the technicality in physics discourses.*		
	Chair: **Deborah Heck**				**Chair:** **Pamela Farrelly**		

THURSDAY 4 JULY							
	Rangimarie 1	**Rangimarie 2**	**Rangimarie 3**	**Angus 1**	**Angus 2**	***Oceania 1***	Oceania 2
3.10-3.30pm	**AFTEROON TEA – OCEANIA**						
3.35-4.15pm Session 15	**Simon Taylor** *Exploration of Collaborative Learning Environments in New Zealand Secondary School Science classrooms*	**Deborah Heck, Trudy-Ann Sweeney** *Exploring curriculum development in science teacher education curriculum courses through most significant change stories.*	**Jim Watters & Clare Christensenskas** *Vocationalism in science and technology education: Aligning school curricula with workplace needs?*	**David Treagust & Chi-Yan Tsui** *Contributions of Multiple Representations to Biological Education.*	**George Aranda, John Cripps Clarke** *Blogging as a tool in teaching science communication.*		
	Chair: **Melanie Isaacs**	**Chair:** **Rena Heap**	**Chair:** **Kathryn Garthwaite**	**Chair:** **Marie-Noel Bety**	**Chair:** **Tim Stohfeldt**		
4.20-5.00pm Session 16	**Chris Joyce** *E-learning for engagement - but what are students engaging with?*	**Marie-Noel Bety, Patrice Potvin & Patrick Charland** *Evolution of in-service primary school teachers' knowledge and teaching practices following a workshop about conceptual change.*	**Linda Hobbs** *When teaching out-of-field means learning at the boundaries.*	**Peter Hubber, Alicia Richardson, Katherine Swalf & Jennifer Hubber** *Teacher change in implementing a research developed representation construction pedagogy.*	**Sally Birdsall** *Using identity as a lens to theorise effects of professional learning.*	**Tahani Al-Muzaini** *The Effectiveness of a Suggested In-service Training Programme in Developing Female Science Teachers' Action Research Skills.*	
	Chair: **Anne Forbes**	**Chair:** **David Treagust**	**Chair:** **Belinda Cridge**	**Chair:** **Sheryl Maher**	**Chair:** **Bronwen Cowie**	**Chair:** **Deb Corrigan**	
7.00-11.00pm	**CONFERENCE DINNER – OCEANIA**						

FRIDAY 5 JULY							
	Rangimarie 1	**Rangimarie 2**	**Rangimarie 3**	**Angus 1**	**Angus 2**	***Oceania 1***	Oceania 2
9.00-9.40am Session 17	**Zahra Parvanehnezah Shirazian** *Problem solving as a lens- A framework for investigating physics teachers' thinking*	**Russell Tytler & Vaughan Prain** *Improving learning by re-thinking concepts in science.*	**Kathryn Garthwaite** *The complexity of scientific literacy: The development and use of an analysis matrix.*	**Shu-Chiu Liu, Huann-shyang Lin** *Taiwanese primary teachers' beliefs about scientific creativity and its teaching.*	**Anne Forbes & Keith Skamp** *The threads that bind: Factors influencing the implementation and development of communities of science practice in primary school classrooms.*	.	
	Chair: **Cathy Buntting**	**Chair:** **Sally Birdsall**	**Chair:** **Chris Joyce**	**Chair:** **Bill MacIntyre**	**Chair:** **Ally Bull**		
9.45-10.25am Session 18	**Poster Session 1- Oceania 1** **Lih-Lian Hwang** *Effects of hybrid problem-based versus lecture-based learning on undergraduates' cancer knowledge.* **Hsiao-ping Yu** *The effect of science learning and career development of gifted girls in university.* **Katrina Elliott** *South Australia's Approach to working with the Australian Curriculum: Science.*				**Poster Session 2- Oceania 2** **Hayashi Nakayama, Yuji Saruta, Tomohiro Mori & Toshikazu Watanabe** *Differences in types of questioning terms by inquiry stage in the science textbooks of lower secondary school in Japan.* **Shiho Miyake & Hayashi Nakayama** *Recent trends on collaboration between schools and local societies in Japanese school science education.* **Jabber Aljabber** *A Content Analytic Study of the Sixth Grade Science Textbook in the Kingdom of Saudi Arabia.* **Chi-Di Lee** *Worksheet Usage and Science Achievement: A Cross-country comparison using TIMSS and PIRLS 2011 data*		
	Chair: **Chris Joyce**				**Chair:** **David Symington**		
10.25-10.45am	**MORNING TEA – OCEANIA**						

FRIDAY 5 JULY							
	Rangimarie 1	**Rangimarie 2**	**Rangimarie 3**	**Angus 1**	**Angus 2**	***Oceania 1***	Oceania 2
10.45-11.25am Session 19	**Melissa Slarp** *How ecoliterate is a five year old? Using a teaching intervention to increase young children's ecological understanding.*	**Cathy Buntting, Deb Corrigan, Alister Jones & Richard Gunstone** *Valuing assessment in science education.*	**Tim Strohfeldt** *Preservice Secondary Science Teachers' Pathways to Integrating Technology in Their Pedagogical Practice.*	**Wei-Ying Lan, Shih Wen Chen & Wen Gin Yang** *The Differences of Semantic Understanding of Taxonomic Relations between Teachers and Students.*	**Foez Mojumder** *Exploring students' attitudes towards school science in Bangladesh.*		
	Chair: Deborah Heck	**Chair: Vaille Dawon**	**Chair: Anne Hume**	**Chair: Pamela Farelley**	**Chair: Kathy Paige**		
11.30-12.10pm Session 20	**Shu-Min Chen** *The impact of an inquiry-based science teaching on gender differences in young children's understanding about force.*	**Cathy Buntting** *Can digital technologies transform school science?*	**Beverly France & Rena Heap** *Developing children's capacity to make evidence-based decisions about the socioscientific issue of volcanic risk.*	**Pamela Farelley** *Student Perceptions of Science in a Middle School: The impact of aesthetics, affordance, agency and position.*	**Ying-Shao Hsu, Yi-Fen Yeh** *Uses of Multimedia in Pre-service Teachers' Instructional Materials.*		
	Chair: Kathy Saunders	**Chair: Russell Tytler**	**Chair: Fiona Mayne**	**Chair: David Treagust**	**Chair: Dayle Anderson**		
12.10-1.00pm	**LUNCH – OCEANIA**						

Abstracts

Session 1

Teaching and learning science in Māori: Language, knowledge and identity

Wednesday, 9.30am – Rangimarie 1

Georgina Stewart
Auckland University

This paper gives an account of the difficulties that arise in teaching and learning science in Māori, due to philosophical conflict between the relativist commitments involved in cultural restoration and the universalist nature of science knowledge. Māori medium education has twin aims: firstly to ensure the survival of te reo Māori me ōnatikanga, and secondly to overcome the longstanding gap in academic outcomes for Māori students. The analysis presented in this paper examines the contradictions between these two aims in the context of Māori medium science education, and the results produced at the levels of language, knowledge and identity. This analysis suggests these contradictions help to explain the disappointing results to date of Māori medium science education, and indicate a need for change in curriculum policy.

Teaching in the Virtual School of Emerging Sciences: Why must my pedagogy change?

Wednesday, 9.30am – Rangimarie 2

Debra Panizzon, Rebecca Cooper & Greg Lancaster
Monash University

The Virtual School of Emerging Sciences (VSES) is an innovative scoping project designed to provide interested Year 10 students with the exciting opportunity to engage in the study of unique “emerging science” units. The VSES’s virtual classroom is broadcast live from a studio at the John Monash Science School using a curriculum developed by JMSS’s teachers in close collaboration with academic specialists from the Faculties of Education and Science from Monash University. The virtual classes comprise students drawn from schools across several Australian states and regularly connect them using WebEx conferencing software. The students also engage with their course materials, teachers and each other using a number of collaborative tools, e.g. RealSmart, WordPress and shared Google+ applications. Clearly, teaching in this virtual environment to students located interstate presents the VSES teachers with pedagogical challenges not normally encountered in typical ‘face to face’ classrooms. Not only do the teachers need to alter the ways in which they prepare and share instructional materials they are forced to explore and employ new technologies to engage, monitor and provide feedback on student progress. This paper provides initial observations and insights around changes in practice and pedagogy as the VSES teachers address these challenges.

Teachers supporting reasoning in primary science in three countries

Wednesday, 9.30am – Rangimarie 3

Russell Tytler, Peter Hubber & George Aranda

Deakin University

The 'Equalprime' project is studying teacher support of reasoning in primary science classrooms in Australia, Germany and Taiwan, through comparative analyses of video records of classrooms of quality teachers. In this paper we will present analyses of discourse in short activity sequences of selected teachers in the three countries to investigate how we might characterize teacher discursive moves to support reasoning, to identify commonalities and differences in the teachers' practices, and to explore how these differences relate to cultural factors. The following analyses of the video record were carried out: a) identification of the sequence of moves through which students were challenged to reason about the target phenomena, including the nature of the task set, patterns of conceptual challenge and input of ideas by the teacher and by students, b) the nature of teachers' re-voicing or response to student claims, as an indicator of control of knowledge, and c) patterns of generation and use of representational resources. We argue on the basis of the analysis that while student reasoning, and support for reasoning, can take many forms, some of them cultural in nature, quality teaching has certain identifiable characteristics that transcend national boundaries.

Polishing up my critical lens: how conversations with students have changed my practice.

Wednesday, 9.30am - Angus 1

Kirsty Farrant

Newlands College, Wellington, New Zealand

The research outlined in this presentation involved reflecting on my teaching practice, to inquire whether changes could be made to the way I teach ethical decision-making on socioscientific issues to ensure students develop competencies they can use in future contexts. During 2011 I actively gathered data for a self-study in science education. Significant data was gathered from interviews with a group of students in my Year 13 Biology class. The interviews, held at the conclusion of the course to minimise ethical concerns, focussed on the teaching that had occurred in a unit on socioscientific issues. Three main ideas emerged from the interview data. I found that my intended outcomes as a teacher did not always match what the students thought the intended outcomes were. It is also really important to teach research skills in general just as well as subject specific research skills, as not a lot of this is being taught by other subjects. My third insight is that there is significant value in talking to students about more than simply the content. Only by changing the focus have I been able to make changes that better to ensure students develop competencies they can use in future contexts.

Using Flip Teaching to Address the Limitations of Undergraduate Chemistry Practical Curriculum

Wednesday, 9.30am - Angus 2

Tang Wee Teo, Kim Chwee, Daniel Tan, **Yaw Kai Yan & Yong Chua Teo**
Nanyang Technological University

The goals of this paper are to present the findings of: (1) the curriculum evaluation study of an undergraduate chemistry practical curriculum which prepares students to become science teachers, and (2) the outcomes of the implementation of "flip teaching" to address some issues identified in the evaluation. Similar to previous studies, the findings gathered from student questionnaires, student interviews, and chemistry practical lesson videos show that students faced time constrains, possessed limited conceptual understanding of the science processes, and did not see how they can apply what they had learned to their own teaching. Based upon the findings, the chemistry instructors adopted "flip teaching" by making pre-laboratory briefing videos that can be viewed on an institutional App on iOS mobile devices. Through such an effort, it was hoped that students would take more ownership of their learning and that more curriculum time may be freed up for class discussions. The strengths, limitations, and suggestions to improve the flip lesson derived from the analysis of transcribed lesson videos, student interviews, and curriculum artefacts will be discussed. Educational researchers and practitioners interested in learning how flip teaching may be used to address the long-standing issues of science practical curriculum may be interested in our presentation.

Session 2

Parents' role in supporting 4-year-old children's exploratory play at an interactive science exhibit in a playgroup setting

Wednesday, 10.35am – Rangimarie 1

Christine Howitt[1], **Fiona Mayne**[1] **& Leonie Rennie**[2]
[1]University of Western Australia & [2]Curtin University

Little is known about how very young children in a playgroup context interact with science exhibits. A science centre has developed a travelling early childhood science Programme for 0- to 4-year-old children. The aims of the Programme are to introduce and engage young children in everyday science and provide an avenue for scientific discovery through play. This research describes how parents in one metropolitan Western Australian community playgroup supported their children's exploratory play at one specific exhibit - the shadow tent. A case study research design was employed, utilising parent-child dyads as the unit of analysis. Data were collected by video-taping two parent-child dyads interacting with the exhibit, and audio recordings of children's conversations using video-still photographs to stimulate recall. Carol explored how to make and manipulate shadows, yet demonstrated limited understanding of how shadows worked. Her mother's interactions in the shadow tent were restricted to pointing to shadows on the tent. In contrast, the other mother's modelling and explaining how to produce shadows led Jeremy to actively explore the relationship between the shape and distance from the light. These results highlight the importance of adults understanding their role of direct involvement in play to extend children's learning.

Learning Together: Exploring the translational potential of the classroom within the science cycle and the role of engagement in science within the development of scientific literacy

Wednesday, 10.35am – Rangimarie 2

Jacquie Bay[`], Helen Mora[1&2], Mark Vickers[1&3], Deborah Sloboda[1&4], Susan Morton[1,2,3] & Peter Gluckman[1&3]

[1]Liggins Institute [2]University of Auckland, [3]Gravida, [4]McMaster University.

The science cycle is not complete until the community for whom new scientific knowledge has relevance is able to engage with this knowledge, and decide if, when and how they will use it. However this requires a level of scientific literacy that allows individuals to participate in transactional communication processes that support translation of scientific knowledge into community understanding. The Healthy Start to Life Education for Adolescents project has designed context-embedded learning modules that facilitate transactional communication to support translation of science and the development of scientific literacy within the classroom setting. These learning modules were applied in 24 urban Year 7-10 classes across 9 schools. Matched pre- and 12-week post-intervention questionnaire responses from 238 students and 99 parents, 6-month post-intervention interviews, and a further 100 matched student questionnaire responses 12-months post-intervention were used to evaluate the ability of the modules to support participants to understand and potentially respond to new scientific knowledge about non-communicable disease risk reduction. We sought evidence of participants using scientific knowledge in decision making relevant to the learning context and observed statistically significant sustained knowledge, attitude and behaviour changes up to 12-months post-intervention. This indicates that teachers were facilitating the communication of new scientific knowledge in a way that allowed participants to decide if and how to use this knowledge. Exploration of the transferability of the scientific literacy demonstrated by participants in this setting is required.

First year chemistry students' understanding of stereochemistry concepts and their perception of modified Process Oriented Guided Inquiry Learning

Wednesday, 10.35am – Rangimarie 3

Venkat Vishnumolakala, David Treagust, Mauro Mocerino & Daniel Southam

Curtin University

The study relates to first year chemistry students' understanding of stereochemistry concepts and their perceptions in an Australian modified-POGIL (Process Oriented Guided Inquiry Learning) context that included group work. Most of these chemistry students had not previously studied stereochemistry. The quasi-experimental post-test and delayed post-test design involved a 5–item two-tier Stereochemistry Diagnostic Test (SCDT) to ascertain the extent to which students' understanding of stereochemistry concepts changed in the POGIL-influenced classroom environment. The researcher-developed and faculty-validated instrument was administered individually and two weeks later administered to groups of 2-4 students as a delayed post-test. Results of a paired sample t-test analysis between post and delayed post-tests indicated that the students' understanding in the delayed-test improved significantly when they were able to participate in POGIL learning following the post-test (from 17% to 41% per item).An important outcome of this research is that although the POGIL-style teaching did not appear to benefit the students in the post-test, given the opportunity to again engage in small group POGIL work after completing the post-test, the learning gains increased markedly in the delayed post-test. In this research, the study also

attempted to validate the previously developed Student Assessment of Their Learning Gains (SALG) survey.

The elusive indigenous perspective through science education student teachers' eyes

Wednesday, 10.35am – Angus 1

Gregory Smith[1] & Michael Michie[2]

[1]Charles Darwin University & [2] Batchelor Institute of Indigenous Tertiary Education

This paper presents an analysis of the perceptions of an 'indigenous perspective' as presented by 140 pre-service science education students. The students were required to choose a concept in science, and then incorporate their notions of an indigenous perspective relative to their chosen science concept. The students presented their science concept and indigenous perspectives using concept maps or mind maps. In this study their concept and mind maps were considered to represent their constructed understandings or perceptions. The maps were analysed for the relationship constructs presented between knowledges. Concepts were drawn from seven overlapping and interrelated areas of Western science: seasons and weather, astronomy, plants, animals, resources, and ecology. The students' responses highlighted that an indigenous perspective is a relational construct between Western science knowledge, indigenous knowledge and knowledge application. This analysis presents science and indigenous perspectives as a complex web of inter-related knowledges. This complex representation moves from Science Understanding (content) to a conceptualisation of Science as a Human Endeavour.

