42nd Annual ASERA Conference

PROMOTING SCIENCE EDUCATION AND SCIENCE EDUCATION RESEARCH IN ALL CONTEXTS AND AT ALL LEVELS OF EDUCATION

June 29th - July 2nd 2011

University of South Australia ~ City West Campus
Adelaide, South Australia

CONFERENCE PROGRAM

AND ABSTRACTS

ASERA 2011

The 42nd Annual ASERA Conference of the Australasian Science Education Research Association

www.asera.org.au

June 29th - July 2nd 2011

University of South Australia ~ City West Campus
Adelaide, South Australia

Hosted by:

University of
South Australia

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Welcome and Introduction

Welcome to Adelaide.

Before European settlement in South Australia, the Kaurna people lived throughout this region. Their territory stretched throughout the Adelaide plains area from Cape Jervois in the south, to Port Wakefield in the north. The boundary followed the eastern shore of St. Vincent Gulf. Stretching on average to 100 kilometres inland, the region incorporated an area of over 7,200 square kilometres.

In 1836, between July and December, eight ships came across to Kangaroo Island. Aboard two of those boats were Colonel William Light, aboard the HMS Rapid, and George Strickland Kingston, aboard the HMS Cygnet. Light and Kingston both set off to survey the coastline and find a bigger land mass for the colonists to settle on. This is when they came across to what is now known as Glenelg. Glenelg was named after Lord Glenelg the Secretary of State for the Colonists. In December 28th 1836 Captain Hindmarsh arrived aboard the HMS Buffalo. There was a replica of this ship made and is running as a restaurant today in Wigley Reserve, Glenelg. It was on this day that Captain Hindmarsh Proclaimed South Australia where the Old Gum Tree stands today.

The official host of the conference is the University of South Australia, School of Education. UniSA is the largest university in South Australia, with 36,156 students, 2396 staff, and five campuses (four in Adelaide and one in Whyalla). As the leading provider of international education in the state we are also a significant contributor to South Australia's economic growth and prosperity. While the University of South Australia is the official host, Adelaide University and Flinders University have also contributed to the planning and running of the conference.

UniSA is committed to educating professionals, creating and applying knowledge, engaging our communities, maintaining cultural diversity among our staff and students, and providing equitable access to education. UniSA's approach to teaching and learning is student-centred, focused on higher education outcomes and delivered through flexible program arrangements. UniSA has increased its research profile and performance, as evidenced by a 50 per cent increase in research income over the past two years

The ASERA 2011 committee would like to thank all of the people who have contributed to this conference. Professor Geraldine Castleton, Head of the School of Education, UniSA, has kindly provided support from the School of Education, including support staff and Administrative assistance to help organise the conference. Our particular thanks go to:

- Sarah Rose and Amanda Fleming, School of Education professional staff
- Bruce White, University of South Australia
- Professor Chris Dawson, Adelaide University
- Debra Panizzon, Flinders University

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

Kathy Paige
Yvonne Zeegers
2011 ASERA Conference Convenors, School of Education, UniSA

The History of ASERA Conferences

In 1970 Peter Fensham (Monash University), the first Professor of Science Education in Australasia, initiated the first conference of what was then the Australian Science Education Research Association. The list of researchers, their institutional affiliations and research interests, who attended this conference can be located by clicking on this link (asera1970). That beginning for ASERA (now the Australasian Science Education Research Association) makes it the second oldest science education research body in the world, after the National Association for Research in Science Teaching in USA. This was also several months before the first conference of the then newly formed Australian Association for Research in Education (AARE). It is thus likely that ASERA was the first professional body in educational research in Australia.

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

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

Venue	Conference Convener(s)
ASERA 1 -1970, Melbourne	Peter Fensham, Lindsay Mackay & Dick White (Monash University)
ASERA 2- 1971, Sydney	David Cohen & Neil Baumgart (Macquarie University)
ASERA 3 -1972, Melbourne	Probably Les Dale (ASEP) & Peter Fensham (Monash) (Australian Science Education Project headquarters, Toorak, Melb) It has not been possible to establish with certainty who organized the conference.
ASERA 4 -1973, Brisbane	Colin Power & Dick Tisher (University of Queensland)
ASERA 5 -1974, Melbourne	Russell Linke & Leo West (Monash University)
ASERA 6 -1975, Adelaide	Arthur Lucas (Flinders University)
ASERA 7 -1976, Newcastle	Max Maddock (University of Newcastle)
ASERA 8 -1977, Wagga Wagga	Tony Blake (Riverina CAE) (now a campus of Charles Sturt University)
ASERA 9 -1978, Brisbane	Cam McRobbie (Mt Gravatt CAE) (now a campus of Griffith University)
ASERA 10 -1979, Perth	Dennis Goodrum (Churchlands CAE) (now a campus of Edith Cowan University)
ASERA 11- 1980, Melbourne	David Symington (State College of Vic, Toorak) (now a campus of Deakin University)
ASERA 12 -1981, Hobart	Paddy Lynch & Andrew Davies (University of Tasmania)
ASERA 13 -1982, Sydney	Bill Butts (Macquarie University)
ASERA 14 -1983, Hamilton (NZ)	Roger Osborne (University of Waikato)

ASERA 15 -1984, Melbourne	Dick Gunstone & Jeff Northfield (Monash University)
ASERA 16 -1985, Rockhampton	Ken Appleton (Capricornia Institute of Advanced Ed) (now a campus of UCQ)
ASERA 17 -1986, Adelaide	Chris Dawson, Mike Sullivan and Effie Best (University of Adelaide)
ASERA 18 -1987, Wagga Wagga	Doug Hill (Riverina CAE) (now a campus of Charles Sturt University)
ASERA 19 -1988, Sydney	Colin Gauld & Barry Newman (University of New South Wales)
ASERA 20 -1989, Melbourne	Dick Trembath (Chisholm Inst Technology, Frankston campus) (now a campus of Monash University)
ASERA 21 -1990, Perth	David Treagust (Curtin University of Technology)
ASERA 22 -1991, Surfers Paradise	Cam McRobbie (Queensland University of Technology)
ASERA 23 -1992, Hamilton (NZ)	Malcolm Carr (University of Waikato)
ASERA 24 -1993, Lismore	Keith Skamp (University New England, Northern Rivers campus) (now Southern Cross University)
ASERA 25 -1994, Hobart	Brian Jones & Max Walsh (University of Tas)
ASERA 26 -1995, Bendigo	Peter Searle & Brian Hand (LaTrobe University, Bendigo campus)
ASERA 27 -1996, Canberra	Tim Hardy & Marilyn Fleer (University of Canberra)
ASERA 28 -1997, Adelaide	Yvonne Zeegers & Paul Strube (University of SA)
ASERA 29 -1998, Darwin	Bill Palmer (Northern Territory University) (now Charles Darwin University)
ASERA 30 -1999, Rotorua (NZ)	Bev France & Mavis Haigh (Auckland College of Education, now Auckland University)
ASERA 31 -2000, Fremantle	Léonie Rennie (Curtin University of Technology)
ASERA 32 -2001, Sydney	Peter Aubusson (University of Western Sydney)
ASERA 33 -2002, Townsville	Steve Ritchie (James Cook University)
ASERA 34 -2003, Melbourne	Rod Fawns & Christine Redman (University of Melb)
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 Executive Board

The members of the ASERA Executive Board are:

- Professor Alister Jones - Managing Director
- Dr Coral Campbell
- Associate Professor Deborah Corrigan
- Associate Professor Bronwen Cowie
- Associate Professor Debra Pannizzon
- Professor Stephen Richie
- Professor David Treagust

Sponsorship Acknowledgement

Major sponsors:

- University of South Australia: School of Education

Other Sponsors:

- Adelaide University
- Credit Union SA

ASERA 2011 Program Overview

Wednesday 29th June

4.00-8.00pm	Registration desk open
6.00-8.00pm	Welcome Reception (Civic Gallery) -*Wines kindly supplied by Adelaide University*

Thursday 30th June

8.00-8.55am	Registration
9.00-9.25am	Official Welcome
9.30-10.10am	Presentation of Papers (one session)
10.10-10.35am	Morning Tea
10.35-12.00pm	Presentation of Papers (two sessions)
12.00-1.00pm	Lunch
1.00-3.10pm	Presentation of Papers (three sessions)
3.10-3.35pm	Afternoon Tea
3.35-5.00pm	Presentation of Papers (two sessions)

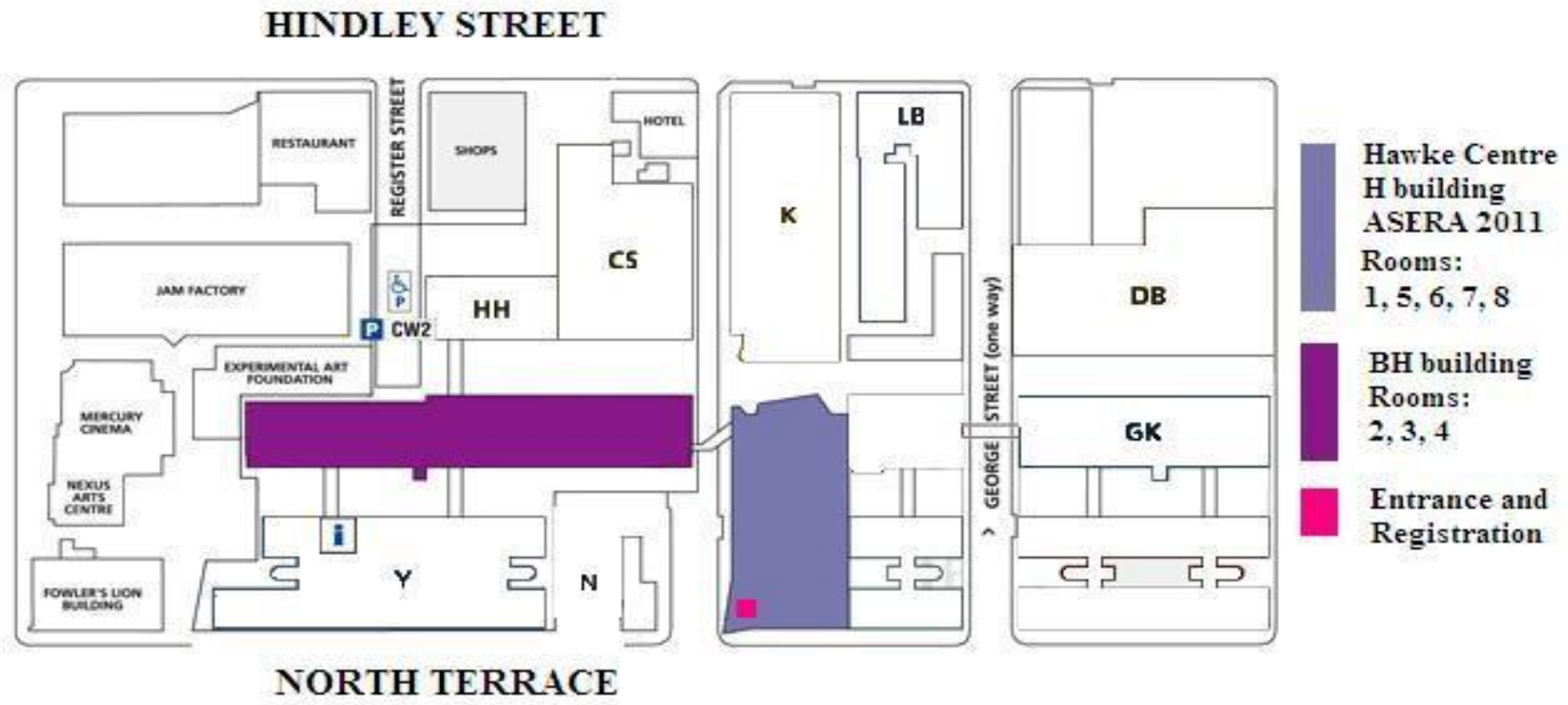
Friday 1st July

8.45-10.10am	Presentation of Papers (two sessions)
10.10-10.35am	Morning Tea
10.35-12.00pm	Presentation of Papers (two sessions)
12.00-12.45pm	Lunch
12.45-2.55pm	Presentation of Papers (three sessions)
2.55-3.20pm	Afternoon Tea
3.20-4.45pm	Presentation of Papers (two sessions)
4.45-5.45pm	AGM for ASERA
7.00-11.00pm	Conference Dinner (Lyrics Restaurant)

Saturday 2nd July

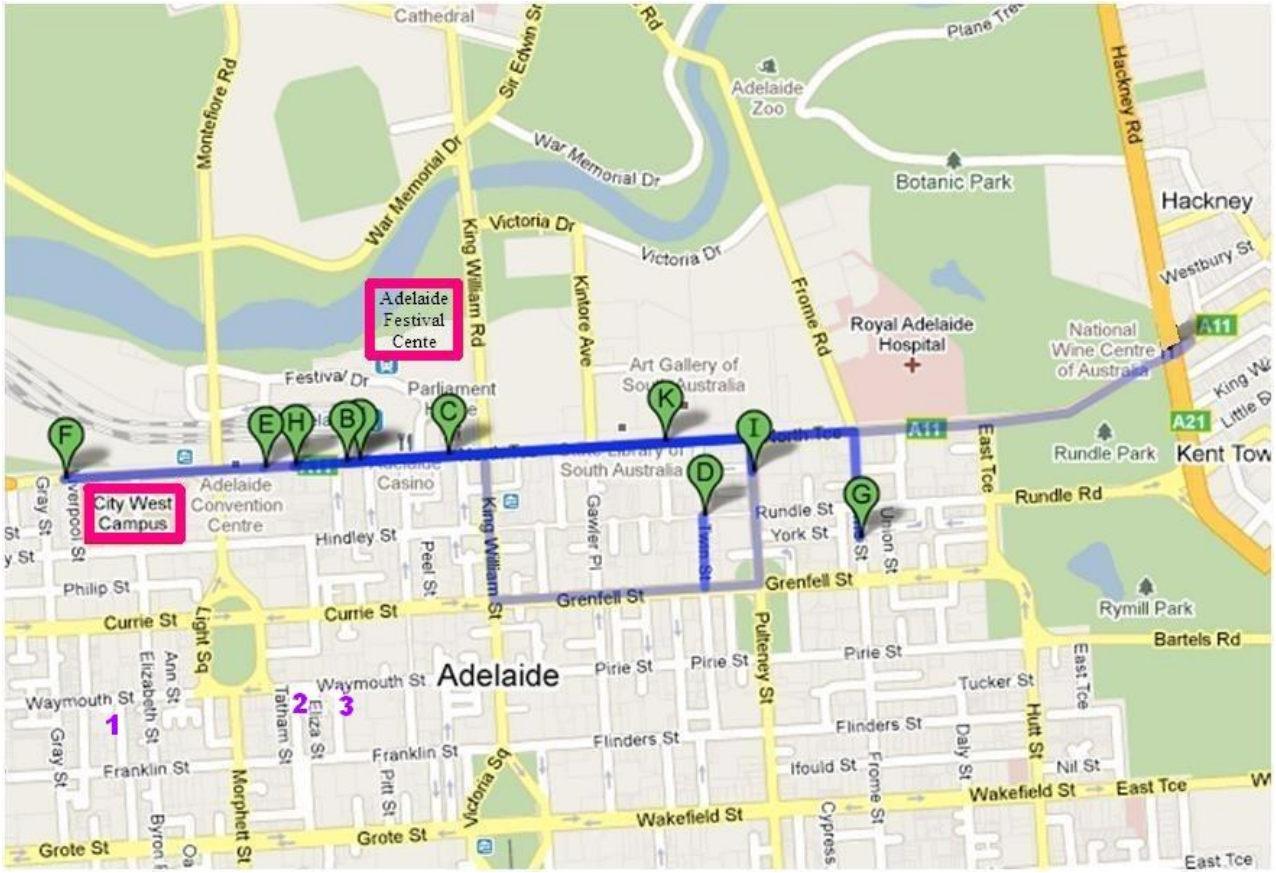
9.00-10.25am	Presentation of Papers (two sessions)
10.25-10.45am	Morning Tea – *Kindly sponsored by Credit Union SA*
10.45-12.10am	Presentation of Papers (two sessions)
12.15–1.00pm	Light lunch (before departure)

City West Campus Map



Barbara Hanrahan (BH) Building	Level 4
Room 2	BH4-32
Room 3	BH4-33
Room 4	BH4-30

Hawke Centre (H) Building	Level 6
Room 1	H6-12
Room 5	H6-09
Room 6	H6-10
Room 7	H6-11



B	Sebel Playford Adelaide
C	Stamford Plaza
D	Hotel Richmond Adelaide
E	Oaks Embassy Hotel Adelaide
F	Best Western Adelaide Riviera
G	Majestic Roof Gardens Hotel
H	Oaks Horizons Hotel Adelaide
I	Quests Mansions Apartments
J	Mecure Grosvenor Hotel
K	InterContinental Hotel
1	My Place Adelaide Backpackers Hostel
2	Adelaide Central YHA
3	Shakespeare International Backpackers Hostel YHA

General Conference Information

Annual General Meeting
The ASERA Annual General Meeting will be held Friday 1st July from 4.45-5.45pm in the Alan Scott Auditorium. All members are welcome to attend.