Igniting children's interest and understanding in science: Experimenting, constructing and presenting

Wednesday, 10.35am – Angus 2

Judy Moreland & Bronwen Cowie

University of Waikato

This case study is of an investigation into how 7 and 8 year old children learnt about the use of solar energy for cooking. The solar energy unit included 12 lessons. The teacher combined activities adapted from the Science Learning Hub with a plethora of resources from elsewhere to develop a unit plan that she thought would engage her young students. She engaged the children in a series of nested science experiences, the construction and use of solar cookers and a public presentation of what was learned to other children and teachers. The children completed pre- and post- tests. The researcher videoed, audiotaped, photographed, made field notes and interviewed the teacher and the children about their science learning and views of scientists. Data were analysed using constructs from assessment for learning, pedaogical link-making and the integral science ideas. This analysis indicated that, right from the beginning of the unit, the teacher engendered a sense of suspense and built student curiosity through her linking and sequencing of the science experiences culminating in the making and use of a solar cooker. The value in the teacher building momentum in this way was evident in the students' enthusiasm, their commentary on their learning, and the number of children who went on to make similar cookers at home. The provision of, and need for, students to use multiple modes of action and representation was a notable feature of the ensemble of activities. The production of functioning artefact and public presentation served to affirm the wider value of what the students had done and learned. This unit raises questions about the nature of activities that engage students and their families in science learning.

Session 3

Gaining meaningful informed consent with 3-year-old children using science stories

Wednesday, 11.20am – Rangimarie 1

Fiona Mayne & Christine Howitt

University of Western Australia

The view that a child's own account of the world can become a valuable part of participatory research is gaining recognition. In the case of very young children, dilemmas exist in enabling them to understand their role as research participants. This paper presents results of a pilot trial involving two 3-year-old boys in Western Australia which used an electronic story to convey the context and purpose of a science research project. The story, which included the research problem, images of actual people, places and events, aimed to increase the effectiveness of the informing process by representing the project through a factual narrative. The story was trialled as part of a project investigating the effectiveness of a travelling early childhood science Programme in a community playgroup. Both children and parents found the story helped them understand the project and their roles as participants. Children understood many of the key elements of the research, including the purpose of the research, their role and their rights as a participant, the researcher's role, the various forms of data collection and how data would be used.

Two chemistry courses compared: NCEA and IBD

Wednesday, 11.20am – Rangimarie 2

Michelle Tewkesbury

Queen Margaret College, Wellington

The last decade has seen much change in secondary school education in New Zealand, including the implementation of the NCEA in 2002 and a revised national curriculum published in 2007. There has been uncertainty and controversy surrounding the implementation and subsequent reform of the NCEA and many schools now offer their students alternative qualification pathways, including the IBD. The primary focus of this study is the exploration of teachers' perspectives of chemistry teaching and learning in the context of the two structurally different qualification frameworks. This research will investigate the relationship between curriculum, pedagogy and assessment, with reference to the NCEA and IBD chemistry courses. This will be explored under the umbrella of three themes: teaching content and procedural knowledge of chemistry; approaches to assessment; and preparation for university. The research takes a comparative case study approach within an interpretive paradigm. Data will be collected in three case schools from multiple sources; document analysis; teacher interviews; classroom observations. The perspectives and practice of chemistry teachers will allow the researcher to determine how teachers manage the tension between learning, teaching and high-stakes assessment in preparing students for the two qualifications.

Power generation and sustainability options: An international study of students' beliefs about, and willingness to act, in relation to two energy production scenarios.

Wednesday, 11.20am – Rangimarie 3

Keith Skamp[1], Eddie Boyes[2], Martin Stainisstreet[3], Manuel Rodriguez[4], Georgios Malamdrakis[5], Roseanne Fortner[6], Ahmet Kilinc[7], Neil Taylor[8], Kiran Choker[9], Shweta Dua[10], Abdullah Ambusaidi[11], Irene Cheong[12], Mijung Kim[13] & Hye-Gyoung Yoon[14]

Southern Cross University[1], University of Liverpool[2], University of Liverpool[3], Ciudad Universitaria[4], University of Western Macedonia[5], Ohio State University[6], Ahi Evran University[7], University of New England[8], Centre for Environmental Education[9&10], Sultan Qaboos University[11], Universiti Brunei Darussalam[12], National Institue of Education[13] & Chuncheon National University of Education[14]

Renewable and nuclear energy are two plausible options to fossil-based energy production. This study reports students' beliefs about the usefulness of these two options in reducing global warming and their willingness to undertake actions that would encourage their uptake. Using a specially designed questionnaire students' responses were obtained from 11 countries (n>12000; Grades 6 to 10). Links between their beliefs about these energy options and their willingness to act were quantified using a range of novel derived indices; significant differences between beliefs and willingness to act occurred across the various counties. One derived index, the *Potential Effectiveness of Education* measures the extent to which enhancing a person's belief in the effectiveness of an action might increase their willingness to undertake that action; this indicated that education may impact on a willingness to act in some counties more than others. Interpretations are proffered for the reported differences between countries including whether how worried students are about global warming had impacted on their decisions, as well as whether cultural attributes had any influence. Recent research on students' emotional responses to conceptual change associated with controversial issues and their acceptance of the plausibility of particular ideas are related to the findings.

Which way does your Boomerang Fly? Indigenous Knowledge of Science Teachers – a Case Study

Wednesday, 11.20am – Angus 1

Craig Rofe

Victoria University, Wellington, NZ

Science students' learning and engagement have been strongly connected to effective teaching practices that support the students' cultural capital and identity. When science pedagogy and curriculum are integrated with aboriginal culture, student' participation in school science is increased. Because of its unique indigenous identity, Australasia's science teachers have an opportunity to integrate cross-cultural science teaching into the classroom. The question arises as to how culturally competent are our science teachers to utilise the students' indigenous knowledge? Teachers from a New Zealand secondary school were asked questions investigating proficiency with elements of Māori culture aligned with the NZ Teachers Council's "Graduating Teacher Standards". Questions such as "What is the local iwi (tribe) in your area?" and "How do you praise your students in Te Reo Māori (Māori language)?" were put to teachers from different subject specialised backgrounds. On average, non-science teachers displayed low aptitude and small improvement after professional development was offered throughout the duration of the project. In contrast, science teachers showed a noticeable progress with identical research conditions. I argue that differences in the

teachers' acquisition of indigenous knowledge for the project could be another illustration of the impact of positive relationships that exist in any learning environment, in this case between the researcher and participants of the research project. We will again focus on cultural aptitude by asking the same research questions to this presentation's audience. We will discuss the results of this anonymous investigation, the differences with the case study results (if any) and the relevance for incorporating indigenous culture into the sciences.

Development of primary students' scientific process skills after the second year of implementation of new science learning materials

Wednesday, 11.20am – Angus 2

Pojchana Khumwong, Kusalin Musikul, Benjawan Hanpipat, Wanchai Noiwong & Sanikan Saneewong

New science education standards aim to promote science literacy and skills for the next generation of Thai students. The authors of this paper designed and developed new learning materials to enhance students' science and language literacy, and scientific process skills. Their research in the phenomenographic tradition investigated whether the new learning materials had promoted science process skills among the participating students, using case studies as the research method. A scientific process skills test, observation field notes, interviews, and student work served as the primary data sources. We found that the students' test scores in the 2nd year were about 10% higher than the 1st year of implementation. The science process skills of the majority of 2nd and 5th graders had improved, especially on observation, classification, measuring, using numbers, inferring, communication, making conclusions and identifying relationship between space and space. In addition, the 5th graders mastered predicting, experimenting, and modelling skills. However, these students still lacked of skills of making hypotheses, defining operationally, and identifying and controlling variables. These findings provided feedback to us for revising and developing the learning materials for the 3rd year of the implementation.

Science Writing Heuristic (SWH) as a means to improve undergraduate students attitude in the topic of stoichiometry in chemistry

Wednesday, 11.20am – Oceania 1

Kirupanithi Pooranavelu & Mageswary Karpudewan
Universiti Sains Malaysia

This paper is based on a quasi-experimental research carried out among undergraduate students in a public university in Malaysia. The sample of the study consists of 80 first year science students. The experimental group was taught using SWH in teaching the topic of stoichiometry. The SWH involved brainstorming during the tutorial class on the topic of stoichiometry which was guided by the tutor. Then the students were divided into groups of four where they were given guidelines to discuss as a group and write down their findings. Then they would apply their findings to a particular question and write the answer as a group. Subsequently they would present this to their peers. The control group was taught using a more traditional method. In the traditional method students were given assignments from the end-of chapter questions. Then the solutions to the questions were given and discussed during the tutorial class. The traditional approach lacks student participation and is very much teacher centered. The objective of the study was to compare the effect of utilising SWH and the traditional method on students' attitude towards learning chemistry. Students' attitude

was gauged using the Test of Science Related Attitude (TOSRA) questionnaire. The findings indicate that the experimental group students' attitude improved significantly after the exposure to SWH.

Session 4

The Use of Spatial Thinking in the Teaching of Secondary Science

Wednesday, 1.00pm – Rangimarie 1

Dennis Fitzgerald
Deakin University

This research project examines the extent to which Spatial Thinking using Geographic Information Systems (GIS) as a representational tool contributes to students' conceptual understanding of the sciences including Environmental Science. A series of lessons were conducted with students gaining skills in the use of the specific spatial technologies, handheld GPS units as data collection devices and Google Earth as a presentation system to analyse collected data as part of a student designed inquiry project examining the environment of a local river. The introduction of new teaching approaches and technologies is often a complex although potentially very rewarding experience. The mediating tool, GIS, uses maps as a representation of the natural environment and allows students to analyse sets of spatially based data. Thus the role of GIS as a representational tool in mediating learning is examined. The analytical methods to be used in this research include Cultural Historical Activity Theory to examine a case study. The students' data sets with annotations, personal video diaries, classroom video and audio tapes and interviews with the students were all examined. The students found it to be a very engaging activity. The analysis of this research is on-going although early indications suggest that there are learning benefits in multi-model representations of spatially based data. There are a number of questions to be further considered including the nature of spatial thinking, the tools that support spatial thinking, the affordances that the representations of the data using mapped locations provide and how technology can support learning in the classroom and in the field.

Are we preparing primary science educators for a science leadership role in the primary classroom?

Wednesday, 1.00pm – Rangimarie 2

Bill MacIntyre
University of Auckland

Leaders in science education at primary school depend, in part, on their initial teacher education. Pedagogical content knowledge (PCK) along with leadership content knowledge (LCK) is identified as key contributors to developing science education leadership in ITE Programmes. Primary science teacher education in six New Zealand's initial teacher education institutes (ITE) is examined with regards to supporting the two key contributors. The evidence is that the face-to-face contact hours are being reduced with Programme changes over the past ten years. A longitudinal study, using the Science Beliefs Quiz (Stein, Barman &Larrabee, 2007), at one of the six ITE providers identified that first year students would be able to provide science leadership content knowledge in (Physical World, Material World and Planet Earth and Beyond). Implications of reduced contact hours in ITE

Programmes for the development of primary science education leaders in the 21st century are discussed.

The Real versus Simulations in Science Teaching: Where is the balance?

Wednesday, 1.00pm – Rangimarie 3

Gerry Healy
University of Melbourne

Two foci seem to be in tension: **1. Science is about the real natural world**: Experiencing the real is an integral part of students' science experience. **2. Increasing use of computer simulations**: Increasingly IT simulations are replacing hands-on experience, practical work and field work; for various reasons: Cost, convenience, time, safety, wider availability. However evidence seems to suggest that students' interest is significantly more stimulated by the experience of the real. Computer simulations can often be seen as just further computer games. In this presentation, student feedback gathered by the presenter over a period of time is described. This is largely based on feedback from pre-service student teachers, with some school based observations, using examples drawn from astronomy, electricity and biology. The preliminary findings were that simulations and diagrams are often quite distanced from experience of the real in learners' perceptions. The presenter, who works in the area of teacher pre-service education, hopes that this will stimulate discussion about achieving the appropriate balance between real experience and simulations.

Culturally responsive science teaching in indigenous settings: What does it look and think like and what is its influence?

Wednesday, 1.00pm – Angus 1

Thomas Owen[1] **& Brian Lewthwaite**[2]
[1]Victoria University & [2]James Cook University

In this study, we present a pedagogical framework for informing the teaching of science in a culturally responsive manner in northern Canadian communities where self-governance agreements have placed imperative on changes to not just the what or content of science education, but also the teaching practices associated with the teaching of science. We provide a description of the processes used to develop this framework and then present an account from teachers who are using the framework to inform their teaching. Further, we provide qualitative and quantitative data to give some preliminary indication of the influence of teachers' adjusted practice on student learning. Finally, we describe our ongoing work in the northern Canadian context and the potential significance of the work to the wider education community where Indigenous peoples seek a learning experience beyond that framed by current educational practice.

Positioning to teach science through inquiry

Wednesday, 1.00pm – Angus 2

Frederick Toralballa Talaue[1] **& Aik-Ling Tan**[2]

[2]Nanyang Technological University

The mandate for an inquiry-based approach to teaching primary science in Singapore was implemented in 2008 and teachers have since then reported felt tensions between changing emphases on content–process and curriculum–assessment goals. In this landscape study, we explored in more depth teachers' positioning with respect to the current practices and values of the local community of science teachers. To elicit discourses about science teaching and learning, we included in our survey indigenous teaching narratives that respondents had to appraise for relevance to their practice and conformity to their ideas about inquiry science teaching. The thematic coding we applied on the 200 survey responses, along with the transcripts of several focus group discussions with teachers from three schools, was guided by the following research questions: (1) What do teachers reveal about what inquiry science means to them? and (2) How do they appropriate inquiry science teaching in their practice? Our analysis revealed varying positions that reflect contrasting, and even oppositional, ideologies about what counts in teaching science through inquiry. These findings provide insights on how teachers construct their science teaching practice and how reform is enacted in schools.

Session 5

"Reasoning through Digital Modelling about Natural Selection as a Complex System Phenomenon"

Wednesday, 1.45pm – Rangimarie 1

Joseph Ferguson

Deakin University

This research seeks to reconceptualise the relationship between complex systems, representations, digital technology and reasoning as they appear in the new Australian Curriculum: Science with the aim of enhancing the quality of science learning by supporting students' learning about natural selection. This is done through bringing together a 'representation-construction approach' and a 'complex systems approach' to the teaching and the learning of science, in particular Peirce's logic as semiotic and the characterisation of natural selection as a complex system. Semiotic analysis of scientific reasoning will be used to explore authentic scientific practice to bring together these disparate strands. This will be done through the design, implementation and evaluation of an educational Programme at a science education centre in Melbourne, Australia. The educational Programme will be based around student's use of NetLogo, a type of multi-agent based modeling software, to reason about natural selection as a complex system phenomenon, using Darwin's finches as an example of evolution. This paper discusses some initial findings from the pilot, including the researchers' observations and the students' experiences of using and creating NetLogo models to reason about natural selection as a complex system.

Back at school: common factors in primary schools where Primary Science Teacher Fellows successfully raise the profile of science

Wednesday, 1.45pm – Rangimarie 2

Dayle Anderson
Victoria University of Wellington

Primary Science Teacher Fellowships aim to raise the profile of science in New Zealand primary schools. They enable primary teachers to spend six months working alongside scientists in a scientific organisation. Six professional development days, distributed across the period of the fellowship, are designed to develop the fellows' understanding of the aims and purposes of the science learning area of the New Zealand Curriculum. They support fellows to link their experiences working alongside scientists with the Nature of Science strand and build their capability to implement science with their own class and, by supporting other teachers, across their schools. This study aimed to identify any common practices in schools considered to be successful in raising the profile of science following the return of a teacher fellow. Semi-structured interviews with fellows and principals from a purposive sample of three schools in differing contexts were recorded, transcribed and analysed. Common factors identified include: active support of the principal; use of existing school structures to support and promote science; understanding of the needs of teachers and ways to address them; a sense of accountability for addressing the expectations of the fellowship; and the positioning of the fellow as a science leader.