Airport Transfers
The Adelaide airport is just 15 minutes from the city centre.

Taxi: Taxi fares from the airport to the city, depending on the time of day and traffic conditions, will cost approximately $20.00 (AUD)

Bus: The Adelaide Metro provides buses from the airport into the city every 15 minutes. Between 9am and 3pm a ticket will cost $2.80 (AUD), before 9am and after 3pm this fare increases to $4.60 (AUD).
The buses come down Currie Street and Grenfell Street and stop at various locations within walking distance from hotels and backpacker hostels.

Airport Shuttle: Skylink provides a regular scheduled bus service between Adelaide Airport, Keswick Interstate Railway Terminal and the Adelaide CBD. There are set-downs and pick-ups from most major city hotels. The shuttle service operates every day of the year, except Christmas Day and costs $10 each way.

Many of the larger hotels also provide shuttle buses to and from the airport – please speak to your hotel to see if they provide this service.

Chairing Sessions
If you are presenting a paper, then you have probably been assigned to chair a session for someone else. Please check the program 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.

Conference Dinner
The Conference Dinner will be held in Lyrics Restaurant at the Adelaide Festival Centre on Friday 1st July. Pre-dinner drinks will be served from 7pm, and a three-course dinner will be served at 7.30. After 10.30pm you will need to buy your own drinks. This year a band for dancing will be provided but there is also space for quiet conversation.

The Adelaide Festival Centre is approx. 1.2km from the UniSA City West Campus. A free tram runs along North Terrace and south down King William St (see Parking and Transport map below for details).

Help

In an Emergency call 000 (Ambulance/Fire/Police)

IT help desk: Jeffrey Dunn phone: +61 8 8302 0359

Meals

Lunches, and morning and afternoon teas will be served on level 5 of the Hawke Centre. All day tea and coffee will also be available in this area.

Official Welcome

The Official Welcome will be held from 9.00 – 9.25am on Thursday morning in the Alan Scott Auditorium on the level 3.

Parking and transport

It is anticipated that most delegates will be staying within walking distance of the University of South Australia, City West Campus.

AdelaideMetro is the city's transport system, servicing the greater metropolitan region with trains and buses and the tram. You can travel around the Adelaide city centre for FREE when you hop on board the tram between North Terrace and South Terrace, or the 99C bus. You can find all route and timetable information on www.adelaidemetro.com.au.

The Adelaide Connector Free Bus Service is a convenient link between the major facilities within North Adelaide and Adelaide city centre. Facilities such as universities, schools, community services and shopping precincts are now linked and accessible via the Adelaide Connector free bus service. For more information see the Adelaide Council Website www.cityofadelaide.com.au/get-around/adelaide-connector-bus.

For taxis please call Suburban Taxi's on 131 008 or Yellow Cabs on 132 227

If parking is required please see the map below for parking locations.

Registration Desk

This will be located in the entrance foyer of the Hawke Building, North Terrace. It will first open on Wednesday from 4.00-8.00pm. The registration desk will open on Thursday and Friday at 8.00am and Saturday at 8.30am.

Welcome Reception

The Welcome Reception will be held from 6.00 – 8.00pm on Wednesday evening in the Civic Gallery, Level 3. There will be drinks and canapés provided and the registration desk will be open at this time.

Program of Presentations

ASERA Conference 2011							
THURSDAY 30TH JUNE (Sessions before Morning Tea)							
	Room 1 H6-12	**Room 2 BH4-32**	**Room 3 BH4-33**	**Room 4 BH4-30**	**Room 5 H6-09**	**Room 6 H6-10**	**Room 7 H6-11**
8.00-8.55am	Registration -Hawke Centre, Foyer, North Terrace						
9.00-9.25am	Official Welcome -Alan Scott Auditorium						
9.30-10.10am	**Jang-Long Lin, Jun-Yi Chen, Huey-Por Chang, Hsiao-Wen Li & Ying-Chi Chang** *Integration of communication skills for 5E Inquiry Teaching for Ninth-grade students on Circuit unit Learning Effect* **Chair: Washington T. Dudu**	**Pamela Mulhall, Maurizio Toscano & Jacinta Duncan** *Science Ideas: The Bigger the Better* **Chair: Pei-Ling Lin**	**Jinmeei Hsieh Kuo & Lihwa Wang** *Promoting 6th Graders' Capabilities about Communication through Inquiry-Based Instruction* **Chair: Pattamaporn Pimthong**	**Igal Galili** *"Physics as a Culture" as a framework for development teaching materials* **Chair: Wen-Hua Chang**	**Shinyoung Lee, Eunhee Kang, Heui-Baik Kim** *Construction of Scientific Models and Elements Characterising Collaborative Models in a Group Learning Environment* **Chair: Mzamose Gondwe**	**Chu-Hsun Kuo, Yichan Lin, Shueyung Wang & Mei-Chen Kuo** *Employing Meta-cognitive Reading Strategies to Enhance Solving Abilities on Math-Word Problems for 4th Grade New Inhabitant Students* **Chair: Pi-Chu Kuo**	**Nicoleta Maynard & Rekha Koul** *Engineering Education: Linking Science, Engineering and Technology* **Chair: Sharon Russo**
10.10-10.35am	Morning Tea -Level 5, Hawke Centre						

THURSDAY 30TH JUNE (Sessions between Morning Tea and Lunch)							
	Room 1 H6-12	**Room 2 BH4-32**	**Room 3 BH4-33**	**Room 4 BH4-30**	**Room 5 H6-09**	**Room 6 H6-10**	**Room 7 H6-11**
10.35-11.10am	**Kenneth Tobin, Stephen M. Ritchie, & Senka Henderson** *Emotions and Mindfulness in Science Education* **Chair: Hsiao-Wen Li**	**Marie-Noël Bêty & Patrice Potvin** *A bridge between conceptual change models and elementary science teaching to improve teachers' actions in class.* **Chair: Pei-Ling Lin**	**Sylvia Christine Almeida** *Environmental Education in a Climate of Reform: Understanding Teacher Educators' Experiences* **Chair: Jinmeei Hsieh Kuo**	**Amelia Druhan & Léonie Rennie** *Science by Doing: Impact at the 'Chalk face'* **Chair: Igal Galili**	**J. Lawrence Bencze & L. Carter** *A Framework for Socioscientific Citizenship Education: Students Advocating for the Common Good* **Chair: Shinyoung Lee**	**Chun-Yen Tsai** *Scaffolding Students' Qualities of Arguments by Online Argumentation System* **Chair: Chu-Hsun Kuo**	**Anne Hume** *Making Connections with Primary Science Classrooms* **Chair: Rekha Koul**
11.15-12.00pm	**Jennifer L. Oakley, Stephen M. Ritchie & Kenneth Tobin** *Using Cogenerative Dialogue to Transform Teaching Practices and Emotional Climate in a Beginning Science Teacher's Classroom* **Chair: Kenneth Tobin**	**Kim Chwee Daniel Tan, Yam San Chee, & Ek Ming Tan** *The Legends of Alkhimia* **Chair: Marie-Noël Bêty**	**Chung Yi (Brian) Huang, Wen Gin Yang, Shih Wen (Allen) Chen** *Students' understanding toward the logical relations within the semiotic systems in science text* **Chair: Sylvia Christine Almeida**	**Louisa Tomas** *"It made me proud": Students' Positive Emotional Responses to Writing Stories about a Socio-scientific Issue* **Chair: Amelia Druhan**	**Belinda Bray & Bev France** *The essential elements of effective science communication: What are they and what do the experts say?* **Chair: J. Lawrence Bencze**	**Junjun Chen & Bronwen Cowie** *Engaging primary students in learning about New Zealand birds: A socially relevant context* **Chair: Chun-Yen Tsai**	**Shiho Miyake** *How Do Japanese Students Perceive Sustainable Development? A Case Study on the Image of Sustainable Development among Young People* **Chair: Anne Hume**
12.00-1.00pm	Lunch -Level 5, Hawke Centre						

THURSDAY 30TH JUNE (Sessions between Lunch and Afternoon Tea)							
	Room 1 **H6-12**	**Room 2** **BH4-32**	**Room 3** **BH4-33**	**Room 4** **BH4-30**	**Room 5** **H6-09**	**Room 6** **H6-10**	**Room 7** **H6-11**
1.00-1.40pm	**David Clarke** *A less partial vision: Utilising multi-theoretic designs for classroom research* **Chair: Jennifer L. Oakley**	**Ming-Hua Chuang, Sheng-Chang Chen, Li-Yu Huang, & Hsiao-Ching She** *Investigating the Cognitive Processing of Chemistry Concepts with the Use of an Eye Tracker* **Chair: Kim Chwee Daniel Tan**	**Coral Campbell** *Primary science education – reality or myth* **Chair: Chung Yi (Brian) Huang**	**Michael Fitzgerald** *The Four-Fold Root of "Sufficient" Professional Development in a Large-Scale Astronomy Inquiry Initiative.* **Chair: Louisa Tomas**	**Paichi Pat Shein, Kun-Chang Wu, Chun-Yen Tsai, Yuh-Yih Wu, David Chao, Tai-Chu Huang** *A study of the public perception on global warming and attitudes toward science and technology of Taiwanese adults* **Chair: Belinda Bray**	**Mihye Won & Bertram C. Bruce** *Community Action as Learning for Scientific Literacy: A Deweyan Approach* **Chair: Junjun Chen**	**James J Watters** *From the frying pan into the fire: Mid-career science professionals transitioning to teaching* **Chair: Shiho Miyake**
1.45-2.25pm	**Jenny Arnold** *"Did you answer your thought?" Researching Student Agency in Science Classrooms* **Chair: David Clarke**	**Eunhee Kang, Shinyoung Lee, Heui-Baik Kim** *Exploring the Social Interaction and Atmosphere of Small Groups in an Analogy Based Inquiry into Blood Flow in the Heart* **Chair: Ming-Hua Chuang**	**Karen Murcia** *Multimodal Representations of Science in Interactive Whiteboard Classrooms* **Chair: Coral Campbell**	**Alberto Bellocchi, Maryam Sandhu, Satwant Sandhu, Stephen M. Ritchie** *Emotional Climate During Classroom Debates of Socio-scientific Issues in a Pre-Service Teacher Education Class* **Chair: Michael Fitzgerald**	**Anusit Kueakool** *The Factors on Grade 10 students' conceptual change about the Atomic Model* **Chair: Kun-Chang Wu**	**Yu-Chih Huang & Jeng-Fung Hung** *Promoting the Science Learning, Interest and Concept Understanding of Students with Hard of Hearing or Deaf in an Elementary School* **Chair: Mihye Won**	**Jenny Donovan & Grady Venville** *Blood, bones and crime: The mass media and students' conceptions of genes and DNA* **Chair: James J Watters**

THURSDAY 30TH JUNE (Sessions between Lunch and Afternoon Tea)							
	Room 1 **H6-12**	**Room 2** **BH4-32**	**Room 3** **BH4-33**	**Room 4** **BH4-30**	**Room 5** **H6-09**	**Room 6** **H6-10**	**Room 7** **H6-11**
2.30-3.10pm	**Lihua Xu & David Clarke** *The Challenges of Making Sense of the Microscopic World in a Secondary Science Classroom* **Chair: Jenny Arnold**	**Denis Goodrum** *Reflections on the development of a national curriculum* **Chair: Eunhee Kang**	**Elaosi Vhurumuku** *Representations of the nature of science in South African Grade 9 Natural Science textbooks* **Chair: Karen Murcia**	**Yu-Ta Chien & Chun-Yen Chang** *Exploring the Feasibility of the MAGDAIRE Model to Assist Pre-Service Science Teachers in Learning Technology Integration* **Chair: Alberto Bellocchi**	**Ying-Chi Chang, Jang-Long Lin & Hsiao-Wen Li** *A Study of Conceptual Change of Ninth-Grade Students in "5E" Inquiry Instructional Strategy Integrating into A Multidimensional Framework of Conceptual Change to Develop"Rotational Motion and The Torque"* **Chair: Anusit Kueakool**	**Gillian Kidman** *Developing an Operational Model of Inquiry-based Teaching: Teacher Roles and Pedagogies* **Chair: Yu-Chih Huang**	**Kimberly Wilson** *Reframing Science Education for a Flexible Learning Context: Making Science Matter* **Chair: Jenny Donovan**
3.10-3.35pm	Afternoon Tea -Level 5, Hawke Centre						

THURSDAY 30TH JUNE (Sessions after Afternoon Tea)							
	Room 1 H6-12	**Room 2 BH4-32**	**Room 3 BH4-33**	**Room 4 BH4-30**	**Room 5 H6-09**	**Room 6 H6-10**	**Room 7 H6-11**
3.35-4.10pm	**Etsuji Yamaguchi, Shigenori Inagaki & Tomoyuki Nogami** *Elementary Teachers' Acquisition of Pedagogical Content Knowledge from Curriculum Materials: A Case Study of Japanese Pre-service and In-service Teachers* **Chair: Lihua Xu**	**Sung-Pei Chien, Ming-Chin Hsin, Ya-Wen Tsao, Tsung-Hau Jen, Ying-Shao Hsu, Chen-Yung Lin** *Development of a Science Inquiry Index (SII) and Exploration of Students' Inquiry Abilities in Taiwan* **Chair: Denis Goodrum**	**Keith Skamp, Eddie Boyes, Martin Stanisstreet, Manuel Rodriguez, Georgios Malandrakis, Roseanne Fortner, Ahmet Kilinc, Neil Taylor, Kiran Choker, Dua Shweta, Abdullah Ambusaidi, Irene Cheong, Mijung Kim, Hye-Gyoung Yoon** *Secondary students' beliefs and willingness to act to reduce global warming: An international study related to transport options and its consequences for science education* **Chair: Karen Murcia**	**Hayashi Nakamaya, Yuji Saruta, Manabu Sumida** *Analysis on questioning terms in the Japanese Primary School Science Textbooks* **Chair: Yu-Ta Chien**	**Christine Howitt** *Flexible and adaptable: An early childhood science resource that acknowledges teachers know best* **Chair: Ying-Chi Chang**	**Margaret Freestone** *A tale of discovery of EfSD principles in Science Education Research* **Chair: Gillian Kidman**	**Kun-Chang Wu, Paichi Pat Shein, Pei-Yu Hsieh, Jui-Chou Cheng, Dong-Hwang Chen, Tai-Chu Huang** *Nanoscale science teaching in an informal setting: An investigation of the relationship between pedagogical approaches and students' situational interests* **Chair: Kimberly Wilson**

THURSDAY 30TH JUNE (Sessions after Afternoon Tea)							
	Room 1 H6-12	**Room 2 BH4-32**	**Room 3 BH4-33**	**Room 4 BH4-30**	**Room 5 H6-09**	**Room 6 H6-10**	**Room 7 H6-11**
4.15-5.00pm	**Li-Yu Huang, H. C. She, W. C. Chou, M.H. Chuang** *Exploring EEG activity in a Chemistry-Related Working Memory Task* **Chair: Etsuji Yamaguchi**	**Carole Haeusler** *Can the national science curriculum revitalise science education in Australia?* **Chair: Sung-Pei Chien**	**Anne Forbes & Keith Skamp** *Knowing and learning about science – primary students developing "scientific intuition" through interactions with professional scientists: The scientists' view.* **Chair: Keith Skamp**	**Mellita Jones** *How do pre-service teachers learn to teach science? A theory-practice approach using the 5Es Inquiry framework for teaching primary science.* **Chair: Hayashi Nakamaya**	**Zuraini Ramli** *Teaching and Learning Mathematics and Science in a Second or a Third Language* **Chair: Christine Howitt**	**Jill Robbins** *'That's got me really thinking': technology in early childhood* **Chair: Margaret Freestone**	**Michael Michie** *Identity Learning, Culture Shock and Border Crossing into Effective Teaching in Indigenous Science Education* **Chair: Kun-Chang Wu**