STEPS – Science Teacher Education in Partnership with Schools

Wednesday, 1.45pm – Rangimarie 3

John Kenny[1], Coral Campbell[2], Linda Hobbs[2], Jeffrey King[3], Sandra Herbert[2], Gail Chittleborough[2], Mellita Jones[4] & Christine Redman[5]
[1]University of Tasmania, [2]Deakin University, [3]Royal Melbourne Institute of Technology, [4]Australian Catholic University, [5]University of Melbourne

The project will address funding Priority 3 *Innovation and development in learning and teaching*. This project responds to international concern about primary teachers' lack of science knowledge and confidence to teach science, and recent questioning of the effectiveness of traditional approaches to teacher education. This project will review and build on established, innovative and successful practices at five universities, to develop and promote a framework supporting school-based approaches to pre-service teacher education. The models involve partnerships between universities and primary schools to engage pre-service primary teachers in classroom teaching and learning that effectively connects theory with practice. Through critical appraisal of these and similar models, the project will identify key features of the approach and the critical success factors required to establish and maintain strong working relationships with schools and build student capacity. The principles, framework, and resources together with exemplifying case studies, will be designed and disseminated to promote uptake of these innovative practices in the sector.

Science education research really does make a difference!

Wednesday, 1.45pm – Angus 1

David Paterson
Cashmere High School/Curtin University

The introduction of a new curriculum for New Zealand schools in 2010 required all science content to be delivered using the Nature of Science as the unifying overarching strand. As the Head of Science in a large co-educational secondary school I was required to implement this directive with little guidance and few resources. I decided to undertake a research project through Curtin University, while still working as Head of Science, with my main question being: How effective is the Nature of Science strand in the NZ science curriculum in terms of engaging Year 9 and 10 students in a New Zealand high school science Programme? I will present preliminary findings from this case study at my own school, data being collected through interviews of staff and students, a survey on attitudes to science and classroom observations. The significance of this is not just in the findings related to the research question, but in how science education research can be used to make a difference in schools. Both the process of research and the application of findings have helped change teaching practise leading to positive outcomes for staff and students.

Initial Classroom Shockwaves Subsequent to the Darfield (Canterbury) Earthquake

Wednesday, 1.45pm – Angus 2

Azra Moeed & Mike Taylor
Victoria University of Wellington

On 4 September 2010 Darfield, Canterbury was shaken by a magnitude 7.1 earthquake. We report findings from an exploratory questionnaire administered nationally, designed to capture New Zealand social science and science teachers' early curriculum response to the earthquake. As well as taking a professional interest in a major disaster in their backyard, it is assumed that teachers' curricula responses are also influenced by the educational environments in which they work. Thus it was of interest to see whether the significance of the Darfield earthquake was mirrored by a concomitant classroom response by teachers whose subject specialism is closely aligned to the scientific processes and social repercussions of natural disasters. Analysis of questionnaire responses offered empirical support for an early nation-wide classroom response. In particular, a distance decay effect from the epicentre of the earthquake was recorded in relation to geography teachers' focus on attitudes and values. The findings suggest curriculum enactment commensurate with policy that encourages school based curriculum development to be responsive to community needs and interests.

Session 6: Poster session

The response of secondary school geography and science teachers to Canterbury earthquakes

Wednesday, 2.30pm – Oceania 1

Chris McIntyre, Azra Moeed & Mike Taylor

Victoria University

This paper explores the impact of a significant national disaster on the curriculum taught in secondary school geography and science. In a highly devolved education system in which school-based curriculum decision making prevails over a centrally prescribed curriculum, this study ask**s** the question 'How was the geography and science curriculum influenced by the series of Canterbury earthquakes?' The study draws upon data collected from semi-structured interviews in focus group teacher discussions as well as activity-based focus groups undertaken by students learning science and geography. Using the metaphor of 'curriculum s-waves', the paper highlights the tension between locally based curriculum decision making and the need for curriculum to support understanding about disasters. The medium through which curriculum s-waves were refracted varied; teacher capacity, distance from Christchurch, pragmatism, compassion, and perspectives of learning were all given as reasons by teachers for omitting the Canterbury-Christchurch earthquakes (thus reducing curriculum s-waves) from their planning. Not as many substantive curriculum s-waves as we expected were observed. The fissures between geography and science, within science, and between the taught and learned curriculum – what teachers believed they were communicating post-quake do not directly translate to what has been learnt by students.

Analyzing content to evaluate the level of learning of scientific concepts in science books used for the 1st primary year in Saudi schools

Wednesday, 2.30pm – Oceania 1

Amani Al-hussan

Princess Nora Bint Abdul rahman University

There are obstacles to learning scientific concepts from science curriculum books used for the first primary year. The science books for Saudi schools are translated and designed for another society by the American company Macro Hill. There are no current studies that evaluate the suitability of their content and their scientific concepts for Saudi society. There is a deep need for evaluative scientific studies for their content. This study aims at evaluating scientific concepts presented in the books for the 1st primary year. The research asks the following questions : What is reading level for the scientific concepts in the science books? How do the concepts component correlation? What is the level of learning activities that support the scientific concepts? What is the level of styles for evaluating the scientific concepts? The current study will concentrate on science books of the 1st primary year including all their products such as the student book, and activity handbook. The study will use an analytic descriptive method. Data will be collected and analyzed by SPSS.

Infusing Ethical and Moral Issues in a Grade 12 Biology Laboratory

Wednesday, 2.30pm – Oceania 1

Janjira Saisang[1] and Chokchai Yuenyong[2,]

[1]Khon Kaen University Demonstration School, Khon Kaen, Thailand and [2] Science Education Programme, Faculty of Education, Khon Kaen University, Thailand

This study aimed to enhance awareness of ethical and moral issues in a Grade 12 biology laboratory. The participants were 45 Grade 12 students who studied in a school of Khon Kaen city, during semester 2, 2012. The methodology drew on an interpretive paradigm. The moral issue of kindness was infused by doing mediation, listening to biological music, and praying for awareness of the merits of animals. The intervention was carried out for 4 months. Students' tasks, including discussion and explanation and written laboratory evaluation, as well as participant observation, and interviews were used to gather evidence of students' kindness in their biology laboratory. The findings revealed that majority of students showed appreciation of animals in their laboratory practices. It seemed that they took good care of living things used in the studies, showed greater concentration during the laboratory and showed appreciation of the value of living thing things. Students expressed more kindness towards animals, and did not damage or play with them inappropriately. They showed awareness of the sin of using animals in experiments when they composed a biological song. These findings suggest that students developed desired ethical and moral attributes including a generous mind, living in the society with happiness, and moral carefulness.

Explorations of ideas about water transport in plants—a cross-age survey

Wednesday, 2.30pm – Oceania 1

Carrie VanderZwaag

Reparoa College, New Zealand

Science education literature includes many studies of plant misconceptions commonly held by students, but few address students' knowledge of water transport in plants. This cross-age study investigates what some American students know about water transport in plants using a six question written survey. The study focuses on *the typical kinds of expert thinking* and *typical kinds of problems* identified in written responses to the questionaire, which was administered to fifth grade through unversity graduate students and faculty (sample size = 283). Rubrics were derived from the survey results and used to code responses according to methods of grounded theory. Results indicate that expert ideas of turgor are held by some students at all levels. Similarly, students living in environments as different as Alaska and southern California accurately explain the effect of temperature, humidity, wind conditions, and soil saturation on plant water uptake. In contrast, although experts explained transpiration as the primary reason for plant water loss, no elementary or intermediate students used the term transpiration and very few secondary and undergraduate students cited transpiration in their explanation of water lost by plants. Implications for classroom teachers related to instruction about plants are addressed.

A Study of Elementary School Science Teachers' Attitudes toward Multicultural Education Issues

Wednesday, 2.30pm – Oceania 2

Hsiu-Ping Huang[1], Chih-Hung Wang[2], Ying-Yao Cheng[3] & Yueh-Suey Shiao[1]

[1]National Taitung University, [2]National Changhua University of Education, [3]National Sun Yat-Sen University

The population of Taiwan has become more diverse recently. However, indigenous students and immigrant children are viewed as minority groups in education in Taiwan. This study investigated elementary school science teachers' attitudes toward multicultural education literacy. A survey was used for this study. The sample was drawn from science teachers in the 92 elementary schools in Taitung County. With a sample size of 274 and 233 respondents, the response rate was 85%. The data were analyzed by descriptive statistics, t-test, and one-way analysis of variance. Findings are as follows:1) Elementary school science teachers' multicultural education literacy is above average and they have positive attitudes. 2) Science teachers who have different backgrounds show no differences on multicultural education literacy. 3) Science teachers who have different level of education regarding multicultural curriculum practice do show differences. 4) Different ethnic groups of elementary school science teachers show significant differences on multicultural education practices. 5) Science teachers who have experience of teaching new immigrant or aboriginal children show significant differences on multicultural curriculum practice. 6) Science teachers who had different attending times at multicultural workshops show significant differences on multicultural curriculum practice.

A study of elementary school students' knowledge of energy-saving and carbon reduction in Taitung

Wednesday, 2.30pm – Oceania 2

Yueh-Suey Shiao, Huey-Lien Kao & Hsiu-Ping Huang

National Taitung University

Questionnaires were used to investigate elementary school students' knowledge of energy-saving and carbon reduction. Students who participated in this study were from four school districts of Taitung county in Taiwan. 2049 students from grades one to six participated, with more than 300 students in each grade. Three different questionnaires designed according to grade levels, lower（1-2）, middle（3-4） and upper（5-6）, The topics covered included the basic concepts of energy-saving, the causes of global warming, methods of carbon reduction, and the current energy usage situation, issues and problems in Taitung and Taiwan. Every question required either a single or multiple choice response. Although the number and the content of the questions in each level were slightly different some of the questions were similar. The Percentages of correct responses were calculated to understand the students' knowledge and responses to similar questions in different levels were compared. The main finding is was that at each level the percentage of the correct answers was low for most questions. Students' knowledge of energy-saving and carbon reduction was limited and they had misconceptions as well. Most students across the grade levels did not understand how to estimate a household appliance's energy consumption, or the rating and meaning of standby power consumption. The number one renewable energy used in Taiwan is hydro-power. However, most students in middle or upper levels regarded it as either solar or wind energy. Upper level students had a lot of misconceptions, and scored better than younger students only on a very small number of questions.

Elementary school science teachers' reflections on the Nature of Science during a force and motion learning activity

Wednesday, 2.30pm – Oceania 2

Chokchai Yuenyong[1], Khanittha Patho[2], and Suthida Chamrat[2]

[1]Khon Kaen University, [2]Khon Kaen University

The nature of science has been part of Thailand's science education curriculum since 2008. However, teachers lack of understanding about the nature of science (NOS) and its teaching, particularly element school science teachers. In 2012, the Science Institute of Thailand MOE, started a project of Elementary Science Teacher Professional Development to enhance their thinking about the Nature of Science. The project aimed to enhance teachers' understanding of NOS, science teaching for explicit and reflective NOS, with the aim of extending their understanding of NOS to other teachers. This project selected 366 educational persons. The group was made up of a teacher and a teacher supervisor from 183 educational areas in 74 provinces all Thailand. The project provided a one week workshop and a year's follow up. The week-long workshop consisted of 11 activities of science teaching for explicit reflection on 8 aspects of NOS. This paper examines elementary school science teachers' understanding of NOS from the force and motion learning activity which provided explicit reflection on 5 NOS aspects. These were: empirical basis, subjectivity, creativity, observation and inference, and sociocultural embeddedness**.** An interpretive paradigm was used to analyse the teachers' reflections in a NOS worksheet. The findings indicated that majority of them could reflect about the empirical basis of science and creativity but few reflected on observation and inference, or sociocultural embeddedness. The paper will explain the teachers' NOS thinking and discuss the further enhancing of their understanding and organizing NOS explicit and reflective science teaching.

A Case Study of One Taiwan's Paiwan Elementary School Implementing Culturally Responsive Teachings in Science and Mathematics

Wednesday, 2.30pm – Oceania 2

Huey-Lien Kao[1], Yueh-Suey Shiao[2], Ming-Chou Su[3], Ching-Yi Chang[3], Wei-Min Hsu[3], Chih-Lung Lin[3] & Chi-Liang Chang[3]

[1]National Pingtung University, [2]National Taitung University

Multicultural inclusiveness is an important feature of democratic countries which wish to enhance indigenous educational and cultural work. These issues have become an important component in the current recommendations of international education and culture. However, indigenous people who struggle to enter the mainstream society, who struggle to maintain their inherent cultural characteristics, face the dilemma of nationality "culture blindness" and even a "cultural double-blind". Taiwan's indigenous students in public schools are removed from their parent cultures and tribal heritage. This has often resulted in a splitting into a double cultural identity, resulting in their contempt for their own culture and feelings of inferiority. The challenge for educational researchers and educators is to find ways of strengthening students' cultural identity. This study reported in this paper investigated the implementation and effectiveness of an elementary-kindergarten mathematical and science instructional module, Peksim, which was designed to incorporate Paiwan culture.

Session 7

Does meaningful cognitive cooperation occur in a collective problem solving activity on Mendelian genetics?

Wednesday, 3.30pm – Rangimarie 1

Eunhee Kang, Shinyoung Lee & Heui-Baik Kim

Seoul National University

This study aimed to identify the processes and factors of cognitive cooperation in a collective problem solving activity. The activity was implemented following a Mendelian genetics lesson for 32 small groups of 9th-graders. Each group member was asked to select one offspring among four different phenotypes from a cross between two round yellow peas and justify why it could be an offspring of parents. In this process, students reasoned about the genotype of the parents collectively based on the reasoning of each member. It was intentionally designed to facilitate cognitive cooperation among group members. However, only five groups solved the problem through cognitive cooperation, and it was one group that correctly determined the parents' genotype. We found that two factors limited meaningful cognitive cooperation. First, in the understanding of the problem, there were following challenges; focusing only on an offspring of one phenotype, or on the phenotype of parents and offspring. Additionally, in the resolution of the problem, students showed difficulty in reflecting their own and others' ideas. When conflicts among members about the genotype of the parents were revealed, two groups that showed deficiency in clarifying the conflicts through reflective dialogue eventually failed to reason the parents' genotype.

"Did something happen to you over the summer?" Tensions in Intentions for Chemistry Education

Wednesday, 3.30pm – Rangimarie 2

Brian Lewthwaite[1], Tanya Doyle[1] & Thomas Owen[2]

[1]James Cook University, [2]Victoria University

This paper examines, through an instrumental case study (Stake, 1995), five teachers' response to a new chemistry curriculum in Canada promoting a tetrahedral orientation to the teaching of chemistry (Mahaffy, 2005). The five teachers self-selected for this study were a part of a larger group of 72 participants in a five-year professional development initiative. The teachers selected were those whose orientations to teaching were significantly different from other participants, as evidenced in the difference in their teaching practices between their Grade 11 and 12 classes. The study focuses on the apparent contradictory nature of each teacher's beliefs towards their responsibilities and roles in the teaching of chemistry across the two grade levels. Central to the study is the adjustment in beliefs teachers between the two year levels and how this manifests in teaching and, correspondingly, students' response as they progress through Year Eleven to Year 12. The study is informed by two major theoretical underpinnings, teacher identity and human development. Implications of this study on professional development and chemistry education curriculum policy and practice are discussed.

Experiences of Pride and Triumph in Learning Science.

Wednesday, 3.30pm – Rangimarie 3

Alberto Bellocchi, Stephen Ritchie & Maryam Sandhu

Queensland University of Technology

The role that student emotions play in learning science has not been a major focus of research in science education. Yet, recent neuroscience research has shown that brain activity involves both emotion and cognition. In this case study of a Year 8 science class we explore how the production of emotions contributes to conceptual learning through classroom interactions. After initial observations of classroom interactions we asked, “to what extent are pride and triumph associated with learning science” and “how are these emotions significant to science students?” Data sources include emotion diaries, written artifacts, video recordings of lessons, and interviews. These data sources provide rich information about students’ in-the-moment emotions as they learn science. Specifically, pride and triumph emerged as emotions related to students’ successful achievement of challenging activities. These emotions were important for students in terms of their social status in the class, learning and understanding of science concepts. The findings suggest that changes in emotions during learning episodes are likely to be related to changes in student understanding of science concepts and confirmation of understanding of science concepts. Recognition of these visible changes in emotions could help teachers and researchers to monitor students’ understanding and progress with science.

Does feedback help?

Wednesday, 3.30pm – Angus 1

Sheryl Maher

Charles Darwin University

The inter-dependency of content, assessment and feedback means they must all build on each other. Developing authentic assessment tasks requires consideration of the content and framing the project to allow students to see the beyond the assignment application of the task. The paper investigates student development through feedback provided in a second level clinical microbiology unit. The assessment for this unit was designed to have low risk, rapid feedback tasks early in semester and very similar high value items later in the semester. The marking criteria for each assessment were very similar. Student performance (based on each criteria) was compared between the related tasks to identify overall improvement. Feedback from the first task identified specific areas each student would be able to improve. In the second task student improvement based on their response to feedback was determined. Student evaluation showed support for the format and types of assessment used. Each student addressed and improved in specific areas addressed in the feedback from the first task, but the overall performance showed no improvement in the second task. Assessment load from other subjects and overall ‘busyness’ were not considered in this analysis and may have a significant effect on overall student performance.

The Transformative Potential of Engaging in Science Inquiry and Design-based Challenges: The ATSE Wonder of Science Challenge

Wednesday, 3.30pm – Angus 2

Louisa Thomas Engel, Cliff Jackson & Karen Carlisle
James Cook University

Well-documented declines in student participation in Science, Technology, Engineering and Mathematics (STEM) in schools are regularly linked to perceived inadequacies in both the science curriculum and teachers' self-efficacy for teaching science inquiry. In 2012, the Australian Academy of Technological Science and Engineering (ATSE) *Wonder of Science Challenge* pilot focused on these concerns. Students in 15 schools across northern Queensland, Australia, were provided with a design- or inquiry-based research problem. The Challenge required student teams to conduct research and present their findings at a regional student forum. This paper presents a case study of the experiences of one primary teacher – Mr Matthews – and his students. Analysis of interview and survey data revealed improvements in students' attitudes towards science-related careers, increased motivation and ownership of the inquiry process, and developed depth of science knowledge and understanding. For Mr Matthews, his participation in the Challenge enhanced his confidence in developing his students' science inquiry skills, and he reported plans to transform his teaching and assessment practices. Evidence from the case study suggest that the design and inquiry underpinnings of the Challenge created a transformative space to support and enhance students' move from participation in teacher led-school science to making a 'shared' contribution to their science learning experiences.

Session 8

Co-Teaching and Co-Generative Dialogue: Case Studies in Science Classrooms with Academically Talented Students

Wednesday, 4.15 pm – Rangimarie 1

Rekha Koul
Curtin University

The idea of co-teaching and co-generative dialogue was first proposed by two leading educationists, Roth and Tobin, making an international impact in educational research. Co-teaching and co-generative dialogue are applied for understanding student working patterns. A longitudinal study aiming to investigate the effectiveness of co-teaching and co-generative dialogue in the science learning and teaching was carried out. This presentation reports on part of the main study, discussing two case studies with academically talented lower secondary science classes. Research was conducted in two year-9 science classes from different public high schools in Western Australia. Multiple research methods (interviews, observations, students' reflective journals, and questionnaires) were used to develop in-depth understanding of the participants. The results show that co-teaching and co-generative dialogue helped the science teachers to develop their pedagogical praxis, improve teaching behaviour, and improve interactions with the students. The science teachers' teaching transformation in return implicated on improving students' engagement and achievement.

Secondary school students' attitudes to nanotechnology: What are the implications for science curriculum development?

Wednesday, 4.15 pm – Rangimarie 2

Karen Murcia
Edith Cowan University

Nanotechnology is guided by the assumption that with the ability to shape or re-shape at the molecular level we could manipulate the physical world. Some speculate that this ability will be the beginning of the next technological revolution. Hence, an aim of secondary science education should be the development of scientifically literate citizens and scientists capable of contributing to and using nanotechnologies in informed and responsible ways. The inclusion of Science as a Human Endeavour in the Australian Curriculum and specific reference to emerging technologies such as nanotechnology has increased the need for contemporary learning resources informed by research. Social constructivist theory indicates that students' prior knowledge is fundamental to their engagement and knowledge construction. As such, a study was conducted to determine a sample of 87 lower secondary students' attitudes to and knowledge of nanotechnology. Responses to both open questions and a 14 item Likert scale suggested students had neutral to positive attitudes to nanotechnology but were mostly unable to demonstrate understanding, provide examples of its use in everyday life or describe the sort of jobs or tasks carried out by a nanotechnologist. These findings have implications for science curriculum resource development.

Activity makes a difference: discrete emotions of year 8 science students

Wednesday, 4.15pm – Rangimarie 3

Donna King, Stephen Ritchie, Alberto Bellocchi & Maryam Sandhu
Queensland University of Technology

The type of activity that students do in science makes a difference to their emotional experience of science. In this study of a year 8 science class we researched students' discrete emotions expressed during science activities in a unit on Energy. Multiple data sources including classroom videos, interviews and emotion diaries completed at the end of each lesson were analysed to identify students' emotions. Using a theoretical perspective drawn from theories of emotions founded in sociology predominantly from the work of Turner (2007) and Collins (2004, 2008), we identified the emotions of happiness, joy and wonder during specific activities. Two students from the class are presented as case studies who communicate positive emotions during a laboratory activity and demonstration. In particular, the way the activities are structured by the teacher contributes to their positive emotional experiences. The study found that the freedom to carry out the laboratory work in groups, learning something new and the building of anticipation and excitement were characteristics of the activities necessary for students' enjoyment.

The rhetoric and reality of University engagement: a case study

Wednesday, 4.15pm – Angus 1

Margaret Marshman & Michael Christie
University of the Sunshine Coast

In this position paper the authors argue a case for greater engagement on the part of university leadership and lecturers in promoting science learning and understanding in school and society. The vision statements and strategic plans of six sandstone and six regional Australian universities are

scrutinized in order to determine what exactly is promised by way of engagement with the public. Using discourse analysis the feasibility of enacting this particular vision, as compared to the two other duties of the university (teaching and research), is analysed. One of the conclusions of the paper is that there is little cooperation between university leaders and lecturers in carrying out the vision and promise of public engagement. A particular case is presented which exemplifies how this might be rectified. The case is evaluated and its effect documented. The case involves cooperation between a Deputy Vice Chancellor, a university science teacher-educator, a PhD student and a secondary school teacher, who lead a small group of senior science students on a visit to the Australian Synchrotron. The paper concludes with suggestions for a more thorough investigation of this area. Judging from a literature search this area appears to be under researched.

Reflections of POGIL Implementation in Foundation Chemistry in Qatar

Wednesday, 4.15pm – Angus 2

Sheila Qureshi
Weill Cornell Medical College

This paper discusses the implementation of POGIL (Process Orientated Guide Inquiry Learning) in Foundation chemistry at Weill Cornell Medical College-Qatar over a two-year period. This Foundation Programme is only for Qatari nationals and it leads to pre-medical general chemistry course. Surveys were carried out in year one and year two in order to assess the students' attitude and perception of learning through POGIL. These surveys reveal mixed learning preferences (i.e. traditional lecture versus POGIL). Results show that in the second year some of students still have negative opinions of POGIL. These findings are very similar to results reported by other instructors in various institutes. The study poses a question whether it is the methodology or the higher-level course content used in POGIL material that forms this kind of student judgment. Similar assessment questions were used in previous years before POGIL was introduced in order to compare learning outcomes between pre and post POGIL. The outcomes show a slight improvement in topics such as equilibrium and acid-base chemistry. Last year's students who progressed to the pre-medical general chemistry course showed a significant improvement in their grades when POGIL was used to teach over 60% of the chemistry curriculum.

Session 9

Elements of chemistry: the books and their authors (1820-1850)

Thursday, 9.00am – Rangimarie 1

Dr WP Palmer
Curtin University

This is a second paper in the series '*Elements of chemistry*: the books and their authors.' The first paper covered the period 1700-1820 and is currently about to be published; this paper covers the period 1820-1850. 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 the task 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. Books with more specialist titles have generally been excluded to cut down on the

vast number of books that otherwise can be found on 'Worldcat'. About a hundred books were found with the title *Elements of chemistry* between 1700 and 2010, with or without the definite article; twenty of these will be chosen to illustrate the history of the chemistry textbook and the lives of their authors.

Primary students' explanations from interaction with a magnets science diagram

Thursday, 9.00am – Rangimarie 2

Christine Preston
University of Sydney

Science diagrams are used widely in primary schools for instruction and assessment, despite lack of substantive research into their effectiveness as aids for conceptual development. This paper presents the results of a study that investigated how interaction with a science diagram affected students' conceptions about magnets. The primarily qualitative research design incorporated task-based interviews with 21 year 3 and year 5 students from one primary school. Students' preconceptions were elicited as they handled magnets before being asked to read and interpret a science diagram. Follow-up interviews determined any change in students' conceptual understandings about magnets and in their explanations relating to the science diagram. Findings indicate that interaction with a science diagram can assist students in explaining the scientific phenomena of magnetism. Examples will be presented illustrating the individual nature of students' responses and the insightfulness of their thinking. This study raises significant implications for teachers' use of science diagrams as learning aids with primary age students.

Translating NOS into the taught curriculum as "science capabilities"

Thursday, 9.00am – Rangimarie 3

Rosemary Hipkins
NZCER

The New Zealand Curriculum (NZC) states that all students will learn science "so that they can participate as critical, informed, and responsible citizens in a society in which science plays a significant role". The science section of NZC includes a Nature of Science (NOS) strand that provides some broad and generic signals about what this overarching intent could mean for learning. However it is up to individual schools and teachers to act on this intent via the learning experiences they devise. Survey research carried out in 2012 showed that teachers were least confident about their ability to implement the "Essence statement" (as cited above) and less confident in their ability to implement the NOS strand than the more traditional content strands. An audit of existing science resources, carried out at the same time, showed that these did little to amplify how the learning objectives signalled in the NOS strand might *change* teaching and learning of content with citizenship outcomes in mind. To address these challenges the researchers developed five NOS-informed "science capabilities". These will be introduced, along with examples of how they might be used to refocus learning experiences at different curriculum levels.

Teaching communication or concepts in flip-lecture science instruction: The impact of teaching multiple representations across a semester of 1st year university physics.

Thursday, 9.00am – Angus 1

Matthew Hill[1] & Manjula Sharma[2]

[1]University of Sydney, [2] University of Sweden

It has long been recognised that multiple representations (the mediums of communication, thinking, and problem solving) are important for physics and science learning (Aldrich & Sheppard, 2000; Beichner, 1994; Britton, 2005; W. M. Roth & Bowen, 2003). This investigation explores how to develop student ability in multiple representations (such as graphs, equations and diagrams) through weekly online flip-lecture instruction to 1st year physics students at The University of Sydney. Of the 883 enrolled students, approximately 250 completed pre-lecture instruction on upcoming representations (experimental group), approximately 250 completed pre-lecture instruction on upcoming concepts (control group 1) and the remainder elected not to complete any pre-lecture exercises (control group 2). Common questions to both groups indicated significant differences in understanding and reasoning as a result of the instruction content and the differences were further explored through two sets of pre and post testing. The results promote the use of flip-lecture material which prepares students for the representational reasoning contained in upcoming lectures even over the accepted method of preparing students with upcoming conceptual information.

The influence of an extended outreach Programme on the attitude of year 8 pupils towards science

Thursday, 9.00am – Angus 2

David Warren

University of Otago

Negative attitudes towards science are reported in many countries around the world, see for example by the ROSE project. In New Zealand the 2007 National Education Monitoring Project (NEMP) reported that year 8 students showed an increasingly negative attitude towards science, mirroring data reported in Europe. Suggestions for pupils to be 'inspired by science' include efforts by the scientific community to engage with schools, with the Prime Ministers Chief Science advisor calling for the science community to support teachers. This paper reports on a long-term involvement between the University of Otago Chemistry Outreach Programme and a semi-rural Otago school. The NEMP attitude survey was applied to year 4 and year 8 pupils in the school and compared with the data collected in 2007. The results appear to show year 4 pupils with similar attitudes as those in the NEMP study but year 8 pupils that are more positive about science. Interviews with teachers who were in the school before the Programme started indicate that pupils are now more interested and look forward to science activities. The teachers themselves value the support the Programme provides and are attempting to include science in their teaching across the curriculum rather than in isolation.

Concept maps as a diagnostic tool for teaching and learning physics

Thursday, 9.00am – Oceania 1

Mihye Won[1], Siv Ling Ley[2] & David Treagust[1]

[1]Curtin University, [2]University of Duisburg-Essen,

Concept maps are used to help students visually organize their science conceptions and to learn science holistically. Concept maps can be used as a diagnostic assessment tool because they are easy to administer and provide rich information on how students conceptualize and link (or do not link) various science concepts. However, evaluating the students' concept maps has proven to be difficult. In this study, we devised a marking guide based on a learning progression model for the topic of energy and we investigated how teachers evaluated students' concept maps and how their judgments correlated with students' achievement outcomes. Ten science teachers and 225students from three government schools in Western Australia participated in this study. After teaching students how to draw a concept map, we asked them to draw a concept map on the topic of energy and answer a competency test also on energy. The participating teachers and researchers separately evaluated students' concept maps with the marking guide. Our preliminary data analysis shows that the teachers and the researchers evaluated concept maps in a very similar way (correlation r=0.665), and the teachers' marking of the concept map is a relatively good indicator of students' test performance (correlation r=0.337).

Session 10

Integrating Information and Communication Technology into Teaching Physics – a Pedagogic Model

Thursday, 9.45am – Rangimarie 1

Nhung Nguyen, John Williams & Michael Forret

University of Waikato

This paper presents a pedagogic model which integrates information communication technology (ICT), sociocultural and constructivist learning principles into teaching. The model was developed based on the literature. Subsequent evaluation of the model was carried out by New Zealand and Vietnamese experts in science education. Based on these experts' advice, the model was revised and named Pedagogic Model of Integrating **C**onstructivist, Sociocultural Learning Principles and **I**CT (CSI Model). The CSI Model was then implemented by a university physics lecturer into a 14 weeks Optics course. Two groups of undergraduate students participated in the research: a Morning Group and an Afternoon Group, each with a slightly different treatment. This presentation will discuss findings from interviews and tests which revealed that the implementation of the model appeared to have a positive impact on students' learning. The interview data disclosed that the CSI model enhanced students' physics learning. The test results showed that the students' physics post-test scores were significantly higher than their pre-test scores. Moreover, the post-test scores for the Morning Group, who used a learning management system in their course, were statistically significantly higher than the scores of the Afternoon Group.

Moving beyond good intentions: Explicit Science as a Human Endeavour content in senior secondary

Thursday, 9.45am – Rangimarie 2

Melanie Isaacs[1] & Deb Corrigan[2]

[1]ACARA & [2]Waikato University

Explicit teaching about science as a human endeavour, including the nature of science and the ways in which science is constructed and used, is increasingly touted as the means to increasing students' scientific literacy, engagement with science and capacity to apply their science understanding to make informed decisions. However, translation of this intent into curriculum documents, particularly in the senior secondary years of schooling, is often limited to statements in the curriculum aims and rationale rather than as explicit content to be taught and assessed. The senior secondary Australian Curriculum for Biology, Chemistry, Earth and Environmental Science and Physics was published in December 2012. These curricula build on the Foundation to Year 10 Australian Curriculum for Science (2010) and have retained the three strand structure of Science Understanding, Science Inquiry Skills and Science as a Human Endeavour. This paper will explore the range of challenges addressed in the development of explicit content in Science as a Human Endeavour for the senior secondary Australian Curriculum for science, including negotiation of stakeholder perceptions, the development of a defensible scope and sequence and resolution of the tension between content specificity and flexibility.

Strengthening engagements between schools and the science community

Thursday, 9.45am – Rangimarie 3

Ally Bull

NZ Council for Educational Research

This presentation reports on a NZ Ministry of Education funded research project that aimed to generate evidence-based recommendations for strengthening partnerships between schools and the science community to support students' science learning and engagement. The research was underpinned by a future-oriented perspective, framed by larger questions about the purpose of science education in the context of a rapidly changing 21st century world. It digs beneath assumptions about *why* learners' and teachers' engagement with the science community is considered important, and examines what kinds of approaches and supports might sustain future-oriented science education for New Zealand learners. The research was carried out in two phases. The first comprised a survey of teachers and science providers, and a brief literature review. The second phase (the focus of this presentation) comprised 5 case studies of science community engagement initiatives, providing a spread of types across several different regions in New Zealand. The research highlights that there are many different types of initiatives where the science community is engaging with schools. The major challenge is how to integrate across what is already known in order to advance our collective thinking and abilities to seek the "next step" for the future of engagements between education and school communities.