FRIDAY 1ST JULY (Sessions before Morning Tea)								
	Room 1 H6-12	**Room 2 BH4-32**	**Room 3 BH4-33**	**Room 4 BH4-30**	**Room 5 H6-09**	**Room 6 H6-10**	**Room 7 H6-11**	**Room 8 H5-26**
8.45-9.25am	**Catherine Milne, Jan Plass, Bruce Homer, Trace Jordan, Ruth Schwartz, Mubina Kahn & Dixie Ching** *Exploring the Use of Narrative within Multimedia Chemistry Simulations: Engendering Motive and Problematising* **Chair: Li-Yu Huang**	**Adam Bertram** *Science teachers' views on CoRes and PaP-eRs and the impact on their practice* **Chair: Carole Haeusler**	**Peter Hubber & Gail Chittleborough** *A professional learning program based on a representation intensive pedagogical approach* **Chair: Anne Forbes**	**Rekha Koul, Yuli Ramhawati, Darrell Fisher** *Being Reflective Science Teachers through Collaboration, Dialogue and Critical Reflexivity* **Chair: Mellita Jones**	**Jane Gilbert** *Thinking Skills in Science Education: Back to the Future?* **Ally Bull** *Thinking in science* **Chris Joyce** *Thinking with evidence*	**Tatiana Anesbury** *RESEARCH PROJECTS: Using competitions to encourage students to focus on science* **Chair: Jill Robbins**	**Hyun-Jung Cha, So-Jung Kim, & Chan-Jong Kim** *Perception and Experiences of Science Teachers Implementing Cooperative Learning in their classroom* **Chair: Michael Michie**	**Huei-Chih Chang** *Enhancing Understanding of Solar Cells and Enjoyment of Science-Technology-Society-Environment Instruction by Using Solar Energy Toys* **Chair:David Palmer**
9.30-10.10am	**Peter Fensham** *The Challenge of Generic Competences to Science Education* **Chair: Catherine Milne**	**Cathy Buntting and Kathy Saunders** *Scaffolding ethical reasoning using a digital learning object* **Chair: Adam Bertram**	**Sophia Bickford & Nancy Longnecker** *Secondary Science Teacher Perspectives on Excursion and Incursion Activities* **Chair: Peter Hubber**	**Man-Sum Lo** *Development of Pedagogical Content Knowledge for Teaching Nature of Science: Incremental Growth Versus Growth in Perspectives* **Chair: Rekha Koul**	**Chair: Zuraini Ramli**	**Yang Liu & David F. Treagust** *An Interpretive Examination of High School Biology Teachers' Use of Diagrams* **Chair: Tatiana Anesbury**	**John Drew** *How are science teachers being selected in South Australia?* **Chair: Hyun-Jung Cha**	**Chokchai Yuenyong** *Postgraduate Science Teacher Students' Representations of Pedagogical Content Knowledge* **Chair: Huei-Chih Chang**
10.10-10.35am	Morning Tea -Level 5, Hawke Centre							

FRIDAY 1ST JULY (Sessions between Morning Tea and Lunch)								
	Room 1 H6-12	**Room 2 BH4-32**	**Room 3 BH4-33**	**Room 4 BH4-30**	**Room 5 H6-09**	**Room 6 H6-10**	**Room 7 H6-11**	**Room 8 H5-26**
10.35-11.10am	**David H McKinnon** *Backward-faded scaffolding, the 5 Es, and inquiry-based pedagogies: Approaches adopted in the Space to Grow Project* **Chair: Peter Fensham**	**Chao-Ti Hsiung & Jui-lin Chen** *Constructing a situated learning environment to improve students' understanding of a sustainable aquatic pond* **Chair: Cathy Buntting**	**Ming-Chin Su & Che-Ming Tsai** *Designing Reform-Based Science Materials on the Development of an Experienced Teacher's Teacher Knowledge* **Chair: Sophia Bickford**	**Chris Dawson** *Conceptual mediation: Can recent findings shed more light?* **Chair: Man-Sum Lo**	**Meng-Yu Lin, Ying-Yi Chen, Wu-Lung Chung** *Development of Distributed Leadership in a Professional Learning Community: A Case Study of a Vocational High School. Developing an Innovative Biomass Energy Curriculum in Taiwan* **Chair: Jane Gilbert**	**Judith Gomes & Pamela Mulhall** *"Just because I enjoy it doesn't mean I learn": Science teachers' perceptions about students' interest in science* **Chair: Yang Liu**	**Sean Perera** *Serving-up the Peirian Waters: A Role for Science Communication in Formal Science Education* **Chair: John Drew**	**Silvia Wen-Yu Lee** *Relationships between Students' Learning Approaches, Views of the Nature of Science, and Performances in Online Discussions* **Chair: Chokchai Yuenyong**
11.15-12.00pm	**Susan Millar & Mary Oliver** *An exploration of the impact of 'Thinking Science' professional development on the pedagogy of participating teachers* **Chair: David H McKinnon**	**Marilyn Fleer & Garry Hoban** *The generation of a new scientific self-awareness through "Slowmation" (Student-generated Animations) in early childhood education* **Chair: Chao-Ti Hsiung**	**Meichun Lydia Wen & Pi-Chu Kuo** *Social Engagement and the Effectiveness of Online Meeting for Science Teacher Professional Development* **Chair: Ming-Chin Su**	**Erin Sperling & J. Lawrence Bencze** *Are we teaching girls to fish? Community-university collaboration for youth food justice education* **Chair: Chris Dawson**	**Mary Hanrahan** *A Motivational Theory of Development in Science Literacy* **Chair: Meng-Yu Lin**	**Francisco Ben** *South Australian Students' Uptake of Physics* **Chair: Judith Gomes**	**Wendy Nielsen & Alex Miller** *Laptop Ubiquity: A Case Study of Science Teachers' Response to the Digital Education Revolution* **Chair: Sean Perera**	**Thidarut Tongdee & Pattamaporn Pimthong** *The Study of Grade 6 Student Conceptions about Evaporation Using Rock Salt Farm Community Resources and the Inquiry Cycle (5E).* **Chair: Silvia Wen-Yu Lee**
12.00-12.45pm	Lunch -Level 5, Hawke Centre							

FRIDAY 1ST JULY (Sessions between Lunch and Afternoon Tea)								
	Room 1 H6-12	**Room 2 BH4-32**	**Room 3 BH4-33**	**Room 4 BH4-30**	**Room 5 H6-09**	**Room 6 H6-10**	**Room 7 H6-11**	**Room 8 H5-26**
12.45-1.25pm	**Vaille Dawson** *Effective Teaching strategies to promote argumentation skills about socio-scientific issues* **Chair: Susan Millar**	**Derek Cheung** *Implementing a New Chemistry Curriculum in Hong Kong: Teachers' Concerns* **Chair: Marilyn Fleer**	**David Nutchey** *Scaffolding numeracy in science using a visual description of mathematical knowledge* **Chair: Pi-Chu Kuo**	**Kai Niebert** *Metaphors of Climate Change: An educational reconstruction of global warming based on student's and scientists' metaphors and analogies* **Chair: Erin Sperling**	**1. Chun-Yen Chang & Yueh-Hsia Chang** **2. Yuan-Li Liu & Yueh-Hsia Chang** **3. Ko Kang Chien** **4. Chung-Yen Lin, Chun-Yen Chang, Hsieh-Hai Fu & Sheng-Ting Huang** *(Please see full Program for Abstract titles)* **Chair: Mary Hanrahan**	**Mark Hackling & Pru Smith** *Managing a Discourse of Inquiry in Primary Science* **Chair: Francisco Ben**	**Jiyun Park, Gyoungho Lee, Jongho Shin, David F. Treagust** *Assessment of secondary students' understanding of circular motion using a learning cycle based on the integrated mental model theory* **Chair: Wendy Nielsen**	**Liang-Rong Hsu** *The Teaching Effectiveness of the CPS integrated with Fun Science Activities* **Chair: Thidarut Tongdee**
1.30-2.10pm	**Jing-Wen Lin, Yu-Lun Wu & Yen-Ching Lin** *What are the Impacts of Dynamic Representations on Students' Answering Behaviour in the Two-tier Test in Electricity?* **Chair: Vaille Dawson**	**Miao-Li Changlai, Kun-Yuan Yang & Jen-Horng Hsien** *The Impact of Computer-Assisted Problem-Based Learning on Science Concept Learning and Group Discussion* **Chair: Derek Cheung**	**Che Ming Tsai & Huei-Chih Chang** *Fostering Non-Science Track Students' Knowledge-Based Decision-Making of Solar Energy Policy* **Chair: David Nutchey**	**Tsai-Feng Lee & Chao-Ti Hsiung** *A Study of the Influence of Teacher Questioning on Students' Scientific Reasoning* **Chair: Kai Niebert**	**David T Bottomley** *Harmony Hall, Hampshire: Contributions to Science Teaching by its 19th Century Residents and neighbours Part One: Robert Owen's Four-dimensional elementary curriculum, 1816-1818* **Chair: Yueh-Hsia Chang**	**Ian Clark and Yvonne Zeegers** *Un-greening sustainability education* **Chair: Mark Hackling**	**Marianne Logan** *Attitudes, interest, motivation and student engagement: Exploring the connection between these constructs in the context of science education* **Chair: Jiyun Park**	**Show-Yu Lin** *Controversy between Environmental Protection and Economic Development: Undergraduates' Opinions in Taiwan* **Chair: Liang-Rong Hsu**

FRIDAY 1ST JULY (Sessions between Lunch and Afternoon Tea) - continued								
	Room 1 H6-12	**Room 2 BH4-32**	**Room 3 BH4-33**	**Room 4 BH4-30**	**Room 5 H6-09**	**Room 6 H6-10**	**Room 7 H6-11**	**Room 8 H5-26**
2.15-2.55pm	**Bruce Waldrip & Vaughan Prain** *Using student reasoning through representations to develop conceptual understanding of Newton's laws of motion* **Chair: Jing-Wen Lin**	**Michael Chamberlain & David Fittell** *Enhancing science assessment capacity across Queensland* **Chair: Miao-Li Changlai**	**Chia-Li Debra Chen, Yueh-Hsia Chang & Chun-Yen Chang** *New Technology to Meet Students' Learning Needs: A Future Smart University Classroom in Taiwan* **Chair: Che Ming Tsai**	**Sabine Marsch, Kai Niebert & David Treagust** *Conceptual Change by Metaphorical Change: How understanding science is based on imaginations* **Chair: Tsai-Feng Lee**	**Ming-Chin Hsin, Sung-Pei Chien, Ya-Wen Tsao & Tsung-Hau** *The Validation of a Communication Index for Science Education in Taiwan* **Chair: David T Bottomley**	**Maurizio Costabile & Susanna Carter** *Using mind mapping in teaching Immunology: Enhancing student engagement and linkage of scientific knowledge* **Chair: Ian Clark**	**David Treagust, Yen-Ruey Kuo, Marjan Zadnik, Salim Siddiqui and Mihye Won** *Students' Multiple Representations for Learning Physics* **Chair: Marianne Logan**	**Kongsak Thathong and Ngamnit Thathong** *Integrated learning activities in national resources conservation according to the Philosophy of Sufficiency Economy for students* **Chair: Show-Yu Lin**
2.55-3.20pm	Afternoon Tea -Level 5, Hawke Centre							

FRIDAY 1ST JULY (Sessions after Afternoon Tea)								
	Room 1 H6-12	**Room 2 BH4-32**	**Room 3 BH4-33**	**Room 4 BH4-30**	**Room 5 H6-09**	**Room 6 H6-10**	**Room 7 H6-11**	**Room 8 H5-26**
3.20-3.55pm	**Mahbub Sarkar & Deborah Corrigan** *Teaching for promoting scientific literacy: A case study* **Chair: Bruce Waldrip**	**Beverly Lowe** *Pre-service Primary Teacher Preparedness and Confidence to Teach Science Following a University Methods Course* **Chair: Michael Chamberlain**	**Melissa Slarp** *If you're ecoliterate and you know it, clap your hands!* **Chair: Chia-Li Debra Chen**	**Fitriati, Elizar & I Gusti Ngurah Darmawan** *Factors Affecting Indonesian Student Achievement in Science* **Chair: Sabine Marsch**	**Kun-Yuan Yang, Chun-Tao Tsai, Miao-Li Changlai** *The Impact of Self-Regulated Learning on Cell Concept Learning for Seventh Graders* **Chair: Ming-Chin Hsin**	**Carol Aldous** *Creative Problem Solving and Innovative Science: Implications for learning and teaching* **Chair: Susanna Carter**	**Lihua Xu** *What does it mean to be Scientifically Literate?: A comparative investigation of science curricula from Australia, China, and Finland* **Chair: David Treagust**	**Debra Heck& Christine V. McDonald** *Exploring the influence of an argumentation professional development program on in-service secondary science teachers' ideas about scientific argumentation* **Chair: Kongsak Thathong**
4.00-4.45pm	**Rebecca Cooper & Deborah Corrigan** *A frame for linking values and scientific literacy* **Chair: Mahbub Sarkar**	**Heojeong Yoon & Ae Ja Woo** *Design and implementation of a problem-based learning laboratory course and an investigation of its effectiveness* **Chair: Beverly Lowe**	**Othman Talib, Mokhtar Nawawi, Wan Zah Wan Ali, Rosnaini Mahmud & Tengku Putri Norishah Tengku Shariman** *Simple Explicit Animation (SEA) Approach In Teaching Organic Chemistry* **Chair: Melissa Slarp**	**Hsiao Lan Sharon Chen & Chao-Ti Hsiung** *Enhancing Teachers' Pedagogical Awareness in Science Classrooms: A Research-based Professional Development Approach* **Chair: Fritiati**	**Debra Panizzon, Katrina Elliott & Martin Westwell** *e-Assessment in the senior secondary years: What do my students actually know and understand?* **Chair: Kun-Yuan Yang**		**Charlotte Taylor** *The concept of hypothesis testing: Misconceptions and categories of understanding* **Chair: Lihua Xu**	**David Palmer** *What is motivation?* **Chair: Debra Heck**
4.45-5.45pm	AGM FOR ASERA -Alan Scott Auditorium							
7.00-11.00pm	CONFERENCE DINNER -Lyrics Restaurant, Festival Centre							

SATURDAY 2ND JULY (Sessions before Morning Tea)							
	Room 1 H6-12	**Room 2 BH4-32**	**Room 3 BH4-33**	**Room 4 BH4-30**	**Room 5 H6-09**	**Room 6 H6-10**	**Room 7 H6-11**
9.00-9.40am	**Julian Smith** *Does replacing a beaker and spatula with a bowl and spoon make science learning and teaching any more authentic and real-life, and any less other worldly, for primary science teachers and students?* **Chair: Rebecca Cooper**	**Donna King** *Context-Based Science in the Middle School: Achieving resonance between the real-world field and the field of formal science knowledge* **Chair: Heojeong Yoon**	**Kathryn Saunders** *Teaching and learning about ethical inquiry into socio-scientific issues* **Chair: Othman Talib**	**Carolina Castano** *The intersection between science education and children's attitudes* **Chair: Chao-Ti Hsiung**	**Matlhodi Moloto & Elaosi Vhurumuku** *Representations of Indigenous Knowledge in South African Grade 9 Natural Science textbooks* **Chair: Debra Panizzon**	**Premnadh Kurup & Ralph Levinson** *How high school students use knowledge to make decisions on global warming: An intervention study in two London high schools* **Chair: Carol Aldous**	**Lena Danaia** *Students' perceptions of secondary school science and their knowledge outcomes: Preliminary results from the Space to Grow Project* **Chair: Lihua Xu**
9.45-10.25am	**Jun-Yi Chen, Ming-lin Lu, Jinmeei K. Hsieh, Jang-Long Lin,& Huey-por Chang** *Improving fourth-grade students' conceptual understandings and scientific explanations about simple circuits through inquiry-based teaching* **Chair: Julian Smith**	**Alex Baron & Hsiao-Lan Sharon Chen** *Looking In Science Classrooms: Exploring Cultural Differences in Science Teaching and Learning Through A Reflective Approach* **Chair: Donna King**	**Melinda Cross** *The journeys of pre-service primary teachers in learning how to teach science: A longitudinal case study* **Chair: Kathryn Saunders**	**Bolanle Olaleye, Mark Hackling & Karen Murcia** *Enhancing Teachers' Knowledge for Teaching Chemistry with Multiple Representations in Nigerian Senior Secondary Schools* **Chair: Carolina Castano**	**Mei-Ling Chow, Elisabeth Settelmaier, Peter Charles Taylor & Jasmine Hashim** *Enhancing engagement of students in science through use of ethical dilemma stories* **Chair: Elaosi Vhurumuku**	**Cheryl Jakab** *Small talk: Children's everyday 'molecule' ideas* **Chair: Premnadh Kurup**	**Yao-Chou Ho & Chih-Hsiung Ku** *Pictorial Metaphors in Typhoon Forecast Charts: An Analysis Based on the Theories of Conceptual Metaphor and Conceptual Blending* **Chair: Lena Danaia**
10.25-10.45am	Morning Tea -Level 5, Hawke Centre						

SATURDAY 2ND JULY (Sessions between Morning Tea and Lunch)							
	Room 1 H6-12	**Room 2 BH4-32**	**Room 3 BH4-33**	**Room 4 BH4-30**	**Room 5 H6-09**	**Room 6 H6-10**	**Room 7 H6-11**
10.45-11.20am	**Washington T. Dudu** *Exploring learners' understandings of nature of scientific inquiry (NOSI): The validation of a research instrument* **Chair: Jinmeei K. Hsieh**	**Leonie Rennie, Grady Venville, John Wallace** *The Worldly Perspective: Seeking Balance and Connection in Science Curriculum* **Chair: Alex Baron**	**Amrit Pal Kaur** *Pre-Service Science Teachers' Attitudes towards the use of selected ICT tools in Teaching: An Exploratory Study* **Chair: Melinda Cross**	**Wen-Hua Chang, Peying Tsai, & Sufen Chen** *Fostering Critical Reading of Science News Articles by Using a Writing Frame* **Chair: Bolanle Olaleye**		**Stephen Keast** *Developing a Pedagogy of Science Teacher Education* **Chair: Cheryl Jakab**	**Phairoth Termtachatipongsa** *Instructional Context, Motivation and Strategies in Teaching Genetics for Conceptual Change* **Chair: Yao-Chou Ho**
11.25-12.10pm		**Pei-Ling Lin** *Investigating Gender Differences in Scientific Literacy in Media (SLiM)* **Chair: Leonie Rennie**	**Pattamaporn Pimthong** *Pre-service teachers' lesson plan during a learning management in chemistry course* **Chair: Amrit Pal Kaur**		**Mzamose Gondwe & Nancy Longnecker** *A framework for engaging Indigenous students with science through storytelling* **Chair: Mei-Ling Chow**	**Pi-Chu Kuo** *The Formation of a Learning Community: Patterns of a Social Network in an Elementary Science Online Forum* **Chair: Stephen Keast**	**Sharon Russo & Wong Kung-Teck** *Interactive Whiteboards: Teachers' perspectives of potential pedagogical benefits and issues in teaching science for young children* **Chair: Phairoth Termtachatipongsa**
12.15-1.00pm	Light Lunch - Level 5, Hawke Centre						

Abstracts

Creative Problem Solving and Innovative Science: Implications for learning and teaching

Friday, 3.20pm – Room 6

Carol Aldous
Flinders University

Fostering a sense of wonder, enthusiasm and awe in the natural and physical world is important for sustaining curiosity and interest in science. It is also important in encouraging students to engage with scientific and technical matters. However, acknowledging an important role for an effective response to science, not merely its cognitive aspects, is something that tends to be overlooked in science curricula and teaching. Through an examination of the place of creativity in the development of innovative science and its role in the scientific process, this paper examines the relationship between creativity, problem solving and learning and discusses what this means for pedagogical knowledge and best practice. Evidence drawn from cognitive psychology, neuroscience and history is used to show an important role for both cognitive (thinking) and non-cognitive (feeling) activity in successfully solving novel problems in science and a conceptual framework developed. A case is made for identifying and describing engaging pedagogies that scaffold the content, process, context and affective dimensions intrinsic to the conduct of science.