Progression of learning within the Victorian Certificate of Education (VCE) Psychology Study Design

Thursday, 9.45am – Angus 1

Karen Marangio
Monash University

This study explored the notion of progression of learning of psychology within the VCE curriculum. A directed approach to analyse the document content was employed. Systems theory (Bronfenbrenner, 2001) was used to embrace the conceptual and methodological diversity of psychology and the science practices that build conceptual understandings within systems were considered for analysis. This study assumed that systematic revisiting of concepts in different contexts enables learners to grasp the underlying concepts, understand links between and within topics, and develop ideas of their own (Bruner, 1960) and sophisticated conceptual understandings go hand-in-hand with mastery of understanding the science practices used to construct this knowledge (Duschl, Maeng, & Sezen, 2011). Starting points for developing a notion of progression were found but only to a limited extent. Complexities of each practice and concept were not emphasised and an overarching theme to connect and build on prior learning was missing. The psychology curriculum is in danger of being taught as single, isolated and unrelated topics.

Curriculum emphases in junior secondary science textbooks in Bangladesh and their relationship with real life situations

Thursday, 9.45am – Angus 2

Syeda Tahmina Akhter
Monash University

A number of studies have found that in Bangladesh science teaching is textbook oriented and students are assessed based on the content of these textbooks. This situation has influenced teachers and students into depending heavily on the textbooks. Teachers do not usually work with the curriculum. Instead they follow the textbooks as a de-facto curriculum. This paper examines whether and how the curriculum emphases are represented in the content of the science textbooks (grades VI to VIII) of Bangladesh, and whether there are connections with students' real lives. Roberts's seven curriculum emphases, and three added by Fensham, were used to analyse the textbooks to find out whether they had the potential to encourage students to apply their knowledge in real life. The findings indicate that the textbooks mostly present science content with poor representations of real life aspects. This makes it a challenge for students to apply their knowledge in real life. The researchers recommended that more emphasis should be given to real-life applications of the science content in the textbooks.

Session 11

Using Design-Based Research (DBR) to develop a professional development Programme to build Nature of Science (NoS) understanding of a group of New Zealand teachers

Thursday, 10.45am – Rangimarie 1

Kate Rice

University of Otago

The building of teacher capability for teaching science Programmes incorporating NoS, as described in the *NZ Curriculum* (Ministry of Education, 2007), is important. The Science Learning Area introduces NoS as both "overarching" and "unifying", bringing together understandings about science, scientific investigation processes, scientific communication, and socio-scientific issues. But do teachers know how to bring these components of NZC together? This study examined whether implementation of a DBR methodology could result in professional development that built teachers' understanding of NoS, leading to explicit NoS teaching. The research question was: Is the collective construction of specific NoS content knowledge, science pedagogical knowledge and technical knowledge developed by engaging teachers in NoS-related activities and facilitating their sharing of science teaching experiences? DBR methodology provided for the development and refining of a professional development Programme over three iterations with clusters of Year 1 – 10 teachers. We found that the design developed using DBR provided a sound theoretical platform for building teachers' understanding of NoS, while presenting an approach to teaching science that models constructivist approaches to learning and providing the opportunity for student-directed science Programmes. The intervention design offers a tool that could build teacher NoS understanding in other NZ regions.

Which Children left Behind? Assessment of science learning and equity

Thursday, 10.45am – Rangimarie 2

Peter Fensham

Monash University

In schooling, formative and summative assessments play a powerful role because they are an essential means of communication between teachers and learners, between the school and parents, and, in due course, between the school or school system and employers. Research in the field of assessment has revealed both positive and negative effects on student learning. In this paper we review what is known about the relationships between student participation and learning in science and its aims/intentions and the modes of its assessment. The expansion of the aims/intentions of today's science curriculum challenges the traditional ways its learning has been assessed. Some modes of assessment have been found to favour particular groups of students whose differences arise from their family background, gender, race, or socially created disability. There is a sense that to be fair, assessment must be on a common playing field, but ***Can this field be a level one for all students?*** In the current heightened climate in Australia about equity in education this is important that this question be discussed.

Toward a better understanding of school/community collaboration in school science

Thursday, 10.45am – Rangimarie 3

David Symington & John Cripps Clark
Deakin University

There is a widespread and growing interest amongst community members and organisations contributing to school science Programmes. There is dearth of knowledge of the factors that influence the effectiveness of such collaborations. This paper reports a study which explored the perceptions of community members who have participated in such collaborations focussed on science. Through phone interviews the researchers engaged with non-school people across Australia involved in a broad range of such collaborations. The interviews covered the nature of their activity in these collaborations, the motivations behind their engagement, the actual and intended outcomes of the Programmes in which they were participating, what factors helped or hindered the collaboration, and what advice they would give to others contemplating such school/community collaboration in science. Analysis of the data revealed that these community members identified curriculum, communication and organisational structures and practices as significant issues in the establishment of productive collaborations. In the paper the authors draw upon the data analysis, the findings from earlier studies in which members of the Deakin research team have explored such collaborations from different perspectives, and concepts evolving through an interest in 'boundary crossing', to suggest ways to enhance the benefits for school science when drawing on available community resources.

Producing scientific explanations: What it takes

Thursday, 10.45am – Angus 1

Jennifer Yeo[1] & John Gilbert[2]
[1]Nanyang Technological University & [2]Kings College

In this paper, we propose a framework for scientific explanations, and apply it to understand how students construct scientific explanations. Drawing upon three different traditions of research in scientific explanations – science philosophy, functional linguistics and science education, we identified three aspects of scientific explanation – (1) the *function* of a scientific explanation, (2) its linguistic *form* and generic organization, and (3) its *level* of precision, abstractness and complexity, highlighting the role of material and social tools in the construction of a scientific explanation. We analyzed scientific explanations of an electromagnetic induction phenomenon constructed by high school students using Lemke's (1998) multimodal framework. We found that the construction of a scientific explanation was a complex coordination of bodily and cultural-specific tools, not only to represent entities (visible or inferred) of the phenomenon, but also to shift towards increasing abstractness and to support thinking and reasoning about the phenomenon at the abstract level. The findings highlight the importance of providing relevant contexts to develop students' competency in shifting towards increasing abstractness and the importance of identifying and developing the skilful use of schemes of scientific representations (representations and their meanings) in learning to construct scientific explanations.

Assessing Learning, Teaching and Thinking Levels in Y7-13 Science, Biology and Chemistry at one New Zealand high school

Thursday, 10.45am – Angus 2

Rana El Farra & Tarik Rashid
Tarawera High School, New Zealand

Science, Biology and Chemistry at one New Zealand high school are taught using several approaches. This paper uses a pre-defined combination of Bigg's model of constructive alignment, Bloom's taxonomy and Biggs and Collis' SOLO taxonomy to identify the occurrence of the multi structural thinking level in current assessments and teaching\learning strategies of science, chemistry and biology for Y7-13. This is an attempt to identify opportunities for students to develop their thinking levels. Focus group interviews, teacher and student-directed structured questionnaires and structured analyses of current assessments target the multi-structural thinking level. Preliminary data shows a 10% frequency of this level at Y7-9, 36% at Y10-11 and 30% at Y12-13. The research work refers to other thinking levels for evaluation purposes. The researchers suggest that a well-structured blend of informed teachers, students, and curricula, teaching methods and assessment design and procedures is essential to raise the current thinking, learning and teaching level in the emphasized learning areas. The paper also acknowledges the importance of the psychological and social climate of both classroom and institution for fostering the development of thinking levels.

Session 12

"It's too hard": Supporting secondary science teachers to change their practice

Thursday, 1.00pm – Rangimarie 1

Lorraine Spiller & Rosemary Hipkins
NZ Council for Educational Research

This case study research investigated whether a sustained focus on assumptions about *purposes* for learning science might provide a productive means of stimulating changes in classroom practice. The researcher worked with two teachers to help them make changes in at least two units of work. Both teachers worked in multicultural school contexts. One requested help to change her practice and the other was invited to take part. The researcher visited each school multiple times, talking with the teacher at the planning stage, observing how the ideas discussed subsequently played out in the classroom, and in one school, in conversations with other science teachers. A small focus group of students from each school also talked with the researcher about what they had learned and why they thought the teacher might have seen this learning as important. These conversations were used by the researcher to provide feedback to the teacher. In neither case was change sustained, albeit for different reasons, and with different implications for stimulating more widespread change. The nature of the challenges encountered and their implications for gaining and sustaining change in practice will be discussed.

Socio-scientific issues: a reflective glance

Thursday, 1.00pm – Rangimarie 2

Kathy Paige
University of South Australia

Skamp (2012) states that "SSIs are usually scientific topics that are controversial and engage students in dialogue, debate and discussion. Moral reasoning and an evaluation of ethical concerns are involved in attempts at making resolutions of the issues". This well-intentioned strategy for engaging children and young people with the importance and relevance of their science lessons to their wider and everyday life, presents considerable challenges for pre-service teachers to implement, who themselves, are still coming to terms with the nature of science and its implications for them as teachers. These challenges are particularly acute in the professional journey of non-specialist primary and primary middle pre-service teachers. Primary-middle pre-service teachers at the University of South Australia have been directly confronted with these issues over the past decade where, through their science and mathematics courses, they have been challenged to participate in authentic experiences through place based learning, environmental pledges, transdisciplinary units of work, and voluntary experiences. Evaluation data has been obtained from a recent cohort of primary-middle pre-service teachers through, course evaluations, focus group meetings, interviews and questionnaires. The outcomes from these evaluations along with the lessons learned from implementing this pedagogical approach will be presented.

Professional learning partnerships: PCK development as an outcome of pre-service and associate teacher collaboration in CoRe design

Thursday, 1.00pm – Rangimarie 3

Anne Hume[1] & Amanda Berry[2]
[1]University of Waikato & [2]Leiden University

This paper reports findings from an ongoing interpretive study investigating Content Representation (CoRe) design as a tool for promoting the PCK development of student teachers on teaching practicum. This phase of the study focused on how collaboration between chemistry student teachers and their associate teachers in CoRe design might impact on student teachers' ability to acquire the professional knowledge needed to become effective chemistry teachers. This professional partnership involved identifying and discussing pedagogical issues related to a practicum-teaching topic using a student teacher's draft CoRe as a starting point and ongoing focus for their professional dialogue. Practicum offered an opportunity for aspects of the student teachers' budding PCK, as depicted in their draft CoRes, to be critiqued, 'massaged' and transformed into classroom Programmes with the support and input of associate teachers. Different contextual factors produced varied findings, but all the student teachers found their CoRes to be very useful frameworks for engaging in focused professional dialogue with their teaching mentors. They valued the expertise, currency of knowledge and mentoring of their associates and reported positively about the contribution this support made to their PCK development. Collaborative CoRe design was shown to be a useful mediating tool on teaching practice.

Western Australian High School Students' Understanding of Climate Change

Thursday, 1.00pm – Angus 1

Vaille Dawson & Katherine Carson

Curtin University

Climate change is a significant global problem that will impact the lives of young people. It is essential that school science education provides opportunities for students to understand the mechanisms and consequences of climate change. In this study 39 secondary science teachers and 437 Grade 10 students from 13 schools were surveyed about their perceptions of the importance of climate change as a topic to understand as well as their understanding of the science, controversy, challenges and consequences of climate change. It was found that despite its perceived importance, teachers' understanding was variable and students' understanding was poor. A high proportion of students believe that the greenhouse effect (GHE) is caused by ozone and that the GHE protects against UV radiation while most stated that CO2 is the main greenhouse gas. The findings have important implications for curriculum design and resources as well as preservice and inservice teacher education.

Using strengths: collaboration between organisations to support primary science

Thursday, 1.00pm – Angus 2

Jessie McKenzie[1], Azra Moeed[2], Dayle Anderson[2] & Rex Bartholomew[2]

[1]Royal Society of New Zealand, [2]Victoria University of Wellington.

Concerns about the on-going lack of science teacher professional development available locally to primary teachers led to collaboration between experienced science teacher educators at Victoria University of Wellington, the local science teacher association (Capital City Science Educators), and the Royal Society of New Zealand. The aim was to collectively find a way to support primary school teachers to develop confidence in teaching science, especially the overarching curriculum strand, the Nature of Science. Each organisation identified aspects that they could provide at little or no actual cost that would support a sustained Programme of in-service primary science teacher education. Forty-eight Year 1-8 primary school teachers started a professional development course (attending at least seven two-hour workshops),and 30 completed it. Data were collected from a questionnaire at the completion of the course by those who had attended eight workshops. Analysis showed that teachers believed the Programme to be very effective in increasing their confidence in their content knowledge and improving their understanding of, and ability to include, the Nature of Science strand when planning for science teaching.

Organisational culture and it's role in developing a sustainable science communication platform

Thursday, 1.00pm – Oceania 1

Belinda Cridge[1] & Bev France[2]

[1]University of Otago & [2]University of Auckland

We are seeking to define the organizational culture that allows for sustained science communication activity to occur within a centre such as the Centre for Brain Research (CBR). The communication of an organization's science activities is an increasingly important component of its community responsibilities but can be difficult to achieve partly due to a lack of organizational support. Due to

the high level of science communication, and the high degree of researcher participation in these activities within the CBR, we are interested in examining how this culture has been developed and sustained. We have conducted an interpretivist study whereby ten interviews were conducted with a range of people aligned to the CBR who have varying degrees of involvement with their science communication activities. The data was analyzed within the ideas of complex adaptive systems which allow for dynamic situations and also for the interplay of individual agency within a cultural context. Our analysis highlights the importance of cultural values in permitting individual actions and also suggests that this culture revolves around "hubs" of motivation. In our study, key individuals were cited as important in driving communication activities but it was clear that a complex interplay of cultural expectations and motivations was at work.

Session 13

Networked Inquiry Learning in Secondary Science classrooms

Thursday, 1.45pm – Rangimarie 1

John Williams, Kathy Saunders, Elaine Khoo & Bronwen Cowie
University of Waikato

This paper will present the findings of a 2 year research project which aimed to understand and explore the ways electronically networked (e-networked) tools can support authentic science inquiry by working with teachers in junior secondary classrooms. Internationally, claims are made about the potential for inquiry based learning to address the challenges of relevance and engagement for the 21st century school science learner. In collaboration with four teacher researcher partners, the research team explored ways teachers could adopt e-networked tools in support of inquiry learning in a range of science units such as working like a scientist and more practical activities such as an eye dissection exercise. The findings of this project highlight that e-networked tools can support collaboration and the co-construction of knowledge within and across all aspects of an inquiry cycle. Tools such as online discussion platforms, Skype, and mobile technologies afford new ways of communicating and sharing of information and ideas through synchronous and asynchronous, direct and indirect means. The discussion of the findings will elaborate on the teacher strategies and classroom conditions that are needed to leverage the potential of these e-networked tools in junior secondary science classrooms. For example, learning activities requiring students to collaborate and co-construct ideas in science inquiry need to be explicitly planned for, and traditional teacher and student roles need to be recast in order for students to develop the agency and the capacity to pose and meaningfully pursue questions of their own design.

Developing teachers' capacity to manage classroom discourse in primary science classrooms

Thursday, 1.45pm – Rangimarie 2

Pru Smith
Edith Cowan University

Learners actively construct knowledge and develop understandings from their shared experiences and via interaction with others (Driver, Asoko, Leach, Mortimer & Scott, 1994). However, talk that fosters students' capacity to reason is lacking in many classrooms (Alexander, 2006) and teachers tend to control the discourse by asking a predominance of closed questions and using a question-

answer recitation script which limits the exploration of students' ideas (Nystrand, Gamoran, Kachy, & Prendergast, 1997). Previous research has also shown puppets can be used to effectively engage students in classroom discourse (Simon, Naylor, Keogh, Maloney, & Downing, 2008). This paper reports on the way that the beliefs, knowledge and practice of three primary school teachers were influenced by their participation in an action-research based professional learning intervention which focused on managing classroom discourse and matching appropriate communicative approaches (Mortimer and Scott, 2003) to the phases of scientific inquiry. Data was gathered before, during and after the professional learning intervention. The analysis of classroom video, questionnaires, and teacher interviews provided insights into the development of teachers' understandings about: quality talk; a supportive classroom culture for talk; and, the skills of using puppets to engage students in discourse. Detailed analysis of transcripts of whole-class discussions revealed changes to the way the teachers used questioning, discourse moves and communicative approaches to orchestrate sustained conversations and the impact this had on the quantity and quality of student talk. Highlights from these analyses will be presented.