Environmental Education in a Climate of Reform: Understanding Teacher Educators' Experiences

Thursday, 10.35am – Room 3

Sylvia Almeida
Monash University

This paper is about a PhD study concerning the practice of environmental education within teacher education. The context of the study is India. The study examines the role of teacher educators in developing and implementing environmental education in India. In a climate of national and international policy reform in environmental education, this study is particularly important in helping to explain the ways in which environmental education is understood, negotiated, determined and implemented by teacher educators in the organisational culture of teacher education. Furthermore, while there is increasing policy development there remains to be a serious dearth of research concerning teacher educators' experiences in the development and implementation of environmental education. This is particularly manifested in India where research in teacher education and environmental education is lacking. This study is the first of its kind in India. Furthermore, the theoretical framing of this PhD thesis is situated in teacher education and teacher educators' practices and identities. This is critical in presenting a postcolonial framing or reframing of environmental education in teacher education.

Using competitions to encourage students to focus on science

Friday, 8.45am – Room 6

Tatiana Anesbury
Flinders University

Preparing students for successful careers in the 21st century requires both innovation and creativity. Schools/teachers are preparing students for careers that possibly do not exist today and will change and evolve in an ever changing environment, at an ever increasing pace. Students of today will need skills such as collaboration, problem solving and communication to successfully navigate their future.

In an attempt to address these issues the "New SACE" has introduced the "Research Project" to encourage final year school students to develop these life skills while researching and pursuing their passion. The diversity of topics chosen by students can be daunting for science educators at first as they do not see themselves as experts of everything. However, the underlying research skills involved are the same.

Awards, events and competitions (such as Oliphant Science Awards and CREST) which have established frameworks were utilized. Which ones are suitable and which ones can be modified to fit the "Research Project" criteria and enhance student learning is the basis of this paper. Examples of topics with a science focus that were undertaken successfully in 2010 will be presented.

"Did you answer your thought?": Researching Student Agency in Science Classrooms

Thursday, 1.45pm – Room 1

Jenny Arnold
University of Melbourne

Student agency has become a more prevalent focus for research in science education over the past five years. Researchers have claimed that learning can be conceptualised "as agency" (Barton & Tan, 2010), that "students' agency constitutes the core of the driving force of children's engagement" (Goulart & Roth, 2010) and that student agency has "the potential to influence large-scale social change" (Basu, 2008). In this presentation I share an analysis of the variety of ways that researchers talk about student agency in science educational contexts. Some discursive inconsistencies in these research accounts will be discussed in terms of a conceptual resource that can account for the inconsistencies and provide a way of conceptualising agency that avoids them. A current video study of student agency in a year-seven science classroom in Melbourne is presented as an instrumental case to illustrate the utility of this scheme. The study was concerned with the students' positioning in classroom conversations, to what extent and under what circumstances they were positioned or positioned themselves as agentic, and the features of science classrooms in which students have possible access to agentic positionings.

Looking In Science Classrooms: Exploring Cultural Differences in Science Teaching and Learning Through A Reflective Approach

Saturday, 9.45am – Room 2

Alex Baron & Hsiao-Lan Sharon Chen
National Taiwan Normal University

Worldwide proliferation of pedagogical innovations creates expanding potential in the field of science education. While some national school systems excel in science teaching and learning, others struggle to achieve desirable student outcomes. Taiwan's robust science education has produced impressive results on PISA and TIMSS exams, sparking curiosity about Taiwan's science education program. Therefore, this study was designed to: 1) analyse cultural elements that contribute to Taiwan's strong performance in science, 2) identify pedagogical techniques that promote student scientific learning. The authors visited a Taipei city primary school class taught by an experienced science teacher during a four week course unit on Astronomy, with a total of eight periods of 90 minutes each. Research methods employed in this study included video capture of each class as well as investigative interviews with the instructor, which elicited the teacher's reflection upon both her pedagogical choices and the perceived results of these choices in the classroom setting. In the paper, the authors enumerate and analyse unique cultural components from a Taipei classroom that could enhance science teaching and learning practice on a global scale.

Emotional Climate During Classroom Debates of Socioscientific Issues in a Pre-Service Teacher Education Class

Thursday, 1.45pm – Room 4

Alberto Bellocchi, Maryam Sandhu, Satwant Sandhu & Stephen M. Ritchie
Queensland University of Technology

In this case study, we investigated emotional climate in a university class with pre-service science teachers during debates of socio-scientific issues (e.g., Global Warming). Due to the paucity of studies of emotional climate we were interested in exploring the moment-to-moment variation of emotional climate to understand how salient events impact on emotional arousal in individuals and emotional climate of the class. Emotional climate was measured using audience response technology. Conversation analysis of selected video clips and prosody analysis of audio files supplemented emotional climate data. The results indicated that positive emotional climate was identified during engaging student presentations, when debate rituals were disrupted, and during informal talk. Negative emotional climate was identified during flat debating performances. Emotional climate decreased during a formal discussion led by the teacher. Our results suggest that debating socio-scientific issues can be one way of fostering a positive emotional climate in science classes; however, this is dependent on the performances of individual debaters.

South Australian Students' Uptake of Physics

Friday, 11.15am – Room 6

Francisco Ben
University of Adelaide

For decades many science education reports have shown that the number of students enrolling into physics as a subject or a course is on a decline. This decline has been mainly due to students' negative attitudes and perceptions towards physics. This has brought concerns to educationalists and policy makers because of its negative social impact, especially in the economic and scientific literacy aspects. A number of factors (including school- and individual-level factors) that may contribute to students' negative attitudes towards physics, thus influencing subject uptake, have been examined by science education researchers.

This study drew upon existing studies of students' attitudes towards physics and employed quantitative and qualitative methods. School- and individual-level factors that could influence students' attitudes towards a subject have been examined using a total of 306 Years 11 and 12 high school-, and first year university-level students from the Adelaide Metropolitan area. Quantitative and qualitative data were collected using questionnaires and interviews, respectively. Quantitative data were analysed using various statistical methods (including CFA, IRT and HLM) and qualitative data were analysed thematically. Results suggest that school level, curriculum and classroom climate interact with student motivation to influence attitudes towards physics, and thus students' uptake of the subject.

A Framework for Socioscientific Citizenship Education: Students Advocating for the Common Good

Thursday, 10.35am – Room 5

J. Lawrence Bencze & L. Carter
University of Toronto

Educational researchers have, in recent years, increasingly focused on *socioscientific issues* (SSI); that is, debates about potential problems for the *wellbeing of individuals, societies and environments* (WISE) associated with fields of science and technology. Many of the problems can be seen as stemming from neoliberal and neoconservative policies — about which there are heated debates. Progress has been made in addressing such issues by, for example, encouraging students to develop argumentative positions on them. Nevertheless, given the apparent seriousness of many SSI, it seems clear that we need a critical and activist citizenry to tackle them. Promoting sociopolitical activism through school science has, however, been difficult — largely because, we suggest, of hegemonic influences on science education from agents of neoconservativism and neoliberalism. To bring about a more just and sustainable world, we offer a theoretical framework, along with relevant practical examples, for organizing science and technology education in ways that may promote research-informed activism. Although based on principles, including *holism*, *altruism*, *realism*, *egalitarianism*, and *dualism*, that we suggest may help school science generate a citizenry willing and able to proactively contribute to the common good, we also urge readers to use it as a basis for further research and development.

Science teachers' views on CoRes and PaP-eRs and the impact on their practice

Friday, 8.45am – Room 2

Adam Bertram
Monash University

CoRes (Content representations) and PaP-eRs (Pedagogical and Professional-experience Repertoires) have often been reported in the science education research literature to be effective instruments in capturing and articulating science teachers' pedagogical content knowledge (PCK). This presentation offers the findings from a two year longitudinal study which investigated how these instruments might be *valued* by practising science teachers; how their PCK might have developed as a consequence; and the impact, if any, these instruments have had on their professional practice. This is the first such study to report on science teachers' views of these instruments when used in practice. These teachers (n = 6) were involved in a pre- and post-test study with an intervention into their existing practice being based on their learning about, and use of, CoRes and PaP-eRs. The research revealed that CoRes and PaP-eRs significantly helped all six participating teachers to develop an awareness and understanding of PCK and that these instruments prompted meaningful reflection of their practice. The data demonstrated that CoRes and PaP-eRs provided a structure on which the participating teachers could frame new ways of thinking about teaching and learning; and thus enhance their understanding and valuing of their professional knowledge of practice.

A bridge between conceptual change models and elementary science teaching to improve teachers' actions in class

Thursday, 10.35am – Room 2

Marie-Noël Bêty & Patrice Potvin
Université du Québec à Montréal

Learning science is somewhat difficult for students, particularly when it questions their conceptions. A variety of research has been undertaken in the field of conceptual change (CC). Many of these research initiatives focus particularly on explaining CC, and developing CC models. However, on the practice side, it seems that elementary school teachers teach science in a transmissive way (Duit & Treagust, 2003) and feel uncomfortable with science teaching (Martin, Mullis & Foy, 2008).

In order for teaching practice to benefit from the value of CC models/ explanations and their underlying suggestions, a bridge must be established between the practice of science education in elementary schools and prolific research on CC from a selection of CC models: Posner, Strike, Hewson and Gertzog (1982), Vosniadou (1994), diSessa (1993) and Giordan (1996).

Our theoretical research aims at establishing such a bridge. We collected units within a representative sample of texts and used the methods of content analysis and synthesis to describe each CC model and to highlight their teaching indications.

Some suggestions for teaching converge despite the theoretical differences of the models. The results of the analysis are a contribution to making these models available and understandable to elementary school teachers.

Secondary Science Teacher Perspectives on Excursion and Incursion Activities

Friday, 9.30am – Room 3

Sophia Bickford & Nancy Longnecker
University of Western Australia

Excursions, field trips, incursions and guest speakers can increase student engagement with science. Classroom teachers play a pivotal role in determining the educational value of these activities, but research on teachers' experiences with them is limited and focuses mostly at primary and tertiary levels. This paper reports the results of a survey examining how often secondary (Year 8-12) science teachers use excursions and incursions, their goals in undertaking them, and challenges they encounter in doing so. Following a pilot study, a paper-based questionnaire was distributed to 1,100 Australian science teachers. Respondents (N~ 400) valued both affective goals such as inspiration and learning-oriented goals such as access to science experts. Logistical challenges, including inflexible school calendars and cost, ranked above issues of student safety and curriculum relevance for many teachers. Teachers appeared to use field trips more than guest speakers, even though bringing informal science resources into schools might alleviate problems such as cost, transportation and reduced class time for covering required curriculum. Findings are of interest to both schools and excursion and incursion providers. Challenges of survey methodology, including the value of a pilot study, will also be discussed.

Harmony Hall, Hampshire: Contributions to Science Teaching by its 19th Century Residents and neighbours Part One: Robert Owen's Four-dimensional elementary curriculum, 1816-1818

Friday, 1.30pm – Room 5

David T Bottomley
Curtin University

The newly built, Harmony Hall, East Tytherly Parish, Hampshire, England, arising out of farmland was an unexpected sight for visitors in 1844 as they trudged up the hill from the village of Broughton. From London, they might have travelled on the new train line to Winchester; thence by stage coach and foot. The Hall was designed and built by Robert Owen to provide accommodation and schools for an 'Owenite' farm community. The neighbour, Rev. Richard Dawes, of nearby Kings Somborne parish, was using practical methods to teach English and arithmetic to village and farm children, and science to an advanced class. Owen's projects were ill-funded and failed. In 1847 George Edmondson rented the Hall for his Queenwood College, and built a laboratory in the grounds where young scientists taught analytical chemistry to fourteen year-olds.

This is the story of Owen's earlier, enlightened Infant and Elementary school systems. Dawes and Edmondson's stories will be told in subsequent papers.

The essential elements of effective science communication: What are they and what do the experts say?

Thursday, 11.15am – Room 5

Belinda Bray & Bev France
University of Auckland

Experts in science communication were asked to identify the essential elements of a science communication course for post-graduate students. A Delphi methodology provided a framework for a research design that accessed their opinions and allowed them to contribute to, reflect on, and identify ten essential elements. There was a high level of agreement amongst these experts that the audience comes first and their statements signalled the importance of developing empathetic skills to engage an audience. Science communication courses should focus on the audience and how to access their needs, priorities and imagination. They signalled a need for dedicated science communication courses where students need to develop a broad understanding of the scientific and social issues rather than narrowly focusing on technical media skills development.

Thinking in science

Friday, 8.45am – Room 5
(Double Session with Jane Gilbert and Chris Joyce)

Ally Bull
New Zealand Council for Educational Research

Aim: This project aims to explore how a small group of secondary teachers interact with ideas for encouraging their students to *think* about what they are learning in science.

Significance: New Zealand's Curriculum places an emphasis on thinking and doing things with knowledge but provides little practical guidance for teachers as to what this might look like in their classrooms. This project sets out to identify some practical ways to support teachers as they adapt and modify their current practices.

Method: This project consists of a professional learning component and a research component. The professional learning component consisted of a workshop where teachers were introduced to some ideas about why thinking in science is important and some possible ways for how teaching could be organised. The research component documents how the teachers respond to the ideas at the workshop, and what opportunities/ challenges they report in attempting to implement and develop these ideas further back in their schools.

Results: Data collection is only just beginning for this project and initial results will be discussed at the conference.

Scaffolding ethical reasoning using a digital learning object

Friday, 9.30am – Room 2

Cathy Buntting & Kathy Saunders
University of Waikato

Science curricula around the world are including greater focus on socioscientific issues, and there is a corresponding move towards incorporating ethical thinking and reasoning in science classroom programmes. Not surprisingly, teacher confidence and pedagogical content knowledge impact significantly on the learning that can be achieved and there is a need for appropriate pedagogical resources. The ethics thinking tool (www.sciencelearn.org.nz/Thinking-Tools/Ethics-thinking-tool) is a digital learning object (DLO) based on prominent, well-established approaches to ethical reasoning – consequentialism, rights and duties, autonomy, and virtue ethics – that can be customised by teachers to suit any ethical issue. However, the impact of DLOs such as this one needs to be clearly demonstrated and articulated before teachers will include it in their planning. Working with four secondary school teachers, we investigated the learning opportunities afforded by the ethics thinking tool, and technical and classroom management issues associated with incorporating it into a science programme. Our data included classroom observations and audiorecordings of teacher and student talk, teacher and student interviews, and copies of teacher planning materials and student work. One of the case studies will be presented in this paper.

Primary science education – reality or myth

Thursday, 1.00pm – Room 3

Coral Campbell
Deakin University

Amidst an international call for a re-formed and re-envisaged science education agenda, the actual state of teaching science in primary schools is still much the same as it was 15 years or more ago. Whilst much research has provided insights into possible approaches for primary science education, we still find 'blockers' to a fully implemented science curriculum in schools. Pre-service teachers, as part of their assessment in a science education unit, interviewed primary teachers and asked the reason behind the approach to science in schools. The responses were varied, with some schools and teachers paying lip service to science education, whereas, in schools where science is a critical element of the curriculum, it is still mainly through the driving force of one enthusiastic teacher. This research will report on the aggregated responses from the surveys and attempt to identify possible ways forward, as suggested by data analysis.

The intersection between science education and children's attitudes

Saturday, 9.00 – Room 4

Carolina Castano
Deakin University

In this paper I present findings from a research study I carried out regarding the possible intersection among the nature of the science content and the pedagogy with the development of compassion and amelioration of

violence in children. This study breaks new ground in science education, and in the literature, concerning the development of compassion and amelioration of violence since it presents a unique approach. It includes aspects of the development of compassion towards animals, and its extension to changing attitudes and encouraging compassion to humans, in the teaching and learning of science in schools. The methodology was oriented by the principles of action research and included data from students' interviews, written responses, focus groups and field notes. Findings suggest that if science is taught with an approach to understanding how humans relate to animals, our similarities in needs and capacities and in the circumstances that affect both humans and animals, it could improve the attitudes of students towards nature and among the class. Additionally, results suggest that setting up the circumstances in the class where students could share their thoughts and link the presented situations of animals with their lives is also important in improving their attitudes.

Perception and Experiences of Science Teachers Implementing Cooperative Learning in their classroom

Friday, 8.45am – Room 7

Hyun-Jung Cha, So-Jung Kim & Chan-Jong Kim
Seoul National University

Science learning through a social interaction based socio-cultural perspective has been highlighted in science education. This qualitative research investigated in-service science teachers' perceptions and experiences about cooperative learning and various factors related to cooperative learning. In-depth interviews were conducted with 5 in-service science teachers who have carried out cooperative learning in their classrooms and have belonged to a science teacher cooperative learning community. In addition, 10 students who took lessons were interviewed to confirm the teachers' perceptions. These secondary school teachers' interview data were analysed and categorized into five areas: culture of school and class, aim of science learning, teachers' notions toward cooperative learning, teachers' practices and process of cooperative learning, and elements affecting implementing cooperative learning in classrooms. For fostering meaningful interactions in more classrooms, there should be improvements and support in the following areas: (1) teachers have to try to maintain a positive relationship with students and create an atmosphere of mutual trust between them, (2) teachers' and students' understanding of science learning through social interaction should be improved, (3) support in terms of facilities and administrators should be enhanced.

Enhancing science assessment capacity across Queensland

Friday, 2.15pm – Room 2

Michael Chamberlain & David Fittell
Queensland Studies Authority

Developing effective, valid and useful assessments to support teachers' judgments about students' performance against standards is important if teachers are to develop practices that encourage deep learning.

Queensland Comparable Assessment Tasks (QCATs) in English, Mathematics and Science are administered each year to students in Years 4, 6 and 9. Their purpose is to inform the enhancement of programs and pedagogy at the school level rather than system-wide collection of student data.

Many centrally devised science tests (typically multiple-choice and short-response) focus on factual recall. Science QCATs differ by presenting an extended problem and opportunities for open-ended responses, eliciting rich evidence of students' science inquiry skills. Our aim is to empower teachers by modelling quality

assessment, providing a context for moderation that promotes consistency of teacher judgments of student work made against standards.

This paper reports on the project monitoring process in which random samples of teachers' marking from around the state was collected and consistency of marking compared to that of trained markers. Data will be presented to show a high level of correlation, supporting the assertion that this mode of assessment enables consistency of teacher judgments. The paper also presents examples of Science QCATs and qualitative evidence of enhanced assessment capacity of teachers.

Does High School + University + Partnership = Scientific Literacy?

Friday, 12.45pm – Room 5
(Joint Session with other presenters)

Chun-Yen Chang & Yueh-Hsia Chang
National Taiwan Normal University

The greatest goal of science education is the enhancement of citizens' scientific literacy. In 2006, the National Science Council of Taiwan began subsidizing high schools to conduct a multi-year project named the High Scope Program (HSP). The aim of HSP was to develop and implement an innovative science education curriculum in high school classrooms. During the 5 year period of the HSP, a total of 28 high schools participated in and developed, in response to the newly-emerged/developed issues in recent Sci-Tech development, 136 inquiry-based new science curriculum modules. One feature of the HSP was to empower high school teachers as instructional leaders in leading the development and implementation of the new science curriculums; at the same time university faculty acted as consultants, to establish high school-university advisory partnerships in curriculum development. According to the evaluation data analysis, there were 5 forms of cooperation in the high school-university advisory partnerships: curriculum design, professional knowledge development, curriculum evaluation, resources providing/sharing, and cooperation in research activities. In addition, the evaluation analysis also found that the HSP advisory partnership model gave the high school teachers opportunities to systematically examine their teaching practices and professional roles; and also provided high school students with inquiry-based science courses as well as the experience of learning in "situated, authentic, collaborative, and reflective" contexts. Related empirical studies also indicated that the HSP science learning environment can enhance high school students' scientific literacy.

Enhancing Understanding of Solar Cells and Enjoyment of Science-Technology-Society-Environment Instruction by Using Solar Energy Toys

Friday, 8.30am – Room 8

Huei-Chih Chang & Ming-Chin Su
National Taiwan Normal University

In recent curriculum reform documents, teaching science as inquiry and supporting students' inquiries are encouraged. The problem-based learning (PBL) is characterized as a small group of members attempting to achieve a solution to a Science-Technology-Society-Environment problem in a real-life situation. It is frequently applied by school teachers to cultivate the inquiry competency of their students. This paper aims to describe the new PBL curricular material, examine to what extent the instruction facilitated middle school students in

developing understanding of how solar cells function, and determine students' enjoyment of the science lessons. Two classes of middle school students participated in this quasi-experimental study. The coding of concept maps generated by individual students before and after the instruction reveals that, after identifying group questions, developing hypotheses, designing testing procedures, collecting data, generating data patterns, and designing creativity equipment, the PBL students articulated more sophisticated coordination between their ideas and evidences. Furthermore, an ANCOVA of measures on the Enjoyment of Science Lesson Scale indicated a significant increase for the PBL students ($\alpha < .001$). Combined with a videotape analysis of students' engagement, we concluded that through the demand of mental engagement in the PBL, both the students' cognitive and affective learning outcomes can be maximized.

Fostering Critical Reading of Science News Articles by Using a Writing Frame

Saturday, 10.45am – Room 4

Wen-Hua Chang[1], Peying Tsai[2] & Sufen Chen[3]
[1]National Taiwan Normal University, [2]National Changhua University of Education, [3]Taiwan University of Science and Technology

Current reform emphasizes critical reading of science presented in the mass media. This quasi-experimental study aims to report a strategy to utilize science news articles and investigate their effectiveness at enhancing students' achievement. Two classes of seventh graders participated in the Science News Instruction (SNI). A science news article was selected after mapping its argumentative structure and concepts to the core concepts of the Genetics-Reproduction unit. After eight weeks of conventional lectures, the CK-SNI group (n=34) was explicitly prompted to link content knowledge to develop their argument about the science news article, whereas the SNI group (n=31) was not explicitly prompted to do so. The t-tests on scores of written artefacts revealed that both groups performed as well on identifying the data and claim elements made in the science news, and on producing reasons for the coordination between the data and claims. However, the CK-SNI students tended to produce better refuting reasons. The results of ANCOVA indicated that the CK-SNI group outperformed the SNI group on the test of factual, conceptual and procedural knowledge. We conclude that the strategy was effective in focusing students on elaborating key concepts, and thus enhanced their achievement.

A Study of Conceptual Change of Ninth-Grade Students in "5E" Inquiry Instructional Strategy Integrating into A Multidimensional Framework of Conceptual Change to Develop "Rotational Motion and The Torque"

Thursday, 2.30pm – Room 5

Ying-Chi Chang, Jang-Long Lin & Hsiao-Wen Li
National Changhua University of Education

This research was conducted by using a quasi-experimental design. The purpose of this study was to develop the teaching material in the unit, "Rotational Motion and The Torque," for teaching, utilising the 5E inquiry learning strategy (Bybee and Landes, 1988), which integrates into the multidimensional framework of conceptual change, proposed by Tyson, Venville, Harrison and Treaguest (1996). By doing so, we can observe how the junior high students change their concepts and their learning efficiency. The samples were selected from four classes in a junior high school located in central Taiwan, and included 160 ninth-grade students in two classes, identified as an experimental group and a control group. According to results of this study, two findings were summarized as follows：

1. The experimental group performed significantly better than the control group in the conceptual change.
2. The experimental group performed significantly better than the control group in the learning effect.

The Impact of Computer-Assisted Problem-Based Learning on Science Concept Learning and Group Discussion

Friday, 1.30pm – Room 2

Miao-Li Changlai[1], Kun-Yuan Yang[2] & Jen-Horng Hsien[2]
China University of Technology[1], Chung Yuan Christian University[2]

The purposes of this study were to develop and implement a "Computer-Assisted Problem-Based Learning System" (CAPBLS) for an elementary science course, and explore the impact of CAPBLS on science concept learning and group discussion. Using a quasi-experimental design, twenty nine third graders from one elementary school in Tau-Yuan Taiwan, were taught using CAPBLS and twenty nine third graders of the control group by conventional teaching (usually lecturing, without CAPBLS). The results showed that the processes of the water resources unit, which used CAPBLS, were better than that of conventional teaching. CAPBLS could promote the frequencies of participation and presenting of ideas. Also the frequencies of defending and explaining individual ideas regarding the water resources unit were highest according to the contents of online discussions. Such findings suggested that CAPBLS had a positive impact on science concept learning and group discussion for third graders.

New Technology to Meet Students' Learning Needs: A Future Smart University Classroom in Taiwan

Friday, 2.15pm – Room 3

Chia-Li Debra Chen, Yueh-Hsia Chang & Chun-Yen Chang
National Taiwan Normal University

This paper provides an overview of an ongoing research project, namely Centre for excellence in e-Learning Sciences (CeeLS), which aims to renovate the current science learning environment in Taiwan by establishing a Future Smart University Classroom through the innovative smart classroom technologies. The goal of this paper is to offer practical knowledge and experience to inform school teachers, educational researchers, and computer engineers how to better integrate technologies in classroom learning environments.

A baseline study was conducted before the development of the Future Smart University Classroom to survey students' preferences in the various smart classroom technologies. Next, a prototype in one of the Smart Classroom Technology Systems, Speech Driven PowerPoint (SD_PPT), was deployed and pilot tested with 46 undergraduate students in a university science classroom setting. Students' general perceptions toward the system were analysed using paired sample t-tests. The results indicated that their perceptions toward learning with Information and Communication Technologies (ICT), significantly increased both learning motivation and effectiveness. In addition, students revealed in their reflections that they enjoyed learning with the system and that they anticipate having more effective learning if the accuracy of the system can be increased in the future.

Enhancing Teachers' Pedagogical Awareness in Science Classrooms: A Research-based Professional Development Approach

Friday, 4.00pm – Room 4

Hsiao Lan Sharon Chen & Chao-Ti Hsiung
National Taiwan Normal University

Teachers' professional growth is the key to successful innovations in science teaching and learning. However, there is no one best way to organize professional development programs for science teachers. As part of a cross national comparative study of Ensuring Quality in Primary Science Education (EQPSE) between Taiwan, Australia and German, the Taiwan research team invited elementary teachers studying in graduate science education programs to participate in the EQPSE research project to be filmed. The analysis of their classroom pedagogical practices focused on opportunities for students to engage in scientific reasoning. Based on the on-going reflective dialogues with the participant teachers, the project investigators found obvious positive conceptual changes of teachers that lead them to be more aware of and more critical about their pedagogical practices. Emerging out of the EQPSE research process, in this paper, the authors particularly trace the conceptual changes and pedagogical awareness of two 3rd grade teachers teaching the unit of Creatures in Water. Data used for analysis were from the reflective teaching logs and the recordings of the conversations and discussions that the project investigators had with the participant teachers. Through examining the participant teachers' professional growth experience, the authors attempt to make their argument that the research-based approach to professional development is promising for raising teachers' conceptual change as well as enhancing teachers' pedagogical awareness.

Engaging primary students in learning about New Zealand birds: A socially relevant context

Thursday, 11.15am – Room 6

Junjun Chen & Bronwen Cowie
University of Waikato

This paper reports on a classroom study that investigated the way a teacher used materials accessed from the Science Learning Hub. The Hub was developed to make the work of New Zealand scientists accessible. The case study class was a Year 7 class. The teacher utilized a range of interactive and collaborative instructional approaches including a range of reading strategies.

The researchers observed ten lessons from a unit on New Zealand birds, interviewed students after the first and the final lesson, and interviewed the teacher after the final lesson. The students completed a pre and a post-test, and a pre and a post-survey. The three other teachers in the school who taught the birds unit were interviewed.

Classroom observations and interviews confirmed that the students enjoyed and were interested in the unit. Teachers and students considered that students had learned more than usual. In their end-of-unit evaluations, 20 of the 23 students stated that they had learned facts relating to native birds, Five stated that their understanding had increased, six stated that the unit had been interesting, and 12 stated that they felt more confident in their knowledge of native birds and the threats they face. All those interviewed mentioned the tracking tunnel activity as particularly engaging because it identified the animals/predators in their school gully. This linked the ideas from the unit into their local context.

Improving fourth-grade students' conceptual understandings and scientific explanations about simple circuits through inquiry-based teaching

Saturday, 9.45am – Room 1

Jun-Yi Chen[1], Ming-lin Lu[1], Jinmeei K. Hsieh[2], Jang-Long Lin[3] & Huey-por Chang[2]

[1]National Chiayi University, [2]MingDao University, [3]National Changhua University of Education

This study aimed to determine fourth-grade students' conceptual understandings and scientific explanations during an inquiry-based unit on simple circuits. The 5E model was used as a framework to plan the unit. Fifty-seven students were randomly assigned into an experimental group (N=28) and a control group (N=29). In the control group, the teaching strategy was a lecture format. Data were gathered through questionnaires, written scientific explanations, interviews and classroom observations. It was found that there was a significant difference between their science conceptions. The students clarified their ideas and learned scientific conceptions about simple circuits after inquiry-based teaching. In addition, the quality of the experimental group students' explanations was analysed based on three components: claim, evidence and reasoning. During the unit, they wrote down their explanations about series circuits and parallel circuits. (The percentage of students who provided accurate descriptions increased 20% approximately at each component. Most students provided appropriate evidence and reasoning to support their claims. They also had capacities for manipulating the bulbs, batteries and wires to present their claims in interviews. However, their written claims were deficient or incorrect and they had difficulty in using a circuit diagram to represent the connection of bulbs, batteries and wires.

Implementing a New Chemistry Curriculum in Hong Kong: Teachers' Concerns

Friday, 12.45pm – Room 2

Derek Cheung
Chinese University of Hong Kong

In September 2009, the secondary schooling in Hong Kong was shortened from seven to six years. A new chemistry curriculum is offered as a separate subject to Secondary 4-6 students (approximately 16-18 years of age). There are three parts in the new chemistry curriculum: a 198-hour compulsory part, a 52-hour elective part, and a 20-hour investigative study. Teachers not only need to teach new topics such as polymeric biomaterials, liquid crystals and nano-materials, but also have to assess their students' practical skills through school-based assessment. From the literature review, it is evident that many previous attempts at curriculum change failed, and one important reason was that teachers' concerns about the new curriculum design and classroom practices were not analysed and dealt with throughout the process of change. In 2011, five Hong Kong teachers were interviewed to identify their major concerns about implementing the new chemistry curriculum in school. All the interviews were audiotaped and fully transcribed. The teachers were most concerned about workload, inquiry teaching, and learner diversity. Implications of these findings for curriculum development and teacher training are discussed.

Departing from the Inquiry-Based Science Program: An Actor-Network Theory Study of a High School in Taiwan

Friday, 12.45pm – Room 5
(Joint Session with other presenters)

Ko Kang Chien
National Taiwan Normal University

As inquiry-based teaching has been greatly emphasized in the current science curriculum, the High Scope Program (HSP), founded by National Science Council (NSC) in Taiwan, also required the implementation of inquiry-based instruction in high school classrooms. Based on NSC's program evaluation from the 28 participating schools, the results of the implementation in many of the schools deviated from the pre-set program requirements. This paper used the actor-network theory, emphasizing the impact of the combination of human and non-human elements, to investigate the discrepancy between the outcomes and objectives of the HSP. Qualitative interviews were conducted in one particular high school. The participants included one school administrator, four teachers, and two experts from a research institute. The findings revealed that (1) the team members' proposed scripts differed from the inquiry-based program. Instead of emphasizing students' active learning attitudes, data collecting, reasoning skills, and problem solving abilities, the main foci for the program participants were the enrolment of gifted students, the requirement of mandated curriculum, and students' participation in other contests irrelevant to the HSP; (2) the instructional materials resulted in directing inquiry activities for the purpose of competing in contests; (3) the combination of human and non-human elements became an 'actor' (Latour, 1999) that caused the deviated route from the original program.

Development of a Science Inquiry Index (SII) and Exploration of Students' Inquiry Abilities in Taiwan

Thursday, 3.35pm – Room 2

Sung-Pei Chien, Ming-Chin Hsin, Ya-Wen Tsao, Tsung-Hau Jen, Ying-Shao Hsu & Chen-Yung Lin
National Taiwan Normal University

Inquiry ability in science is viewed as the core of national curricula in many countries and an important issue in science education; however, instruments for assessing inquiry ability remain limited in Taiwan. The purpose of this study was to develop the Science Inquiry Index (SII) and then investigate students' inquiry abilities in Taiwan. National curricula from five countries were reviewed and compared to form the initial framework and items. The design of this study combined Delphi survey and a follow- up case study. Delphi technique, in which 62 university professors and 98 science teachers participated, was employed in data collection. Responses from both professors and teachers contributed to the modification of SII. The modified index, listing 3 school stages as elementary, junior and senior high school, includes 3phases and 29 items. The validated SII was then used as a coding scheme to investigate students' inquiry ability. Analyses of professors' options show that the items in SII are important. Analyses of teachers' data confirmed the SII by which teachers' opinions were positively correlated to the school stage of SII. Furthermore, results from the case study indicate that students benefit from guided inquiry teaching. When students participate in more science inquiry practices, their inquiry ability improves.