Learning Science Outside of School: Community Links

Thursday, 1.45pm – Rangimarie 3

Leonie Rennie
Curtin University

This paper is based on the premise that the science students learn at school should be designed to enable them to become scientifically and technologically literate citizens, irrespective of what their future career ambitions may be. Two questions arise: First, science in the "real world" is multidisciplinary, so if students are to understand real problems and find answers to them, how can they learn to integrate and apply knowledge from science with knowledge from other subjects and other branches of science? Second, if students are to learn to apply knowledge and skills to out-of-school situations, how can the gap be bridged between school science and science as it is practised in the community? Research and experience have shown that bridging that gap is not easy. This paper uses case studies to explore how teachers and students have worked within the community to develop students' transferable knowledge and skills and, as a by-product, fostered students' renewed interest and enthusiasm to learn science back in school. Attention is given to the tensions that arise and how they might be dealt with in order to progress students' learning.

Multimodal reasoning in a Western Australian primary science classroom

Thursday, 1.45pm – Angus 1

Karen Murcia, Mark Hackling & Khadeeja Ibrahim-Didi
Edith Cowan University

Research has identified quality reasoning as a desirable outcome from primary science education. Yet, understandings of the complex nature of reasoning and the pedagogical principles underpinning its development are tentative and continue to evolve. To address this gap, a Western Australian case study explored multimodal representation and reasoning in the teaching and learning of a year 4 introductory astronomy unit. The research was framed by the question: How do the case study teacher and students engage with multimodal representations and reasoning in the development of scientific literacy outcomes? A nine week series of science lessons was video captured and semi-structured interviews were conducted with both the teacher and focus group students. Activity theory

provided the descriptive framework needed for examining the data and understanding the socio-cultural learning environment. Social-semiotic theory assisted in analysing the role of discourse, object manipulation and gesturing in the children's reasoning process and construction of meaning. Vignettes are used to present the multimodal classroom activity and to illustrate the finding that discourse needed to be supported by nonverbal sources of information and modes of expression, such as gesturing and the manipulation of objects, to complement and assist children's verbal expression and reasoning process in science.

An Application of the Philosophy of Sufficiency Economy in Conserving the Environment and Generating Income for Local Youths through Growing Golden Teaks at Home

Thursday, 1.45pm – Angus 2

Kongsak Thathong
Khon Kaen University

The objectives of this research were (1) to study the implementation of the student-centred, integrated lesson plans for the conservation of natural resources (golden teak) devised in accordance with the Philosophy of Sufficiency Economy and (2) to examine the opinions of the participants towards these lesson plans. The various instruments were used for data collection. Both quantitative and qualitative data were collected and analysed. The results were as follows: (1) after 6-8 months, out of the 4,964 Golden Teak seedlings distributed to 592 students, 2,954 have survived, which amounts to 59.33 percent. Different schools had different rates of seedlings survival, with the highest being 84.10 percent and the lowest being 21.00 percent; and (2) overall, the teachers' satisfaction with the project was at "highest" level ($\overline{X}$ = 4.53, SD = 0.57), while the students' satisfaction was at "high" level ($\overline{X}$ = 4.21, SD = 0.84). Many teachers were of the view that the project helped develop and foster environmentally-friendly characters among the students and also advance their sense of responsibility towards the environment. They believed that this project should be continued, promoted and extended to other schools. Most of the students enjoyed participating in this project. They were happy to grow the Golden Teak trees and became more aware of the value of planting trees for the society and for themselves. They have grown to 'love', and feel more responsible towards, the environment.

Pre-service teachers' perceptions of a wiki to support Content Representation (CoRe) design

Thursday, 1.45pm – Oceania 1

Dermot Donnelly[1], & Anne Hume[2]
[1]University of California at Berkeley & [2]University of Waikato

In this study we explored seven New Zealand Chemistry pre-service teachers' perceptions of using a wiki to support their individual and collaborative Content Representation (CoRe) design (Loughran et al., 2006). A CoRe is a framework used to aid teachers in making their pedagogical content knowledge (PCK) explicit. Teachers decide the 'big' ideas for a given topic and consider salient pedagogical issues around these big ideas such as students' prior knowledge and misconceptions, teaching procedures to enhance student understanding and assessing student understanding. CoRe design has been shown to support the development of pre-service and practicing teachers' PCK, but the possible benefits of CoRe design on-line form a gap in the literature. Data collection involved pre-service teachers' use of the wiki and the resultant CoRes, field notes and a focus group

interview. Findings indicate pre-service teachers valued the wiki for some aspects of CoRe design, particularly the sharing and refinement of CoRes. However, they preferred the initial CoRe design to be face-to-face due to the contestable nature of the big ideas, and were happy to 'fill in the gaps' on-line outside class time. The implications of these findings for future pre-service teacher CoRe design are considered.

Session 14: Poster session

Preservice Science Teachers' Awareness of Knowledge and Skills for Inquiry Teaching during Their Teaching Practices in Schools (115)

Thursday, 2.30 – Oceania 1

Jirakan Yuenyong

Khon Kaen University Demonstration School (modindeang), Khon Kaen, Thailand

This study examined preservice science teachers' awareness of knowledge and skills for inquiry teaching during their teaching practice in schools. The participants were 3 preservice science teachers enrolled in a school internsip course of Khon Kaen University (KKU) in order to practice their teaching in KKU Demonstration School (modindaeng), during the second semester of year 2009. The KKU teaching practices course allowed these preservice teachers to practice their teaching for 2 semesters in the fifth year of their course. These 3 preservice teachers had finised their teaching practice at the secondary school level, in different schools, before they came to practice primary science teaching in the KKU Demonstration School . An interpretive paradigm was used for the research. Tools of interpretation included questionnaires, interviews, and participant observation. The findings clarified what and how the pre-service teachers learned and became aware of knowledge and skills for improving their teaching , with a focus on inquiry teaching. The paper will discuss their perceptions of problems and solutions for their teaching, pathways of gaining knowledge and skills for inquiry teaching, and the awareness they had of knowledge from 4 years of course work before taking part in these teaching experiences.

Enhancing Grade 12 Thai Students' Creative Thinking in Learning about Ecosystem through Inquiry Cycle

Thursday, 2.30 – Oceania 1

Napaphan Iamsam-ang

Khon Kaen University Demonstration School (Modindaeng), Khon Kaen, Thailand

This study aimed to enhance Grade 12 Thai students' creative thinking in learning about ecosystem through an inquiry cycle of 5Es. The participants were 45 Grade 12 students studying in KKU Demonstration school (modindaeng), Khon Kaen, Thailand. The methodology was action research. An inquiry cycle 5Es ecosystem unit was carried out for 6 weeks. The tools for investigation of students' creative thinking included participant observation, interviews, an ecosystem creative thinking test, and student tasks. Students' creative thinking was examined through 4 thinking abilities: fluency, flexibility, originality, and elaboration. The findings revealed that the majority of students showed a high frequency of thinking abilities of fluency and flexibility in the learning about ecosystem. The inquiry cycle 5Es ecosystem unit could provide students chances to show all four

abilities of creative thinking. Approximately 75 percent of students got an ecosystem creative thinking score of more than 70 percent.

Professional Development Needs in Argumentation-based Inquiry Teaching for Math and Science Teachers in Taiwan

Thursday, 2.30 – Oceania 1

Kuo Hua Wang, Ching Sheng Yang

National Changhua University of Education, Taiwan

Increasing students' argumentation and inquiry abilities is regarded as one important objective of science education all over the world. However, the integration of this new objective into current school science curricula is a challenge for math and science teachers in Taiwan since they need to develop new knowledge and skills in their classrooms. This study sought to identify the professional development needs of teachers related to argumentation-based inquiry teaching. A survey questionnaire was completed by 127 math and science teachers (male=79, female=48) working in junior, senior, and vocational high schools in Taiwan. The results indicated that the 5 (out of 15) highest rated perceived training needs in the teaching argumentation-based inquiry teaching were "teaching students how to formulate research questions during inquiry activities", "developing an assessment to evaluate student ability of argumentation-based inquiry", "teaching students develop research methods and procedure to collect data based on research questions", "teaching students select valid methods to analyze collected data", and "assessing students' level of arguments and teaching them to do peer-assessment". The findings have implications of for professional development, classroom practice and further research.

Professional development in nanoscience education for science teachers of junior high school in Taiwan

Thursday, 2.30 – Oceania 1

Shu-Ching Wang & Kuo Hua Wang

National Changhua University of Education, Taiwan

Inclusion of nanotechnology in the science curriculum has received great attention in many countries. In Taiwan, we also have devoted great efforts to enhance students' interest in learning nanotechnology. However, given the highly interdisciplinary nature of nanotechnology, and the knowledge and skills required to incorporate nanotechnology into classroom practice, professional development is needed for science teachers. This paper examines aspects of research of a professional development Programme on how to facilitate in-service teachers' construction of nanotechnology education knowledge. We invited 12 junior high school science teachers to participate in this study. A collaborative action research method was adopted. The professional development Programme consisted of series workshops on concepts of nanotechnology, curriculum design, and classroom teaching, and reflections through both face-to-face and video-conferences. In this paper, we will report findings on teachers' emerging conceptions of nanotechnology phenomena and teachers' beliefs about nanotechnology teaching and learning before and after the professional development. Implications for science teacher professional development will be discussed.

The impact of a physics teacher's PCK in developing his students' critical thinking and reasoning skills.

Thursday, 2.30 – Oceania 2

Adam Bertram, Anthony Vella & Bruce Waldrip
Monash University

Developing students' critical thinking and reasoning skills is inarguably important in the learning of science. This study explored how a teacher's pedagogical content knowledge (PCK) might explicitly or implicitly impact on developing these skills with his students. The teacher had been identified as having strong PCK, evidenced through classroom observations and his development of a Content Representation (CoRe) for the physics topics taught. Over a four-week period, three separate physics cohorts were observed and audio-recorded. The students undertook a pre- and post-test about their understanding of the topic taught and to explore how their critical thinking skills were developing. The teacher was interviewed pre- and post-study to explore his views on his PCK and their connection to developing his students' critical thinking. Findings revealed that through this teacher's high-level understanding of his own PCK (and confirmed through observation by the researchers) that a direct, causal relationship existed in developing critical thinking skills in his students. This was evidenced through the way they changed their approach to think about scientific concepts and how they demonstrated that understanding both in their pre and post-tests and classroom observations. This finding is significant as it is amongst the first to empirically link PCK with student learning.

The affordances of multimodalities for meaning construction in physics

Thursday, 2.30 – Oceania 2

Shih Wen Chen, Wei Ying Lan & Wen Gin Yang
National Taiwan Normal University

Physics is a school subject that expresses its scientific meaning by using lots of technical terms. The meaning is typically constructed via multiple modes such as written language, mathematical symbolism, and image. This study aimed to investigate the affordances of these three modes on meaning construction by tracking the concept 'force' in Australian primary and secondary school science textbooks. The main findings showed that written language is an appropriate mode to interpret the meaning by the nominalization of technical terms. Mathematical symbolism is good to simplify and transform the meaning via rearrangement and replacement. Image displays its visualization to integrate and compare the meaning. With these findings, this study provided science educators a preliminary idea about the affordances of different modes on constructing the meaning in physics, and offered science teachers an understanding about the applications of multimodalities in their science teaching.

Argumentation and metacognition in physics classrooms in the Thai context

Thursday, 2.30 – Oceania 2

Chokchai Yuenyong & Gegory Thomas
Khon Kaen University

This research aimed to explain Thai physics learning environment for enhancing argumentation and metacognition. The two cases included an urban physics classroom and a rural physics classroom. These classrooms were observed for 4 months. Teachers and students interactions, their

discourses, tasks, and classroom environments were interpreted in order to explain how argumentation and metacognition were enhanced in each case. Augmentative learning was clarified based on Toulmin's Augment pattern or TAP. This model has 6 components: *Claim, Data, Warrant, Backing, Rebuttal/Reservation, and Qualification.* A metacognition orientation in physics learning was clarified by looking for metacognitive knowledge, metacognitive awareness, and metacognitive control. The findings from these two cases of argumentation and metacognition could provide some suggestions for enhancing argumentation and metacognitive orientation in Thai Physics Classroom contexts.

Session 15

Exploration of Collaborative Learning Environments in New Zealand Secondary School Science classrooms

Thursday, 3.35pm – Rangimarie 1

Simon Taylor

University of Auckland

Exploring what happens in Year 9 and 10 science classrooms was the focus of the research presented in this paper. The research question was "What are the student attitudes and perceptions of their experiences in Year 9 and 10 science?" This question will be examined in this presentation with the help of some poignant student encounters from the findings of the PLUTO "Please Let Us Take Off" project in Waikato and Bay of Plenty regions over the years 2009-2011. The research was conducted with 400 Year 9 and 10 students from 15 science classes and 22 teachers. Five student perceptions about their learning were used as a framework to examine these encounters: Personal Relevance-how students make sense of the world; Critical Voice- whether students had the opportunity to express their opinions; Shared Control-students shared control of their learning; Uncertainty-students sensed that science is changing and Student Negotiation-students had the opportunity to discuss ideas with their peers. Both quantitative and qualitative data were used to analyse student perceptions and a summary of the overall findings will be presented.

Exploring curriculum development in science teacher education curriculum courses through most significant change stories

Thursday, 3.35pm – Rangimarie 2

Deborah Heck[1] & Trudy-Ann Sweeney[2],

[1]University of the Sunshine Coast & [2]Flinders University

Information and Communication Technology (ICT) has been identified within the Australian curriculum as a general capability across all curriculum areas. Therefore the Australian Science Curriculum F-10 requires that science teachers develop student ICT capabilities and Teacher Educators engage initial teacher education students with ICT as a component of their science curriculum courses. The Australian Government funded 'Teaching Teachers for the Future' (TTF) project supported teacher educators to incorporate Technological Pedagogical and Content Knowledge (TPACK) into initial teacher education curriculum courses. This paper explores the way science teacher educators engaged with the development of ICT in their science curriculum courses. Following a semester long implementation of a revised science curriculum course, teacher educators developed Most Significant Change (MSC) stories of practice based on data collected from focus

group interviews with teaching staff and students who participated in the course. These data were analysed using content analysis and a Leximancer analysis to identify the patterns of change within the stories. The analysis suggests changes occurred across three domains: course development, ICT capacity of teacher educators and ICT capacity of pre-service teachers with science teacher educators focussed in their course redevelopment on increasing preservice teacher knowledge and understandings, confidence and attitudes towards ICT.

Vocationalism in science and technology education: Aligning school curricula with workplace needs?

Thursday, 3.35pm – Rangimarie 3

Jim Watters & Clare Christensenskas
Queensland University of Technology

This paper focuses on how school science education has addressed the changed nature of the industrial workplace. There are few empirical studies in science education research relating to how science teaching informs workplace practices. In this paper we report on a Queensland policy initiative, the Gateway to Industry Schools Programme, aimed at knowledge transfer between six industry sectors and over 124 schools with the purpose of addressing industry skills shortages. One of the aims of this qualitative study was to analyse knowledge transfer, through the emphasis and composition of science and technology curricula collaboratively developed by schools and industry. Drawing on one industry as an example, our findings suggest applied scientific content representative of the *workplace practices* of engineering and electrical trades is limited. One specifically designed curriculum emphasises an applied learning orientation through teaching strategies and assessment practices which focus primarily on practical skills. Similar observations are made in curricular aligned to food industries. Although key theoretical science and maths concepts have been well incorporated there is little evidence that knowledge deriving from workplace practices is clearly included. The study is significant given international calls for a rethinking of vocational education for 21st Century workers.

Contributions of Multiple Representations to Biological Education

Thursday, 3.35pm – Angus 1

David Treagust & Chi-Yan Tsui
Curtin University

To address the 21st century challenges, there have been numerous calls in many countries for reforms of biological education in high schools and universities. Biology educators have called for rethinking and restructuring biological education at all levels to make learning more relevant to students' lives, as well as for emphasizing the need to educate the elite few who aspire to become scientists to solve biology-based global problems. In this presentation, we describe a unifying framework for biological education using Ainsworth's (1999) functions of multiple external representations (MERs)—to complement information and processes, to constrain interpretation/misinterpretation and to construct understanding of phenomena. We then synthesize recent studies in this research area from more than ten countries to demonstrate how biology educators are using MERs to better inform how teachers can improve their practice and how learners can improve their understanding of biological phenomena. We also show how meaningful learning and quality of teaching can be enhanced, as well as how multiple methods of assessment can be used to inform teaching using MERs. We conclude that Ainsworth's MER functions are a

useful theoretical construct not only for improving biological education but science education in general in the 21st century.