Exploring the Feasibility of the MAGDAIRE Model to Assist Pre-Service Science Teachers in Learning Technology Integration

Thursday, 2.30pm – Room 4

Yu-Ta Chien & Chun-Yen Chang
National Taiwan Normal University

We propose a MAGDAIRE model (Modelled Analysis, Guided Development, Articulated Implementation, and Reflected Evaluation) to facilitate pre-service science teachers in learning technology integration. MAGDAIRE was deployed to renovate a science teacher education course which enrolled 16 pre-service science teachers in Taiwan, and its feasibility was evaluated by both quantitative and qualitative approaches. After two runs of MAGDAIRE, all the pre-service teachers produced their own educational technology artefacts that can be actually used by students for learning scientific subject matter. The results of quantitative analysis indicated that their competence levels were significantly promoted with a large effect size), and most of them (87.5%) believed that they were better prepared to integrate technology into instruction. Moreover, the results of qualitative analysis indicated that MAGDAIRE honed the pre-service teachers' reasoning on the interplays between technology, pedagogy, and content. The portrait of the pre-service teachers' learning trajectory in this preliminary study may offer informative implications for teacher educators to innovate science teacher preparation programs. Some suggestions for incorporating MAGDAIRE into science teacher education courses will be provided in the conference.

Enhancing engagement of students in science through use of ethical dilemma stories

Saturday, 9.45am – Room 5

Mei-Ling Chow[1], Elisabeth Settelmaier[2], Peter Charles Taylor[2] & Jasmine Hashim[2]
[1]Yule Brook College, [2]Curtin University

Nowadays in the science curriculum there is often little place for values or, more specifically, situations in Science which take into account the values students place on them. It is common practice for the teacher to teach the scientific content followed by activities to reinforce the concepts. However, there is little input from the students themselves – their opinions on issues, their decisions on how they might want to change an experimental result. This paper focuses on the importance of using ethical dilemma stories in promoting environmental sustainability to students and looks at recent findings at a particular school in Western Australia. The study shows that two important factors determined the success of dilemma story teaching: (1) the relevance of the topic of the dilemma story, and (2) the method of student engagement in the classroom environment. In this paper, we will discuss how the use of ethical dilemma stories changed students' engagement in Science, with particular focus on two students in the first author's Year nine Science class, and how this teaching approach can contribute to a stronger experience for interested teachers wishing to use dilemma stories in their Science curriculum.

Investigating the Cognitive Processing of Chemistry Concepts with the Use of an Eye Tracker

Thursday, 1.00pm – Room 2

Ming-Hua Chuang, Sheng-Chang Chen, Li-Yu Huang & Hsiao-Ching She
National Chiao-Tung University

This study explored undergraduate students' cognitive process when retrieving chemistry concepts in the representation of image and text. Subjects' accuracy in successfully retrieving the chemistry concepts, as well as their eye-movement behaviour during retrieval, were collected. Results indicated that when students failed to retrieve concepts, they allocated a greater number of fixations and total inspection time than when they successfully retrieved concepts, regardless of image or text. However, in text presentation, when students successfully retrieved concepts they allocated a greater amount of mean fixation duration than when they failed to retrieve concepts. Furthermore, when students failed to retrieve concepts, they allocated a greater number of saccades, and had greater total saccade distance, than when they retrieved concepts successfully, regardless of image or text. In addition, during the presentation of images, when students failed to retrieve concepts, they showed a greater amount of mean saccade distance than when they successfully retrieved concepts. In short, students need a longer mean fixation time to process the concepts in depth so that they can successfully retrieve concepts. When students had a greater number of saccades, and longer total saccade distance, it indicated they could not find the important feature, such that they failed to retrieve the concepts. Therefore, in order to promote students' chemistry conceptual learning, we need to make the key features and key words more salient in image and text.

Un-greening sustainability education

Friday, 1.30pm – Room 6

Ian Clark & Yvonne Zeegers
University of South Australia

In the *Decade of Education for Sustainable Development (DESD*) there is a need for a change in the way we teach about sustainability. In December 2002, the United Nations General Assembly proclaimed the years from 2005 to 2014 the ***DESD***. Agenda 21, a formal resolution of the Earth Summit in Rio de Janeiro in 1992 called for "environmental education to abandon its perhaps all-too-naïve preoccupation with natural systems in order to incorporate the concept of sustainable development-especially in the way it should be concerned as much with issues of peace, human rights, gender, race and social equity as it is with nature conservation" (Fien 1997).

A survey of commencing students in a Master of Environmental Management and Sustainability program confirmed our perception that most students still think sustainability mostly concerns conservation or preservation of the environment. In the spirit of action research, we modified and then evaluated the course such that students might change their thinking about sustainability, by emphasising that to achieve sustainability there must be a balanced consideration of environmental, social and economic aspects.

The presentation will report the results of the survey which in addition to showing that what students think about sustainability pre and post courseworks, showed that the media and previous university courses were the source of most students' understanding of the environment.

A less partial vision: Utilising multi-theoretic designs for classroom research

Thursday, 1.00pm – Room 1

David Clarke
University of Melbourne

Current calls for research that is programmatic rather than only project-specific encourage us to explore collaborative research designs. This paper reports a program of multi-theoretic classroom research. Multi-theoretic designs offer less partial accounts of classroom practice, highlight the circular amplification of privileged constructs, facilitate the reflexive interrogation of selected theories, and optimally anticipate the critical synthesis of the interpretive accounts generated by each analysis of the same setting. Research-based advocacy of any particular instructional action is contingent on the chosen theory/ies. In this research program, multi-camera on-site video technology and post-lesson video stimulated interviews were used in a purposefully inclusive research design to generate a complex data set amenable to parallel analyses from several complementary theoretical perspectives. Even well-constructed mono-theoretic research studies present an inevitably partial account of a setting as complex as the science classroom: privileging some aspects and ignoring others. Theoretically-inclusive (critical) research synthesis attempts to reduce this partiality by the juxtaposition of theoretically-situated descriptions and explanations. This paper will demonstrate how critical research synthesis can highlight discrepancy and agreement, voice and silence, inclusion and omission, and help us to set bounds on our aspirations in using theory.

A frame for linking values and scientific literacy

Friday, 4.00pm – Room 1

Rebecca Cooper & Deborah Corrigan
Monash University

Over the past two years we have been working with six expert science teachers who work in secondary schools in Victoria and Queensland, Australia and teach both senior secondary (biology, chemistry and physics) and middle secondary science classes. Our explorations of their practice have revolved around their notions of scientific literacy and the interplay this has with the values of science they promote through their teaching practice.

This research work has resulted in the development of a frame for the values that underpin scientific literacy that we have and will continue to use with science teachers. This paper will present this frame as well as some data in the form of a case study. This case study is representational of how teachers' own conceptions of scientific literacy can be challenged and restructured to promote the development of scientific literacy in their students.

This frame is central to this research and will be explored more broadly with science teachers across Australia. In applying this frame it will be essential to articulate how this frame supports the science learning of worth highlighted in the National Curriculum.

Using mind mapping in teaching Immunology: Enhancing student engagement and linkage of scientific knowledge

Friday, 2.15pm – Room 6

Maurizio Costabile & Susanna Carter
University of South Australia

This project examined the effect of introducing mind maps as a new tool to facilitate the learning of Immunology N201. Students were introduced to the technique of mind mapping, its structure and during a practical session, how mind maps could be used as a study aid. During lectures, connections between key concepts in related lectures were highlighted. During tutorials the instructor would produce a mind map highlighting key concepts. This allowed students to identify important points as well as being able to compare to their own version. For an assessment item, students prepared a "master" mind map of 10 lectures. At the end of the semester focus groups were held to identify students' reactions to the use of mind maps, their implementation and usefulness. Our results indicated that students enjoyed the process but found the mind maps difficult to prepare. This was especially true for the master mind map where there was too much information to be easily portrayed. We have now changed the focus of the master mind map from a series of lectures to a single concept where the students can now include information from different lectures. This approach has been much more successful.

The journeys of pre-service primary teachers in learning how to teach science: A longitudinal case study

Saturday, 9.45am – Room 3

Melinda Cross
Charles Sturt University

This paper reports the qualitative research outcomes of a BEd Honours investigation conducted in 2010 into a first year science and technology subject designed for primary pre-service teachers based at a rural university. The subject employed a problem-based-learning approach involving deeply drilled cooperative learning to develop students' pedagogical content knowledge. While the overall study examined the impact that the subject had on their sense of personal science teaching efficacy and outcome expectancy beliefs (using STEBI-B), the qualitative component probed students' reactions at a much deeper level. These reactions provided deep insights into participants' thoughts concerning their experiences and painted a picture of their sense of emerging competence and confidence as they overcame the challenges they faced when their Personal Efficacy was deeply threatened by the educational design. Longitudinal syntactical analyses of the two qualitative instruments, a Harvard 1-minute paper and interviews, using Leximancer, were used to probe the findings from the STEBI-B instrument in an attempt to understand better the pre-service teachers' changing thoughts and feelings about science, and reactions to the subject. Interestingly, the analyses also revealed a marked increase in the complexity of students' educational discourse and professional pattern language.

Students' perceptions of secondary school science and their knowledge outcomes: Preliminary results from the Space to Grow Project

Saturday, 9.00am – Room 7

Lena Danaia
Charles Sturt University

This paper reports preliminary findings from the ARC Linkage project Space to Grow: The Faulkes Telescopes and improving science engagement in schools. The educational research that underpins this project is designed to investigate students' perceptions of, and engagement in, science at school and their knowledge outcomes related to astronomy both before and after their involvement with the Space to Grow project. Pre/post-intervention questionnaire data are also being collected from teachers.

The project involves Year 9-12 students from three educational sectors accessing the Faulkes Telescopes to conduct real, inquiry-based science investigations and supports teachers in implementing science.

This paper reports preliminary findings from the pre-occasion student questionnaires: the Secondary School Science Questionnaire; and an Astronomical Knowledge Questionnaire. To date, questionnaire data have been collected from more than 1400 students. Preliminary findings are consistent with previous research in that students are not engaged by the science they experience at school. Many of them spend most of their time 'copying notes' in science lessons and rarely get to experience the 'practical' nature of science. Furthermore, students appear to lack knowledge and understanding of certain astronomical concepts that are supposed to be covered within the first three years of high school.

Conceptual mediation: Can recent findings shed more light?

Friday, 10.35am – Room 4

Chris Dawson
Adelaide University

Almost two decades ago, we experienced difficulties when several studies aimed at changing students' non-scientific conceptions to scientific ones had limited success. As a result, we developed a strategy, called 'conceptual mediation', which was largely grounded in Piagetian and Lakatosian thinking, and was relatively successful. More recently, various authors' writings about the problem of: conceptual change (e.g. are we really aiming to change students' views?); cognitive processes (e.g. the effects and mechanisms of proactive inhibition); and neurological changes (e.g. fMRI studies of the brain during science learning) to see if they shed more light on why conceptual mediation is often effective. A range of issues, and their relationship to conceptual mediation, will be discussed.

Effective Teaching strategies to promote argumentation skills about socioscientific issues

Friday, 12.45pm – Room 1

Vaille Dawson
Curtin University

The ability to justify and defend a decision using a well-constructed scientific argument is an important outcome of science education. Students need to develop the skills to participate in reasoned debate and to make informed personal choices about socioscientific issues (SSI). Using a mixed methods research design, seven teachers participated in a professional learning experience on argumentation, decision-making and SSI before introducing argumentation skills using SSI to year 9 or 10 students studying genetics. Students who were explicitly taught about argumentation improved significantly more in their argumentation skills and ability to use rational reasoning. Qualitative data sources included classroom observations, lesson transcripts, teacher and student interviews. Modelling of argumentation skills, writing frames and class discussion contributed to an improvement in students' argumentation skills. This presentation will focus on the types of teaching strategies used by teachers that were most likely to promote the development of students' argumentation skills. These strategies included: encouraging ideas and valuing different positions; prompting students for evidence; encouraging critique of evidence and claims: and encouraging reflection on the argumentation process.

Blood, bones and crime: The mass media and students' conceptions of genes and DNA

Thursday, 1.45pm – Room 7

Jenny Donovan & Grady Venville
University of Western Australia

The purpose of this research was to investigate whether Year 5-7 students' conceptions appear to have been influenced by messages about genes and DNA presented in the mass media. The research was conducted during the development of the new Australian Curriculum that first introduces genetics at Year 10. Data were collected from students in three case studies in different locations including an urbanised area, a small town and remote location in three different Australian states. These populations vary in their exposure to the mass media, particularly the absence of certain television channels and consequent programs such as crime shows. Data were collected by survey and in-depth interview and analysed quantitatively and qualitatively. Results show that students vary greatly in their overall exposure levels to the mass media and in the quality and quantity of understandings about genes and DNA. The influence of the mass media on students' conceptions and misconceptions was conspicuous in the data. Whether more media has a positive or negative influence on students' conceptions, however, remains ambiguous. The results support vigorous debate about the time of inclusion of genetics in the National Curriculum.

How are science teachers being selected in South Australia?

Friday, 9.30am – Room 7

John Drew
University of Adelaide

New teachers being recruited by the South Australian Department of Education and Children's Services (DECS) can only be selected by DECS staff formally trained and accredited in Merit Selection processes organised jointly through industrial agreement with the Australian Education Union (AEU). A vignette scenario study inquired into the beliefs and attitudes of Merit Selection trained staff regarding the relative importance of curriculum specific tertiary qualifications and pedagogical experience for potential science teacher applicants. This was conducted as a small scale non-representative pilot study to test the efficacy of applying vignette scenario methods in a formal education training situation to overcome normative self-censorship of respondents.

Ordinal analysis of the pilot study data identified a strong positive association between the level of academic qualifications held by Merit Selection trained staff and the likelihood of them favourably selecting specifically qualified science teacher applicants. Thematic analysis of the pilot study data identified a strong preference for selecting applicants demonstrating extensive teaching experience with minimal science qualifications to the exclusion of specifically qualified science graduates with limited teaching experience for science curriculum specific teaching vacancies. The identification of these associations has generated further inquiry on a statistically significant scale for a PhD study.

Science by Doing: Impact at the 'Chalk face'

Thursday, 10.35am – Room 4

Amelia Druhan[1] & Léonie Rennie[2]
[1]Australian Academy of Science, [2]Curtin University

The *Science by Doing* Stage One project is a national initiative for the improvement of secondary science education. It is managed by the Australian Academy of Science and funded by the Australian Government. The project is built around a professional learning approach (PLA) that focuses on the development of a professional learning community (PLC) within a school science department. The PLA is well-resourced through workshops, professional learning resources and curriculum resources.

An independent evaluation of the PLA was conducted during trialling in 2010. A mixed method design was used to collect both qualitative and quantitative data from school staff. Data collection included surveys, interviews with teachers, coordinators and principals, and field notes made during site visits.

One significant finding of the evaluation was that the school context was a powerful factor affecting the implementation of *Science by Doing*. In this paper we will present several case studies that illustrate how different kinds of school contexts impacted on implementation and how the *Science by Doing* PLA and resources supported the formation of a PLC in each.

Exploring learners' understandings of nature of scientific inquiry (NOSI): The validation of a research instrument

Saturday, 10.45am – Room 1

Washington T. Dudu
University of the Witwatersrand

Commitments to inquiry and to laboratory investigation have become hallmarks of science education around the world. South Africa has also moved towards inquiry learning in secondary school science. This is attested to by its new science curriculum which advocates the promotion of both inquiry learning and teaching. This paper discusses the adaptation and validation of one research instrument, on understanding of the nature of scientific inquiry (NOSI) based on data collected from South African Grade 11 learners. The Learners' Understanding of Science and Scientific Inquiry (LUSSI) instrument blends Likert-type items and related open-ended questions to assess how learners' understanding about how scientific knowledge develops. The combined quantitative and qualitative methods enhance the sensitivity of the instrument for detecting varied learners' NOSI views and related-content with increased confidence. Comparison of correlation scores revealed that five of the six NOSI aspects correlate substantially with the total sum of all the constructs. Analysis revealed that learners demonstrated the most confusions and misunderstandings in the laws versus theories aspect of the NOSI. A substantial number of learners demonstrated transitional views that were a combination of both naïve and informed understandings in the other five NOSI aspects.