Blogging as a tool in teaching science communication

Thursday, 3.35pm – Angus 2

George Aranda, John Cripps Clarke
Deakin University

Since blogs emerged in the last two decades from personal webpages, online diaries and forums they have become an important mode of communication for sharing knowledge, reflection, engaging in debate and collaboration. Blogs are increasingly used in education and in disciplines that require critical reflection or collaboration such as education, law, business and medicine. Although there has been research on blogs as a tool of reflection and collaboration there has been little detailed investigation of blogs in learning about communication and in particular science communication in education. As part of a first year science communication course we have used a public blog in order to develop students': personal voice, science interests and writing skills; awareness of and communication with an audience; engagement of a range of media and sources of information; and understanding of evidence, argument and authority. We will be using case studies as illustrations. We focus on the benefits of *comments* in promoting interactive discussion between reader and author and engaging the reader and introducing new evidence into the debate. We propose research into links with social media and the factors which make blogs and comment threads a more productive source of debate and collaboration.

Session 16

E-learning for engagement, but what are students engaging with?

Thursday, 4.20pm – Rangimarie 1

Chris Joyce
NZ Council for Educational Research

This presentation is about the challenges involved in developing responsive on-line formative assessment tasks for science. A design-based inquiry method has been used to explore these challenges, and our experiences to date are shared. The setting for this research is the moving of the Assessment Resource Banks to an interactive platform with assessment tasks to be completed on-line. One of the aims for science in the *New Zealand Curriculum* is students who "can participate as critical, informed, and responsible citizens". We have found that it is relatively easy to develop tasks that provide instant automated feedback, but these sorts of tasks most often are confined to right or wrong answers. Modelling assessment tasks that value 21st century competencies of sharing ideas and building knowledge with others, assessing students through the lens of the Nature of Science strand **and** providing feedback to the learner, is more challenging. Three questions we have been exploring are: How can the principles of good formative assessment pedagogy be incorporated into on-line assessments? In what ways can technology help facilitate deep learning? What is the role of the teacher in formative assessment in the online environment, and how can they be supported? These challenges and some of the decisions we have made in light of both student responses, our knowledge about formative assessment and our understanding of the science in the *New Zealand Curriculum* are discussed.

Evolution of in-service primary school teachers' knowledge and teaching practices following a workshop about conceptual change

Thursday, 4.20pm – Rangimarie 2

Marie-Noel Bety[1], Patrice Potvin[2] & Patrick Charland[2]

[1]University de Montreal, [2]University du Quebec a Montreal

Primary school teachers often hold similar alternative conceptions to their students (about electricity, for instance) and generally teach science in a transmissive way (Duit, Treagust & Widodo, 2008). However, research shows that teaching using conceptual change (CC) is more efficient than traditional teaching (Lee & She, 2010; Piquette & Heikkinen, 2005). We designed a teacher education workshop to bridge the gap between CC research fields and regular teaching practices. The aim of this paper is to report on the influence of this workshop about CC on primary school teachers' learning and practice. We used a design experiment method (Harvey & Loiselle, 2009). The workshop was initially developed using a contemporary understanding of CC pedagogical implications (Bêty & Potvin, 2011), teaching strategies promoting CC in electricity and efficient teacher training parameters (Joyce & Showers, 2002). The workshop was implemented with two groups of teachers. Qualitative data collected before, during and after each of the two implementations was analysed using content analysis (Paillé & Mucchielli, 2005). Our groups of teachers have shown a better understanding of electricity concepts and more CC-oriented teaching practices, particularly the second group. Our results help illustrate the value of CC research field for teachers.

When teaching out-of-field means learning at the boundaries

Thursday, 4.20pm – Rangimarie 3

Linda Hobbs

Deakin University

Internationally, secondary teaching is largely specialized, meaning that teachers teach within discipline-based subjects. However, sometimes teachers can be required to teach subjects for which they have limited background. Whether in-field or out-of-field teaching, sameness and continuity reside in the fact that both fields involve such things as pedagogy, curriculum and meeting learning outcomes. However, teachers can experience discontinuity when experiences result in shifts in degrees of confidence and competence in their ability to effect positive learning outcomes. In this theoretical paper I focus on the need to define the nature of the field in order to identify where learning can take place during a boundary crossing. The research questions are: where is discontinuity experienced, where is each teacher's point of need, where are the possibilities for learning, what is the influence on teachers' professional identity, and what is needed to maximise learning at the boundary? The boundary crossings literature provides a platform for re-conceptualising these experiences as opportunities for professional learning occurring within schools as communities of practice, where teachers are supported and enabled to adapt to new fields and expand their professional identity. In response to the research questions, I explore the learning potential of three out-of-field mathematics and science teachers using Akkerman and Bakker's (2011) dialogical learning mechanisms of boundaries. These are: Identification of the discontinuities experienced by teachers, Coordination of boundary objects that assist in negotiating boundaries, Reflection on practice and identity, and Transformation of identity and practices. Implications for teacher education are discussed.

Teacher change in implementing a research developed representation construction pedagogy

Thursday, 4.20pm – Angus 1

Peter Hubber[1], Alicia Richardson[2], Katherine Swalf[2] & Jennifer Hubber[2]

[1]Deakin University, [2]Salesian College,

The 'RILS' project developed a 'representation construction' approach to teaching and learning in science, which has successfully demonstrated enhanced student learning through sustained engagement with ideas, and enhancement of teachers' pedagogical knowledge and understandings of how knowledge in science is developed and communicated. The current Constructing Representations in Science Pedagogy (CRISP) project aims at wider scale implementation of the representation construction approach. This paper explores a range of issues that confronted four Year 8 teachers in implementing this research-developed approach, such as: preparedness of the teacher in terms of epistemological positioning and positioning as a learner, significant support for planning and modeling by the university expert, and a team ethos where teachers share ideas and plan jointly. The Year 8 teachers implemented a representation construction approach to the teaching of the topic of astronomy. In the presentation the teachers and researcher will illustrate the approach with classroom video, and use the interconnected model of teacher growth (Clarke & Hollingworth, 2002) to analyse their experience in planning and delivering the teaching sequence. This model was found to be flexible in identifying the experiences of teachers in different situations and useful in identifying issues for implementation of a research developed pedagogy.

Using identity as a lens to theorise effects of professional learning

Thursday, 4.20pm – Angus 2

Sally Birdsall

University of Auckland

The construction of one's identity is not static but instead a fluid on-going process as a person makes meaning of their experiences throughout their life. In this way, identity is formed through interaction with others and self-reflection. As one specific type of interaction, a teacher's professional learning can affect their identity. This research investigated student teachers' identity in relation to sustainability education. Twenty-one teachers participated in a series of three workshops that were focused on developing their understandings of the concept of sustainability. An interpretive mode of inquiry was used to analyse interview and documentary data. The results showed that at the end of the workshops, student teachers' understandings of sustainability had become more complex. In order to characterise their identities, an 'identity characterisation tool' was deductively developed. Findings showed that even though all had experienced the same activities, these student teachers had different expressions of identity. The characterisations of their identity were a complex mix of interrelationships between their understandings and their professional and personal beliefs. The efficacy of this tool will be discussed along with implications for sustainability education professional learning.

The Effectiveness of a Suggested In-service Training Programme in Developing Female Science Teachers' Action Research Skills

Thursday, 4.20pm – Oceania 1

Tahani Al-Muzaini
Imam Muhammad bin Saud Islamic University

This study investigated the effect of a proposed training Programme on in-service science teachers' action research understanding and action research skills. This experimental study used a group pre-test- post-test design, and the research sample was 16 science teachers. The researcher designed and developed a training Programme and two instruments: an action research test, and action research skills scoring rubrics. Data analysis using Wilcoxon Signed Ranks Test and Matched Pairs-Rank biserial correlation revealed significant differences in all measures .The research found a statistically significant variation between the participants' praxis rank average in the action research test when the participants scored higher in the post-test than the pre-test. There was a statistically significant variance between the pre-test and post-test average in the action research rubrics scoring; with post-test scores are higher than the pre-test scores. In light of the findings, the researcher recommends the promotion of action research skills among science teachers and supervisors through training, the inclusion of action research concepts in science teachers' preparation Programmes, and the establishment of a an action research unit within the Ministry of Education to help teachers identify and solve teaching problems.

Session 17

Problem solving as a lens- A framework for investigating physics teachers' thinking

Friday, 9.00am – Rangimarie 1

Zahra Parvanehnezhad Shirazian
Deakin University, Australia

There is an increasing awareness of the importance of developing reliable measures of teachers' pedagogical thinking. Using problem and problem solving as an analytical lens offers a new way of investigating teacher Pedagogical Content Knowledge (PCK) and this leads to an exploration of the teachers' cognition. This paper describes a framework for investigating and analysing physics teachers' knowledge and beliefs about teaching and learning motion tasks. This framework, rather than observing teacher's teaching strategy, has focussed on assessing teachers' reflection on and awareness of a range of students difficulties/challenges and problem-solving strategies. A Problem Centred Questionnaire (PCQ), and a Problem Centred Interview (PCI), including varieties of standard and non-standard problems were used. The analysis explored patterns and relationships between teachers' foci across nature, quality, and character of the student solutions of motion tasks. A major finding is that teachers' interpretations and feedback on student solutions could be categorised in terms of the extent to which they attended to Student Thinking or Disciplinary Thinking. The analytical template developed in this study can be used as a guide to interpret teacher belief and comments on student written responses, and for instructional intervention and curriculum development in the area of meaningful problem solving.

Improving learning by re-thinking concepts in science

Friday, 9.00am – Rangimarie 2

Russell Tytler[1] & Vaughan Prain[2]

[1]Deakin University &[2] La Trobe University

In school science, understanding and learning is customarily thought of in terms of generation or acquisition of concepts. However, the increasing prominence of visual, digital and mathematical reasoning tools in knowledge building in science raises the question of the relationship between concepts in science, and their multiple and increasingly complex representation. In this presentation we review recent research on how scientists generate and use concepts that prompts a need to re-think their nature, and their relationship to visual, mathematical and textual representations. We draw on research into student engagement and learning in science, and our recent research on the role of representations in learning science, to argue a need to re-conceptualize the nature and role of concepts in learning and knowing, if we are to engage students in quality learning. We argue that for science initiates, verbal representations of concepts are powerful shortcuts to communication and organization of knowledge. However, their traditional elevated status has the effect of replacing the real work of learning and knowing with abstracted shortcuts, misrepresenting the learning task. Many problems encountered in supporting student engagement with learning science stem from this misrepresentation. We explore implications for curriculum framing in science, and for classroom practice.

The complexity of scientific literacy: The development and use of an analysis matrix

Friday, 9.00am – Rangimarie 3

Kathryn Garthwaite

University of Auckland

The aim of this project was to explore how New Zealand secondary school students expressed scientific literacy in a particular context. Internationally, there are a range of definitions of scientific literacy, and there is little commonality about peoples' perceptions of the term. Additionally, there is limited data about how scientific literacy is expressed. Data from ninety-five Year 10 school students was collected by asking them to complete a literacy activity. This activity contained thirteen questions within two contexts; one developed by PISA and the second by the Assessment Resource Bank. This data was assessed using an analysis matrix, unique to this research. The matrix enabled a fine-grained analysis of students' expression of scientific literacy, both in groups as well as individually. The matrix incorporated the PISA identification of process of science and literacy expression at a particular level. The levelled literacy expression was adapted from a strategy developed by the Ministry of Education. Data of this analysis is presented. This analysis was able to group levels of scientific literacy for more than one context and demonstrated that different levels could be displayed simultaneously. Implications for both teachers and curriculum developers will be discussed.

Taiwanese primary teachers' beliefs about scientific creativity and its teaching

Friday, 9.00am – Angus 1

Shu-Chiu Liu, Huann-shyang Lin
National Sun Yat-Sen University

While a number of studies have investigated people's perceptions or conceptions of creativity, there is a lack of studies looking into science teachers' views. The study explored the meanings of creativity in the science classroom as perceived by a selective group of Taiwanese primary teachers. Participants were 16 experienced science teachers who were also active in learning and implementing inquiry-based teaching. Using a self-report, open-ended questionnaire and follow-up interviews, the participants responded to questions as to (1) what quality, behaviors and abilities characterize a creative learner in their science classrooms, (2) what a science classroom should be like if it is to facilitate scientific creativity, and (3) whether and how such classroom incorporates particular elements of the inquiry approach. The analysis revealed that although the teachers captured the central features of creativity and proposed a diversity of ideas to foster creativity in school science, they seemed to overlook some aspects, such as convergent thinking, problem-finding, and linking art and science, which are regarded as important for scientific creativity in contemporary research. The findings will be discussed along with their implications for teacher education and future research.

The threads that bind: Factors influencing the implementation and development of communities of science practice in primary school classrooms.

Friday, 9.00am – Angus 2

Anne Forbes[1] & Keith Skamp[2]
[1]Australian Catholic University & [2]Southern Cross University

MyScience is a primary science education initiative in which being in a community of practice is integral to the learning process. In this initiative, three key stakeholder groups -primary teachers, primary students and scientist mentors- interact around the 'domain' of investigating scientifically. This paper builds on three earlier publications and summarizes the findings of participants' views within the context of factors influencing the implementation and development of such learning communities in primary school settings. Findings reveal that participants' perceptions of their relationships with others are key to the successful implementation and development of communities of practice and include: their reasons for becoming involved, their sense of belonging through their own and others' contributions and their learning through participation. Implications for science teaching and learning in primary and secondary school settings are discussed.

Session 18: Poster session

Effects of hybrid problem-based versus lecture-based learning on undergraduates' cancer knowledge

Friday, 9.45am – Oceania 1

Lih-Lian Hwang
Ming Chua University

The objectives of this study are to assess the effects of hybrid problem-based learning (PBL) versus lecture-based learning (LBL) on undergraduates' knowledge of risk factors, prevention strategies, and warning signs of cancer. This study adopts a non-equivalent control group pretest–posttest design. Undergraduates enrolled in three different classes of the same 'Medicine and Health' course taught by the same teacher were invited to participate (N=193). Class A (n=61), the hybrid PBL group, was given the cancer educational Programme through hybrid PBL. Class B (n=71), the LBL group, was taught the same topic by LBL. Class C (n=61), the control group, was not given the cancer educational Programme. In the pretest, there were no significant differences in the mean scores of cancer knowledge among the three classes. After the educational intervention, the analysis of variance of changes of the mean score of the posttest and retention tests, compared to the pretest, were all significantly higher for the hybrid PBL and LBL groups than those of the control group (all $p \leq .007$) except for the change of the mean score of the retention test from the pretest score for the hybrid PBL Group. This study highlights the effectiveness of educational intervention using the hybrid PBL versus LBL on undergraduates' cancer knowledge.

The effect of science learning and career development of gifted girls in university

Friday, 9.45am – Oceania 1

Hsiao-ping Yu
National Taichung University of Education

This research investigated the science learning and career development of gifted girls after entering the university. It was follow-up to school-based research and sought to analyze the effect of a change of learning environment, the school-based phase investigated interest in science learning, willingness, perceived difficulty, and the career development of gifted girls when studying in senior high schools. The survey was repeated to understand and explore the influences on the environment change which from high school to university. The research found that gifted girls had their own goals and better career development advice while at high school. They liked the knowledge about life application and were motivated to learn science. However they did experience time pressures related to learning science, with significant differences in science-learning interest, motivation, and difficulty between gifted boys and girls. Entering the university, gifted girls still had their own goals and direction. They felt that learning science in university was easier than in senior high school ($p<.05$). There was better equipment in the university. Again there were significant differences in science-learning interest, motivation, and attitude toward university's environment between gifted boys and girls.