The Challenge of Generic Competences to Science Education

Friday, 9.30am – Room 1

Peter Fensham
Queensland University of Technology/Monash University

Since 2000 there has been pressure from employers for students to become more competent and more confident about a number of competences that are described as generic. This pressure stems from the changing nature of work in the Knowledge Society that is now so dominant. The DeSeCo project identified a number of these competences, and listed them under the headings of *communicative, analytical* and *personal*. They include *thinking, creativity, communication skills, knowing how to learn, working in teams, adapting to change, and problem solving.*

These competences, as whole, pose substantial challenges to the way in which education in science has been conceived. Their importance has, however, been identified explicitly in the various curriculum statements that have recently been developed in Australia and New Zealand. The paper will review how these curriculum documents have tried to relate what is essentially the teaching and learning of very specific subject content to these competences. It will be suggested that a more radical shift from the emphasis on content knowledge to a more procedural view of science will be needed if this challenge to STEM education is to be successful.

Factors Affecting Indonesian Student Achievement in Science

Friday, 3.20pm – Room 4

Fitriati, Elizar & I Gusti Ngurah Darmawan
University of Adelaide

The purpose of this study was to identify potential factors influencing science achievement of Indonesian students and to examine inter-relationships among these factors using the 2006 PISA Student Background Questionnaire data (48 items). Based on previous studies, 7 factors were identified which included gender, home background, science values, instrumental motivation, self-efficacy, self-concept and career motivation. The results show that gender, home background, learning motivation and self-concept directly affects science achievement. Learning motivation and self-concept directly affects career motivation. Home background, learning motivation and gender directly affect self-concept. Home background and gender directly affects learning motivation. One important finding that emerged from this study was that the students' judgment of their capability (self-concept) to do a science task was found to be the strongest factor influencing science performance. In short, students' self-concept, learning motivation, home background and gender factors have significant effects on Indonesian students' achievement in science. However, the analyses showed that career motivation was insignificant with regard to science achievement with a p value of 0.22. The findings of the present study are important for the Indonesian educational system, especially for designing educational interventions to improve students' science achievement. Schools need to support students to develop good self-concepts and a high level of motivation to learn science.

The Four-Fold Root of "Sufficient" Professional Development in a Large-Scale Astronomy Inquiry Initiative

Thursday, 1.00pm – Room 4

Michael Fitzgerald
Macquarie University

In this talk I will outline the hidden dangers of pro-innovation bias, errors due to lack of planning for scalability, the fundamental necessities of evaluation and other such planning fallacies that spontaneously arise from naivety in top-down innovation implementation models. These concepts will be presented from the real-life context of the Space to Grow initiative including insights from deep interviews with teachers involved (and not involved) with the project. The new approach towards teacher involvement and training in this project that deals with these issues, is based on the Diffusion of Innovations model and its four key elements, Innovation, Communication, Time and Sociology will be outlined.

The generation of a new scientific self-awareness through "Slowmation" (Student-generated Animations) in early childhood education

Friday, 11.15am – Room 2

Marilyn Fleer[1] & Garry Hoban[2]
[1]Monash University, [2]University of Wollongong

Vygotsky (1987) argued that, 'The internal motives that move the child forward in the formation of scientific concepts are completely different … to the formation of spontaneous concepts' (p. 178). That is, everyday concepts and scientific concepts 'have a different relationship to a child's experience', even though they are dialectically related. This perspective is fundamentally different to the claim that children's alternative views must be challenged and replaced. How scientific concepts become conscious to young children in everyday life is an important direction in research. We draw upon Slowmation (or "Slow Animation") as a simplified way for both children and student teachers to make a stop-motion animation to explain a science concept (played at 2 frames/second creating a slow-moving image that they narrate), in order to make scientific concepts conscious. In this session we will present the outcomes of two related studies, which used video observations to document how scientific concepts become conscious to children and student teachers as they collectively constructed Slowmation creations. We draw upon two different theoretical perspectives to explain how Slowmation generates a new scientific self-awareness. We argue that Slowmation provides a mediating context in which a system of interdependent concepts can be held constant, whilst the relations between a particular everyday concept and scientific concept can be interrogated through action and thought.

Knowing and learning about science – primary students developing "scientific intuition" through interactions with professional scientists: The scientists' view.

Thursday, 4.15pm – Room 3

Anne Forbes & Keith Skamp
Southern Cross University

This paper describes the ongoing journey of six professional scientists (astronomers) who participated as scientist mentors in a primary school community as it navigated its way from an emerging to a developing 'community of practice' around the notion of 'investigating scientifically'. The aim of this study was to 'understand' the meanings that the participants attached to their involvement in a primary science initiative called *MyScience.* Their views were determined, in part, by using attributes associated with 'communities of practice' (CoP) and the 'nature of science' (NOS) as interpretive lenses.

Mentor interviews about their lived experiences of *MyScience* participation were deductively and inductively analysed using *NVivo®* software to collate and categorise findings, which are presented as six assertions. Summative findings include: a *MyScience* CoP was formed; mentors achieved a sense of agency through their involvement; students showed increasing awareness of the nature of science *because* of mentor-student interactions; and that the *MyScience* educational model influences the development of the community of practice both through affordances (bringing people with science expertise into the classroom and a guiding framework) and through barriers (teachers having too much work to do; teachers not sufficiently preparing or following up students before, during, and after mentor visits; and mentor anxiety about interacting with primary students during the school visits).

A tale of discovery of EfSD principles in Science Education Research

Thursday, 3.35pm – Room 6

Margaret Freestone
Newcastle University

Education for Sustainable Development empowers individuals and communities to live more sustainably by encouraging alternative learning strategies. The literature I have reviewed indicates that lifelong learning through reading fiction may result in transformative change, encourage critical and systems thinking and promote a positive vision for the future.

As it is widely recognised that knowledge alone is not enough to ensure change, the significance of learning through fiction may be that individuals who normally ignore or filter environmental information are influenced by fictional presentation that may bypass existing conceptual filters.

My on-going study involves a survey and then interviews of current Environmental Educators to ascertain the influence of any genre or type of literature on their life choices. This presentation will synthesise the literature dealing with reading and change from a framework provided by the principles of Education for Sustainable Development that were intended to undergird the UN decade within which we find ourselves.

"Physics as a Culture" as a framework for development teaching materials

Thursday, 9.30am – Room 4

Igal Galili
The Hebrew University of Jerusalem/University of Sydney

Our physics education research group has recently participated in the European project HIPST (History and Philosophy in Science Teaching). We have developed several teaching modules in the format of historical excurse in which several central concepts of physics learned in high school were addressed. This new format adopts the previously introduced (by us) discipline-culture structure for presentation of physical theories (Tseitlin & Galili, 2005). In the latter, the disciplinary contents (principles and applications) were accompanied by the alternative ideas (periphery) which contrasted the correct conceptions. The presented conceptual consolidation of modern theories included historical predecessors of modern scientific concepts which often coincide with misconceptions observed in contemporary students. The excurses explicitly elaborated ontological and epistemological changes that took place in the course of the history. After the modules were initially constructed we discussed their contents in a series of workshops provided to in-service and pre-service physics teachers. Their comments and reflections guided our revision, extending the modules from historical cases to excurses, adding questions and activities. I will briefly present the modules and the comments of the teachers. In short, although the modules met high interest, the teachers mentioned the need for special preparation to cover their lack of knowledge of the history and philosophy of science usually not included in teacher training programs.

Thinking Skills in Science Education: Back to the Future?

Friday, 8.45am – Room 5
(Double Session with Ally Bull and Chris Joyce)

Jane Gilbert
New Zealand Council for Educational Research

There is currently strong pressure for change in school science education from a number of different areas, all broadly related to various 21st century developments.

The official curriculum response in many countries has been to talk up the development of "thinking skills" in science. While this is widely seen as an attempt to meet "21st century" needs, cognitive/intellectual development has long been a key aim of school science education. However, this aim hasn't always been well understood by many of the key players. There are a great many reasons for this, many of which are also likely to limit the influence of the current emphasis on thinking skills. One of these reasons has to do with people's understanding of the *purposes* of science education.

This paper will review findings from several recent NZCER projects that have looked at teachers' views of the purpose of science education and education in general, both now and in the future. It will argue that there is a need for debate – and ideally a new consensus – around the question of what exactly it is that we want school science education to achieve – now and in the future.

"Just because I enjoy it doesn't mean I learn": Science teachers' perceptions about students' interest in science

Friday, 10.35am – Room 6

Judith Gomes[1] & Pamela Mulhall[2]
[1]Monash University, [2]Melbourne University

Recent studies have shown post-secondary enrolment in science is declining and is a global issue. These studies have indicated that students' dissatisfaction with school science is also a common phenomenon in most countries. Concerned with such a scenario, this research has explored science teachers' perceptions of their students' interest in school science. The study assumed that science teachers develop knowledge about their learners through their teaching experience and that this impacts on their science teaching and ultimately on the apparently common global phenomenon of declining enrolment. In particular, this study examined teachers' perceptions about their students' likes and dislikes of science topics and about teaching-learning activities that engage their students. A craft knowledge perspective using a multiple case study approach was used to explore the issue. The present study identified that the teachers had uninformed views of their students' likes and dislikes regarding science topics and pedagogical approaches. In particular, findings from this study show that teachers' strong content knowledge background was often insufficient in terms of capturing students' interest that indicates teachers' lack of awareness of engaging pedagogy. These findings suggest that teacher education programmes should consider students as important sources of teacher knowledge that can inform the development of engaging pedagogy.

A framework for engaging Indigenous students with science through storytelling

Saturday, 11.25am – Room 5

Mzamose Gondwe & Nancy Longnecker
University of Western Australia

Indigenous students have low enrolment and poor performance in science subjects. Factors that lead to their disengagement with science education are inappropriate teaching methods, different learning styles, the nature of the curriculum and different worldviews which create two different cultures, a sub-culture of school learning and a sub-culture of everyday home life. Science educators have conceived the term border crossing to describe how students move between these two worlds and how they deal with the cognitive and contextual differences of these environments.

This project proposes using documented learning preferences of Indigenous students to develop two activities, a science and culture story box and digital storytelling, to help Indigenous students navigate between the two sub-cultures.

The science and culture story box is a storytelling activity to help students recognise and value the confluence between scientific and cultural knowledge from a variety of cultures. It is also designed to encourage open mindedness as well as critical and creative thinking. The digital storytelling is an extension of the story box activity where students will develop their stories into short personal narrative films. These activities will be conducted at the Gravity Discovery Centre, a science enrichment centre in West Australia.

This paper will present the framework for developing these two activities for engaging Indigenous students with science learning.

Reflections on the development of a national curriculum

Thursday, 2.30pm – Room 2

Denis Goodrum
Australian Academy of Science

This paper presents a personal case study of the development of the national science curriculum from its conception to the final document. In doing so the various politics of influence are examined and discussed. Within this discussion the following questions will be examined:

- What were the major events along the curriculum development journey?
- What were the challenges, successes and disappointments?
- What were the factors of influence?
- Within the three areas of education, science and the bureaucracy who were the main players and what was their impact?
- How did science education research impact on the curriculum decisions that were made?
- What can the science education research community learn from this experience so that they can be more effective in the educational decision making processes in the future?

Managing a Discourse of Inquiry in Primary Science

Friday, 12.45pm – Room 6

Mark Hackling & Pru Smith
Edith Cowan Institute for Education Research

Managing classroom discussions that maximise learning through the phases of inquiry in primary science requires a rich repertoire of teacher knowledge and skills. Twelve teachers participated in a professional learning program focussed on building teachers' knowledge, confidence and self-efficacy for managing classroom discourse and using puppets to engage students in discussions. The professional learning intervention was framed using Mortimer and Scott's communicative approaches which were matched to phases of the 5Es inquiry model. Analysis of classroom video and teacher questionnaire and interview data gathered before and after the professional learning intervention provided insights into the impact of the intervention on teachers' beliefs, knowledge and practice and students' engagement in discussion. The teachers developed sophisticated understandings about the role of discussion in supporting learning and made significant gains in confidence and self-efficacy for managing classroom discussions. Following the professional learning intervention, the teachers asked more open questions eliciting students' ideas and explanations, increased the proportion of student talk in discussions and the number of elaborated utterances made by students. Analysis of classroom discussion transcripts revealed the complex array of discourse moves used by teachers to create rich and sustained classroom conversations.

Can the national science curriculum revitalise science education in Australia?

Thursday, 4.15pm – Room 2

Carole Haeusler
University of Southern Queensland

The recent roll out of the F-10 Australian Science Curriculum has achieved a long awaited reform of Education in Australia. The Melbourne declaration on educational goals for young Australians (2008) made a commitment to ensure "world-class curriculum and assessment" which includes science as an essential learning area for all students in the compulsory years of schooling. In recent years, widespread concern has been expressed about the serious decline in student enrolment in the sciences at senior secondary and tertiary levels and the lack of emphasis on science in primary schools. The Australian Science curriculum has the potential to be a significant factor in enabling teachers to deliver quality science education and revitalising school students' interest science .This paper provides a critical review the latest version of the Australian Science Curriculum and its potential role in sustaining science education in Australia. It looks at the integrity of the curriculum and assessment framework, identifies significant weaknesses and suggests ways in which the Australian Science Curriculum can be transformed into quality science education programs in schools.

A Motivational Theory of Development in Science Literacy

Friday, 11.15am – Room 5

Mary Hanrahan
RMIT University

In recent years there has been a strong focus on cognitive factors necessary for the development of science literacy, including both rational and more intuitive ways of thinking and representing in science. This has thrown light on the importance of language and other semiotic systems in teaching and learning in science. However, other theories of literacy theory point out that the development of a literacy also involves crucial socio-emotional conditions and that these need to receive sufficient attention. Although most of these can be assumed to be present for students whose prior experience of science has been positive, even the most basic socio-emotional conditions cannot be assumed to be present for students whose prior experience of science has been as a foreign and alienating discourse. Drawing on cross-disciplinary theories of language and literacy learning, I propose a hierarchy of socio-emotional conditions necessary of the development of science literacy. To demonstrate how these can be and have been addressed in science classrooms, I illustrate the levels in the hierarchy with examples of teaching from middle years and junior secondary classrooms. The hierarchy combines aspects of psychosocial, sociolinguistic and critical science approaches to science literacy.

Exploring the influence of an argumentation professional development program on in-service secondary science teachers' ideas about scientific argumentation

Friday, 3.20pm – Room 8

Debra Heck[1] **& Christine V. McDonald**[2]
[1]University of Sunshine Coast, [2]Griffith University

This paper explores five in-service science teachers' views and understandings of scientific argumentation following their participation in a three day professional development program focussed on scientific argumentation. Data sources included open-ended questionnaires and interviews conducted with participants prior to and following the professional development. This paper will report preliminary results indicating shifts in participants' ideas and understandings about scientific argumentation, and will discuss possible reasons for these changes. An analysis of the strengths and weaknesses of the professional development program will be provided including recommendations for future programs.

Pictorial Metaphors in Typhoon Forecast Charts: An Analysis Based on the Theories of Conceptual Metaphor and Conceptual Blending

Saturday, 9.45am – Room 7

Yao-Chou Ho, Chih-Hsiung Ku
National Dong Hwa University

This paper studied the pictorial metaphors in typhoon forecast charts announced by the Central Weather Bureau. Our analysis was based on the Conceptual Metaphor Theory (Lakoff & Johnson, 1980) and Conceptual Blending Theory (Fauconnier & Turner, 2002). The instruments included a self-development questionnaire "The Pictorial Metaphors Test of Typhoon Forecast Charts" and semi-structured interviews. The questionnaires

were distributed to thirty 3rd grade pupils in Taiwan. Six of them were also interviewed. The conclusions show that metaphors can affect pupils' comprehension of typhoon forecasts charts. We argued that typhoon forecast charts were meaningful, coherent, and helpful to scientific thinking. However, typhoon forecast charts might also result in misconceptions and negative effects. Implications for primary/elementary teachers include promoting pupils' meteorological literacy and placing importance on the critical role of metaphors in the comprehension of science-related typhoon forecast charts.

Flexible and adaptable: An early childhood science resource that acknowledges teachers know best

Thursday, 3.35pm – Room 5

Christine Howitt
University of Western Australia

Planting the Seeds of Science is a new early childhood science resource developed through collaboration between science/engineering academics, early childhood teacher educators and early childhood pre-service teachers. Based on best practice early childhood principles, the resource was designed to allow teachers maximum agency through interpretation of information, flexibility in choice of learning experiences, and adaptability in modifying learning experiences. This approach to curriculum development acknowledges teachers as professionals, and that the teacher best knows their children and interests, the teaching context, the environment, and the outcomes they wish to achieve. This paper outlines the emergent development of the resource, and presents an evaluation through multiple case studies. Five teachers each trialled a different module from the resource. These teachers were then interviewed as to how they used the resource, how it was modified, and what the teachers thought of the resource. Observations were also made in classrooms. All five teachers used the modules in different ways and modified activities to suit their class and context. Common strengths of the resource were: the range of ideas and activities presented, the flexibility to adapt for a given context, the integration across the curriculum, and the ease of use in planning and programming. *Planting the Seeds of Science* has been used in the manner it was intended - as a flexible and adaptable resource – and has contributed to a re-imagined curriculum.