South Australia's Approach to working with the Australian Curriculum: Science

Friday, 9.45am – Oceania 1

Katrina Elliott
Department of Education and Child Development

The Department for Education and Child Development (DECD) and South Australia's Teaching for Effective Learning (TfEL) team in association with National Partnerships research have conducted longitudinal research over the past 4 years to examine the impact of teacher pedagogy on cognitive, social and emotional engagement of students, their achievement and lifelong learning capacity. The findings from this research informs system understanding of the relationship between teachers' pedagogy, learner engagement and learner achievement as well as informing system priorities for professional development and targeted resources. 'Leading Learning' is a resource for leaders and teachers, targeted at South Australia's approach to working with the Australian Curriculum, that has been developed to support site based professional learning. Within this resource a scaffolding tool has been designed to address teachers' epistemological understanding, as well as targeting Pedagogical Content Knowledge development. Teachers scaffold a science concept through a series of questions that interweave the three strands: Science as a Human Endeavour, Science Inquiry Skills and Science Understanding. Through using this scaffolding tool teachers explore, 'What is it to be a learner of Science?' and develop an understanding about the big ideas and key concepts of Science. This tool supports teachers to develop an understanding that scientific knowledge cannot be viewed as discrete bullet points of information to cover. The intent is to make this complex work visible and 'do-able' for teachers as they grapple with the new Australian Curriculum and design engaging, challenging learning experiences for all students.

Differences in types of questioning terms by inquiry stage in the science textbooks of lower secondary school in Japan

Friday, 9.45am – Oceania 2

Hayashi Nakayama[1], Yuji Saruta, Tomohiro1 Mori[1] & Toshikazu Watanabe[1]
[1]University of Miyazaki, [2]Kokugakuin University

The research question of this study was 'How do the questioning terms at each inquiry stage in lower secondary science lessons differ?'The methodology was as follows: (1) to extract sentences including questioning terms from textbooks, (2) to group each sentence by type of question, (3) to group each sentence by inquiry stage, (4) to cross-tabulate questions by 'type' and 'inquiry stage'. The results revealed that at the 'background' and 'problem or question' stage, 'what kind of', 'how', and 'yes-no' questions were dominant, and 'what' and 'why' questions followed them. Further, at he 'result' stage, 'how', 'what kind of', and 'yes-no' questions were dominant. At the 'implication' stage, 'what kind of' appeared most frequently, and 'how', 'what', 'yes-no', 'which', and 'why' questions followed. Additional analyses showed that similar types of questions were repeated at the beginning and final stages of inquiry. Questions that were set after observations or experiments gave students focusing points for data-logging activity. Finally, some questions at the implication stage required reasoning of phenomena in contrast to questions before observations or experiments, which tended to entail identification of regularities in phenomena.

Recent Trends on Collaboration between Schools and Local Societies in Japanese School Science Education

Friday, 9.45am – Oceania 2

Shiho Miyake[1] & Hayashi Nakayama[2]

[1]Kobe College & [2]University of Miyazaki

This study considers recent trends illustrating how Japanese science education research can be used to collaborate with social communities, and natural environment in terms of everyday life. A document analysis of 387 articles in two kinds of magazine *School Science Education Monthly* and *Journal of Research in Science Education* published from 2000 through 2011 was carried out. Trends identified were: Everyday life: The terms of 'health', 'food education', 'disaster prevention', 'security', and 'career education' were found as keywords leading to science education in school. Social communities: Collaboration with social communities should develop a proactive attitude among teachers. This links to the quality of educational practice. In fact, educational effects and teachers' abilities in practical research were discussed in several articles. For example, Nakayama (2004) wrote 'If teachers utilize educational facilities and human resources outside school and if they continue to think of how to collaborate with those facilities resources, their teaching quality will improve.' Natural environment: Practical educational activities were developed to connect knowledge in school science and knowledge of surroundings. In particular, learning about the nature of science through observation was emphasized. Some articles introduced the development of new teaching tools and Programmes and others discussed practical education with pedagogical methodology and evaluation tools such as concept mapping. These trends suggest a need to address the quality of practical education including teachers' motivation and teachers' abilities to find a way how they connect their daily surroundings with science teaching.

A Content Analytic Study of the Sixth Grade Science Textbook in the Kingdom of Saudi Arabia

Friday, 9.45am – Oceania 2

Jabber Aljabber

The main purpose of this study was to analyze the content of the sixth grade science textbook in the Kingdom of Saudi Arabia using accurate and precise science standards. This study utilized Indiana State National Science Education Standards, which were issued in 1996 by the National Research Council in the United States of America. The major research study question was to what extend the Saudi 6th grade science textbook covers Indiana State National Science Education Standards. Finally, it was the intention to use the study's results to ensure the quality and effectiveness of the Saudi 6th grade science textbook. The study found that the Saudi 6th grade science textbook covers a great deal of Indiana State National Science Education Standards. This textbook focused on the first four standards: Nature of Science and Technology, Scientific Thinking, Physical Setting, and Living Environment, (percentage coverage was 25.49%, 22.39%, 17.51%, & 15.52% respectively). With respect to the remaining standards, their percentages were 9.97%, 5.76%, & 3.32% respectively. In conclusion, the study recommended conducting similar studies to investigate the last three standards and discuss why their percentage coverage is low. It would be beneficial if more studies were conducted to closely investigate other science textbooks utilizing Indiana State National Science Education Standards.

Worksheet Usage and Science Achievement: A Cross-country comparison using TIMSS and PIRLS 2011 data

Friday, 9.45am – Oceania 2

Chi-Di Lee
National Taiwan Normal University

This study explored the association between worksheet usage and science achievement of grade 4 students across five countries, Taiwan, Hong-Kong, Singapore, Finland, and Germany, using the TIMSS and PIRLS 2011 dataset. The study aimed to demonstrate differences in the associations between several variables across countries and open possibilities for further investigation. The dependent variable, science achievement (SA), was composed of five plausible values in TIMSS dataset. Three independent variables were included in the multiple-regression model. The first one was worksheet usage (WU) reported by teachers. The second was the degree of students' lacking of knowledge and skills (LKS)a ccording to teachers' assessment. The third was students' reading achievement level(RAL) coming from PIRLS dataset. The interactions between WU and LKS, and RAL were also examined. For students in Taiwan, the association between WU and SA was related to RAL and for students with low reading ability, the association was significantly stronger. For Hong-Kong's students, the interaction between WU and SA was also suggested, but the association was significantly stronger for students with high reading ability. For students in Finland, the interaction was between WU and LKS. For students with high degree of LKS, the association between WU and SA was significantly stronger. For students in Germany and Singapore, there was no significant association between WU and SA, and no interactions between WU and LKS, and RAL.

Session 19

How ecoliterate is a five year old? Using a teaching intervention to increase young children's ecological understanding

Friday, 10.45am – Rangimarie 1

Melissa Slarp
University of Sydney

Can a five-year-old child comprehend complex ecological concepts? In today's climate of environmental uncertainty, can we educate our future generations in ecology from their very first day in the classroom? This project posits that the current curriculum places too low an expectation on young children's ability to engage with complex concepts. It hypothesises that Kindergarten children possess a higher level of ecoliteracy than currently acknowledged by the NSW primary curriculum. To test my hypothesis I designed and implemented a teaching intervention that focused on ecological concepts. A total of 25 Kindergarten students were tested across two schools. Ecoliteracy was measured using a pre-, post- and delayed-post testing protocol. I developed a coding matrix to analyse the data collected from children's drawings and interviews at various time points around the teaching intervention. Ecoliteracy scores increased significantly post-intervention and were maintained by the children when retested five months later. Their teachers reported increased interest and knowledge in ecology in the classroom, including applying this knowledge to new situations. These results support my hypothesis that Kindergarten children have advanced ecoliteracy abilities. These findings have implications for teachers in developing science curricula and implementing the curricula to promote science and ecoliteracy in primary schools.

Valuing assessment in science education

Friday, 10.45am – Rangimarie 2

Cathy Buntting, Deb Corrigan, Alister Jones & Richard Gunstone

Waikato University

As part of a recent edited book – 'Valuing assessment in science education: Pedagogy, curriculum and policy' – we developed a frame for thinking about the interactions between assessment, policy, curriculum and pedagogy. This presentation will introduce the frame and draw on the book to explore some of the ways in which the broader educational context interacts with, influences, and is influenced by assessment. We will also consider some of the questions we believe need to be addressed when considering assessment in current and future school science Programmes.

Preservice secondary science teachers' pathways to integrating technology in their pedagogical practice

Friday, 10.45am – Rangimarie 3

Tim Strohfeldt

University of the Sunshine Coast

In school science classrooms Information and Communication Technologies (ICT) can be used to enhance the processes of teaching and learning. Such application of ICT can be referred to as ICT in Education (ICTE). One of the objectives of preservice teacher education Programmes is to advance preservice teachers towards ICTE proficiency. This PhD project is describing preservice teachers' engagement with ICTE during their on-campus course and school practicum. A proposed framework of elements that encompass ICTE efficacy provides the design basis of this descriptive case study. The framework has also been employed to design a survey that measures the foundations of ICTE practice of Australian preservice secondary school teachers. Significant aims of this project are to describe ways preservice teachers transfer their course-based ICTE learning to the practicum classroom, and to explore the resilience of preservice teachers' foundations of ICTE practice.

The Differences of Semantic Understanding of Taxonomic Relations between Teachers and Students

Friday, 10.45am – Angus 1

Wei Ying Lan, Shih Wen Chen, Wen Gin Yang

National Taiwan Normal University

As specialized knowledge, science uses languages specifically to elaborate the relations among science objects. Composition and classification relations are two fundamental and highly related conceptual systems in science. Both composition and classification relations are realized by lexico-grammatical resources, it is essential to explore the linguistic nature expressing taxonomical relations as well as the very meaning of science objects. Different verbs or verb phases were deployed to describe classification and composition relations. For instances, 'Blood "includes" plasma and blood cells', or 'Blood "is constituted of" plasma and blood cells'. The verb of in the latter seems to be more exact than the former in describing composition relation. However, ambiguous lexicons in identifying classification and composition relations would trouble novice readers understanding of science. This study aimed at exploring the differences of semantic understandings of classification and composition relations among science concepts between teachers and students. A total of 66 seventh graders and one science teacher were asked to read the texts of the theme

about “blood “and to judge the taxonomic relations among the objects in the texts. The data were analyzed by the Repertory Grid Technique and Chi-Square test. The results indicated that: (1) the verbs/ verb phrases depicting taxonomic relations were interpreted differently by the teacher and students. (2) Different students had different usages of same verbs/ verb phases. (3) The students are more likely to mix up classification and the composition discourses. Several scholars have suggested that the biggest barrier to the science learning is the language of science. If the students cannot understand and use the language well, it is impossible ever to capture completely the meaning of science text.

Exploring students’ attitudes towards school science in Bangladesh

Friday, 10.45am – Angus 2

Foez Mojumder
Monash University

This case study sought to explore secondary students’ attitudes towards school science by hearing students’ voices. Studies that measure attitudes towards *science-in-general* are more common but this study particularly focuses on *school science*. Furthermore most previous studies measured attitudes by using Likert-type attitude scales, where the given statements and choices are prepared by educators or researchers; the statements reflect their (researchers’) ideologies and are based on what they believe to be the possible responses of the participants. Following Ryan and Aikenhead’s (1992) suggestion, this study conducted five Focus Group Interviews with 32 purposively selected secondary students (Grade IX and X, science and non-science streams, 14-16 years of age) in a school in Bangladesh. Focus group responses were used to develop an open-ended questionnaire to understand the general pattern of attitudes of all the students of the same school. Finally, 32 students were interviewed in 16 pairs, selected based on their questionnaire responses, to get more in-depth insights into their attitudes. A hybrid approach to thematic analysis was followed when analysing the data. The findings will help provide detailed insights into students’ evaluation of school science. These insights could help reshape science education based on students’ demands rather than relying on a score obtained from scales measuring attitudes.

Session 20

The impact of an inquiry-based science teaching on gender differences in young children’s understandings about force

Friday, 11.30am – Rangimarie 1

Shu-Min Chen
National Pingtung University of Education

This study examined the impact of an inquiry-based science teaching on gender differences in young children’s understanding about force. A total of 68 children (32 girls, 36 boys) aged 5 from three kindergartens were interviewed individually before and after an inquiry-based science instruction. A picture task, including 12 questions, was employed to explore children’s ideas about force. Each child was interviewed individually for about 12 minutes at both pre- and post-interviews. Data were collected by a mixture of pointing to parts of the picture and verbal explanations. Data were then analyzed both quantitatively and qualitatively. Boys in this study made significantly more correct choices than girls in the picture task, and gave more reasonable explanations than girls

before and after the instruction. The results indicated that there were gender differences in physics that favoured boys. The findings of this study suggest that gender differentiation in physics starts as early as age 5, and perhaps even younger.

Can digital technologies transform school science? (166)

Friday, 11.30am – Rangimarie 2

Cathy Buntting
Waikato University

This presentation reports on a 17 month study investigating the potential of digital technologies to transform school science. The project took place over three phases. First, an electronic survey collected a wide range of data, including teachers' use of digital technologies and resources to support science teaching and learning. Second, focus group interviews and case studies with teachers and students helped identify ways in which digital technologies are or could be used innovatively in school science. Third, focus groups with a wide range of experts (teachers, secondary and tertiary students, education researchers, facilitators of school-science connections, and a software developer) met to explore future possibilities for digital technologies in science education. The presentation will highlight key findings from each of these phases, including the culmination of the project: a teacher-ready discussion document intended to initiate professional conversations. This project is part of a larger Programme of work funded by New Zealand's Ministry of Education and being carried out by the New Zealand Council for Educational Research in conjunction with the University of Waikato and Learning Media.

Developing children's capacity to make evidence-based decisions about the socioscientific issue of volcanic risk

Friday, 11.30am – Rangimarie 3

Beverly France & Rena Heap
University of Auckland

The Science Learning Hub (SLH) is a New Zealand government funded initiative designed to provide web-based resources for teachers. This research was designed to identify how seven primary teachers from two city schools used this resource to plan and teach about volcanoes from a socio-scientific (SSI) perspective. The research focus was 'How can the SLH support teachers' capacities to develop their students' ability to make evidence-based decisions about volcanic risk?' Data was collected from lesson plans, teacher reports, focus-group interviews and student work. Data was analysed using Sadler's (2011) framework for developing teacher capacity for teaching within a SSI context. Key findings were that teachers with high levels of IT literacy embedded in their PCK did not automatically access the SLH. Also that children were able to provide scientifically-based evidence for their decisions and were seen to be more confident using scientific terms when explaining and justifying their decisions.

Student Perceptions of Science in a Middle School: The impact of aesthetics, affordance, agency and position

Friday, 11.30am – Angus 1

Pamela Farelley
University of Melbourne

Significant research has been undertaken into student engagement in science with emphasis placed on scientific literacy and achievement. This study explored student appreciation of and engagement with their normative science education experience during the middle years of school using an iterative ethnographic approach. Information was gathered to identify student perceptions of the science learning environment in terms of its physical and social dimensions. Year 7 and Year 9 students from a government secondary college provided information about their perceptions of the science learning environment through the use of Personal Meaning Maps (Falk, 2003; Lelliott, 2008; Redman, 2012), photographs and interviews. Presented here are two case studies that highlight factors that influence student engagement in and appreciation of science. Findings from these case studies indicate the importance of the physical dimensions within the science learning environment, an environment that is seen by students to be restricted to the science classroom. Social dimensions, particularly the relationship between the teacher and students, were deemed significant by these students. The findings of this study suggest that students expect and require access to space, equipment and effective instruction via improved classroom acoustics if their engagement in and appreciation of science is to be enhanced.

Uses of Multimedia in Pre-service Teachers' Instructional Materials

Friday, 11.30am – Angus 2

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

The media in multimedia differ in nature (e.g, photographs, animations, simulations). Though different information delivery formats promote student learning, there is an art to meaningfully and seamlessly teaching with multimedia.Domain knowledge (i.e., content, pedagogy, technology) is likely to be greatly emphasized but not the integrative role multimedia could play. This paper reports on an investigation of how teachers organize and present instructional content into a meaningful unit. The overall aim was to inform ways to improve teacher education. In this study, we collected 23 sets of instructional materials, including PowerPoint Files, lesson plans, and worksheets, from 16 earth-science pre-service teachers. These PPT/lesson plans were decoded into meaningful instructional events. Each individual event was further coded with 1) the proficiency of the pre-service teachers in using multimedia to present their instructional content (TPACK-P, Lin, Hsu, Wu, & Hwang, in preparation), and 2) the types of the multimedia representations they used. Results showed that these pre-service teachers were able to prepare multimedia representations to deliver course information (level 1). Real photos and diagrams and layered images in apparatus photos were frequently used. However none of them designed student-centered, interactive instructional tools (e.g., simulation, inquiry tasks) into their instruction materials.