Promoting 6th Graders' Capabilities about Communication through Inquiry-Based Instruction

Thursday, 9.30am – Room 3

Jinmeei Hsieh Kuo & Lihwa Wang
MingDao University

The purpose of this study was to examine the effects on communication abilities through the inquiry-based instruction of 6th graders. Sixty-two 6th graders participated in the quasi-experiment, 30 students in the experiment class with the inquiry-based instruction and 32 students in the comparison class with the traditional teaching. The topic of teaching material related to the concept of electricity and magnetism. All the statements of the 16-hour unit and the teaching strategies based-on inquiry were checked by three expert science educators. The validated instruments included a 25-item achievement test, an 8-item open questions, a 16-item questionnaire of communication capabilities and observation transcription with video recording. The quantitative data with ANCOVA showed that there were significantly differences between the two groups in both science achievement and communication capabilities. It was also appeared that students' science achievement was strongly linked with the communication ability. Additionally, more group discussion, talk and engagement were observed in the experimental class.

The Validation of a Communication Index for Science Education in Taiwan

Friday, 2.15pm – Room 5

Ming-Chin Hsin, Sung-Pei Chien, Ya-Wen Tsao & Tsung-Hau
National Taiwan Normal University

This research was aimed at presenting a framework for a communication index in science education, and at its validation process. Recently, communication has been addressed in many national curricula. The framework of a communication index was developed based on relevant literature and focus group discussion. Literature and national curricula regarding science education and communication were reviewed. Also, after consideration of socio-cultural perspectives, negotiation and argumentation were both pinpointed in the index. A Delphi technique using a questionnaire survey was conducted to collect experts' feedback regarding the index with professors, researchers, and school science teachers contributing their comments. First, the result emphasized the importance of communication in science education. Secondly, the developed framework of the communication index identified three phases including presentation, reaction, and negotiation. Each phase comprised a few indicators fitting the three school stages: elementary, junior and senior high school. The indicators were set for students to achieve at a certain school stage. In summary, this research shed light on communication in education in order to advance students' communication skills in the process of learning science.

Constructing a situated learning environment to improve students' understanding of a sustainable aquatic pond

Friday, 10.35am – Room 2

Chao-Ti Hsiung & Jui-lin Chen
National Taipei University of Education

The purpose of this study is to describe a science teacher using the different facilities as an example of the design and implementation of a sustainable environment-based learning activity. In this more than one-hundred years old school, the case teacher took the decoration-type concrete fish pond and the new eco-type biodiversity pond as the learning situated fields to scaffold the fourth graders (n=27) to distinguish and construct the relevant concepts about aquatic environment. She integrated the flow learning idea suggested by Cornell, and a role-playing strategy, to stimulate students' enthusiasm, attention, sharing, reasoning and reflection. The teacher guided students to inquire into the survival difficulty for water living beings faced today to encourage students' scientific reasoning toward making a decision for proper environmental action. Data were collected by the videotaping, recording, field notes, classroom tests and documents. Findings showed that (1) there was a big change from the students preferring the concrete fish pond to the eco-pond in the beginning, toward the understanding of the value of eco-pond after the situated learning strategy, (2) most of the children changed their worldviews of aquatic environment from a human-centred perspective to an eco-centred perspective. The results showed the impact of situated learning on students' conceptual change.

The Teaching Effectiveness of the CPS integrated with Fun Science Activities

Friday, 12.45pm – Room 8

Liang-Rong Hsu
National Taichung University of Education

The purpose of this study was to explore the teaching effectiveness of the Creative Problem Solving (CPS) model integrated with fun science activities. According to the CPS model, we designed nine lessons on 'static force balance' into which were integrated three fun science activities. This study is conducted in a two-year span. The first year we organized a teachers' team to develop the teaching, and conduct a pilot study that focused on modifying the teaching processes, material and research instruments (conceptual learning and inquiry ability). In the second year, we conducted a quasi-experiment study for the fifth graders. The results are as follows: (1) on the conceptual learning of the experimental group (N=30), the ratio of right answers was improved from 51.0% to 89.6%. (2) The paired-samples T-test indicated there was a significant difference between pre-test and post-test (P< .01), and pre-test and retention-test (P< .01), and no significant difference between post-test and retention-test. (3) On the inquiry ability, the result of ANCOVA (pre-test as co-variable, post-test as dependent variable) indicated the experimental group was significantly higher than the control group (P< .05).

Students' understanding toward the logical relations within the semiotic systems in science texts

Thursday, 11.15am – Room 3

Chung Yi (Brian) Huang, Wen Gin Yang, Shih Wen (Allen) Chen
National Taiwan Normal University

Language and images are two commonly used semiotic systems to represent the logical relations among concepts in science texts, so students need know how to make use of these systems for a good understanding of them. Therefore, language and images play an important role in students' understanding of these relations. This study analysed the logical relations of concepts in the two semiotic systems of science texts, and explored students' understanding on them by the data collection of questionnaires from 30 participants. The findings were as follows: firstly, different hierarchies of relations among science concepts were usually embedded within the semiotic systems; secondly, students showed a better understanding in a dual-level hierarchy than in a single-level one, which might result from the ambiguous description of logical relations in the semiotic system. This research suggested that the semiotic systems of language and images should be represented clearly and accurately to enable students' good understanding and reasoning on the logical relations within science texts.

Exploring EEG activity in a Chemistry-Related Working Memory Task

Thursday, 4.15pm – Room 1

Li-Yu Huang, H. C. She, W. C. Chou & M.H. Chuang
National Chiao Tung University, Taiwan

This study explored the brain activity involved during the encoding process of chemistry-related concepts in a working memory task. Subjects were presented with concepts in three categories – concrete word, concrete picture and abstract word. Results showed there was no significant difference in reaction time across the three

categories and the accuracy of responses was higher than eighty percent for all three categories. Results of time-frequency analysis indicated obvious hemispheric encoding and response asymmetry effect. The theta power showed greater left-frontal hemisphere activation during encoding and greater right-frontal hemisphere activation during response across the three categories. The theta synchronization preceded alpha desynchronization during encoding in the frontal midline cluster, indicating attention-guided cognitive processing. The theta synchronization in conjunction with alpha desynchronization in the frontal midline cluster indicated cognitive load during response. A long period of alpha synchronization followed desynchronization during response in left-frontal and frontal midline clusters, showing mental inactivity and relaxation. The theta power increase in the frontal midline cluster showed greater cognitive control for the abstract word and the concrete word categories than for the concrete picture category. This study showed how the working memory works while students are involved in the encoding process of chemistry-related concepts in different presentations and suggests that teachers could present concrete concepts with pictures in order to reduce students' cognitive load.

Promoting the Science Learning, Interest and Concept Understanding of Students with Hard of Hearing or Deaf in an Elementary School

Thursday, 1.45pm – Room 5

Yu-Chih Huang[1] & Jeng-Fung Hung[2]
[1]National Pingtung University of Education, [2]National Kaohsiung Normal University

The purpose of this study is to provide a science learning environment which promotes science learning, interest and concept understanding of students hard of hearing or deaf. We designed eight science games which took into account participants' prior knowledge and provided the opportunities for inquiry and visual learning using oral and sign language. The students used a checklist to record their hand-on conclusions and tried to explain them. Teachers illustrated and clarified students' explanations immediately, and helped them to learn the science conceptions. Four elementary school students and two teachers participated in this case study with the research lasting three months. The students were third, fourth, and two sixth graders. The students mainly used oral and sign language for communicating because of being hard of hearing or deaf, and they all wore a deaf aid. Our data collection included classroom video, recording, and interviews. The results revealed the four students had a high learning interest for hand-on science games, especially for exploring. During the hand-on processes, they could perform the science phenomenon, and observe the pattern from the phenomenon. Furthermore, we found the language ability was a more important factor for learning conceptions than grade.

A professional learning program based on a representation intensive pedagogical approach

Friday, 8.45am – Room 3

Peter Hubber & Gail Chittleborough
Deakin University

A representation-intensive pedagogical approach challenges students to generate and negotiate the representations (text, graphs, models, diagrams) that constitute the discursive practices of science, rather than focusing on the text-based, definitional versions of concepts. Previous research conducted on a small scale with a few topics and teachers successfully demonstrated enhanced outcomes for students, in terms of sustained engagement with ideas, and quality learning, and for teachers' enhanced pedagogical knowledge,

and epistemological understanding. This paper explores the efficacy of embedding a representations-intensive pedagogical approach into a state-wide professional learning program that was delivered to Victorian secondary science teachers in 2010/2011. The professional learning program involved participating teachers undertaking two successive days of professional development, then completing a small classroom-based project in their schools before returning for the third day of professional development. The program was supported by online drupal website. In determining the impact of the professional learning program on the teachers' practice data was collected in the form of program participant surveys, presentations of the teachers' classroom-based projects, focus group interviews and phone interviews. Teachers demonstrated the applicability of this pedagogical approach by adapting it to a variety of science topics.

Making Connections with Primary Science Classrooms

Thursday, 10.35am – Room 7

Anne Hume
University of Waikato

Preparing novice primary teachers for teaching in an educational environment where science education has low status, and many teachers have limited science content knowledge and lack the confidence to teach science, is a big challenge for teacher educators. The study investigated the sustained simulation of a primary science classroom programme in an undergraduate science education course to determine the effectiveness of the simulation as a mediational tool for connecting two communities of practice – initial teacher education and expert primary science teaching. The course lecturer and student teachers role-played the expert classroom teacher and primary students (Years 7/8) respectively, using a unit from the *Primary Connections: linking science with literacy* programme, in an attempt to gain insights into teaching and learning primary science through authentic activity that models good practice. This inquiry was conducted within an interpretivist paradigm using a case study approach, an action research design known as *practical action research,* and activity theory to help frame and analyse the data. Findings from the first trial indicate that the simulation was very effective in initiating science pedagogical content knowledge (PCK) development of primary student teachers.

Small talk: Children's everyday 'molecule' ideas

Saturday, 9.45am – Room 6

Cheryl Jakab
University of Melbourne

This paper reports on 6-11yo children's 'sayings and doings' (Harré, 2002) in dialectical-interactive interviews (Hedegaard et al., 2008) designed to explore their awareness and use of cultural molecular artefacts. Our everyday world is populated with an ever increasing range of molecular or nano-world words, symbols, images and games. What do children today say about these artefacts? What are the sources of their everyday ideas? What are children afforded when they are assisted in using molecular tools in early chemical and nano-world thinking?

Tool dependent discursive studies show provision of cultural artefacts can assist and direct developmental thinking in science. Shoultz et al. (2001) describe children's early cosmological reasoning as more sophisticated in the presence of an Earth globe. Early development of the major organising ideas of mathematics and biology (germ theory, cell theory and evolution) are well documented (Siegal, 2009). Young children's use of molecular

artefacts as cognitive tools has not received as much attention to date. Results of this study show that children do express everyday ideas of molecular artefacts and that using these ideas can help young children putting on 'molecular spectacles' (Kind, 2004). An interactive game (ICT) is shown to assist children's progress with meaning making about molecules, atoms and chemical symbols.

How do pre-service teachers learn to teach science? A theory-practice approach using the 5Es Inquiry framework for teaching primary science.

Thursday, 4.15pm – Room 4

Mellita Jones
Australian Catholic University

The 5Es instructional model developed by the Biological Science Curriculum Study in the 1980s (BSCS, 2011) has recently been adopted in Primary Connections materials (Australian Academy of Science, 2009) and in an adapted form, has become the primary instructional model across curriculum areas in Victorian government schools (DEECD, 2007). The growing prevalence of this model requires teacher preparation courses to effectively prepare pre-service teachers to adopt the model in their own practice, especially in their science teaching. The study reported here aimed to develop such ability in primary pre-service teachers in a science education unit. Thirteen pre-service teachers were partnered with practising teachers to plan, implement and reflect on a series of science lessons using the 5Es framework. Pre-service teachers participated in online discussion, expert-facilitated round table discussions, and presented examples of their use of the 5Es once the teaching period concluded. Analysis of these discussions and presentations revealed that the authentic teaching experience, coupled with expert-facilitated discussions provided opportunities for transformational learning to occur. However, the level of transformational learning was limited to the first three of the 5Es components. Factors effecting this limitation are considered alongside recommendations for developing a more holistic working knowledge of the framework.

Thinking with evidence

Friday, 8.45am – Room 5
(Double Session with Jane Gilbert and Ally Bull)

Chris Joyce
New Zealand Council for Educational Research

Aim: This paper is based on data collected from the national standardisation trials of a series of science tests. One aim of the tests was to model assessment in science that focused on thinking.

Significance: The New Zealand Curriculum identifies five key competencies necessary to develop its stated vision of students "who will be confident, connected, actively involved, lifelong learners" (Ministry of Education, 2007, p.7). At the top of the list is the competency "thinking". What is valued by students and teachers is often driven by what is assessed. Therefore, if we say we value thinking we must find ways to assess this.

Method: A three-phase process was followed to construct the tests – developing and piloting the test items, a national item trial to check item suitability and Rasch modeling to develop a common scale, and finally a national standardisation trial of around 2,000 students from each of Years 7-10 to provide normative data.

Results: The trials identified a complex mix of factors that influenced students' thinking competencies. Some specific test items will be used to illustrate the complexities of assessing and analysing students' thinking.

Exploring the Social Interaction and Atmosphere of Small Groups in an Analogy Based Inquiry into Blood Flow in the Heart

Thursday, 1.45pm – Room 2

Eunhee Kang, Shinyoung Lee & Heui-Baik Kim
Seoul National University

This study aims to identify the influence of a unique group atmosphere on peer interaction. We categorized the patterns of social interaction according to the zone of interaction and the task engagement, and identified the group atmosphere by discerning group norms established in each group. Fourteen groups of 4 students in the 8th grade participated in an analogy based inquiry for blood flow in the heart. Students' behaviours and dialogues during group activities were videotaped and recorded. The results show four patterns of social interaction: on task/collective zone, on task/multiple zone, on task/individual zone, on + off task/multiple zone. Group norms allowed us to identify task fulfilment, membership, etiquette, collaboration, and justification. Positive membership, etiquette, and collaboration created a friendly atmosphere. On the other hand, negative or nonresponsive membership and etiquette not only deterred collaboration and interaction between peers, but also impeded task fulfilment and knowledge co-construction in groups.

Pre-Service Science Teachers' Attitudes towards the use of selected ICT tools in Teaching: An Exploratory Study

Saturday, 10.45am – Room 3

Amrit Pal Kaur
University of Adelaide

Research into the field of Information and Communication Technology (ICT) integration in education has indicated that teachers' attitudes towards ICT play crucial role in the use of ICT by them. But there is serious lack of qualitative studies to investigate the ICT related attitudes of the pre-service teachers, particularly science teachers.

This qualitative study was conducted to explore the ICT use related attitudes of pre-service science teachers at the University of Adelaide. Specific aims were to identify the factors leading to these attitudes and to investigate the changes in their attitudes after teaching practice. The research was carried out in two phases i.e., pre- and post-teaching practice. Open-ended questionnaires were used to collect data from self-selected participants, followed by in-depth one-to-one semi-structured interviews of purposefully selected participants in the second phase.

The findings from data analysis, using comparative and open-coding techniques, indicated that overall attitudes of student-teachers were positive. But issues like lack of ICT facilities at schools and lack of ICT related knowledge and skills among student-teachers were emerged. It is recommended that student-teachers should get appropriate training and opportunity to use ICT in educational contexts. Further large-scale research is needed to give suggestions for new policies.

Developing a Pedagogy of Science Teacher Education

Saturday, 10.45am – Room 6

Stephen Keast
Monash University

Articulating and researching my pedagogy of science teacher education (STE) has been an important part of my learning about teaching preservice science teachers (PST). By modelling the practice for PSTs, and encouraging them to do the same, has made it possible for them to articulate their developing pedagogical knowledge (Morine-Dershimer & Kent, 1999). The aim was to make explicit the values that underpin my pedagogical practices in STE so that I have a more informed view of the purposes of teaching of science method within the secondary preservice teaching program. The study has developed over four years using a mixed methods research design that led to a grounded theory framework for analysis, such that knowledge was built-up from the complex description of the classroom (Nicaise & Crane, 1999) and lecturer-student, student-lecturer, lecturer-lecturer and student-student interactions. In 2010, this included a research assistant who attended all classes and the video taping of classes: the video tapes, journals and transcripts of lessons were then analysed for themes. The process has given me a clearer understanding of what values I take to STE and allowed me to work with PST in ways that helps them to better understand their developing pedagogy.

Developing an Operational Model of Inquiry-based Teaching: Teacher Roles and Pedagogies

Thursday, 2.30pm – Room 6

Gillian Kidman
Queensland University of Technology

This paper aims to explore how teachers prepare to teach Australia's National Curriculum: science. One of the unique aspects of this curriculum is the emphasis on practical work and inquiry-based learning. Students build their scientific understanding and investigative skills through scientific inquiry where they make connections between their prior knowledge and with new ideas and evidence – but what role does the teacher play in this? A two-fold rationale drove this research study. First, there was the goal of examining the international literature relating to inquiry classrooms, and to use this literature to form a theoretical operational model. Second, the theoretical operational model was then examined and modified based on actual classroom observations and teacher interviews. Specifically, this study developed (from published literature) and refined (from classroom observations and teacher interviews) an operational model based on teaching and learning via guided and open inquiry-based pedagogies.

The paper explores the following research questions:

1. What was the range of inquiry-based pedagogies employed by the teachers?
2. What were the differences between the teachers in their choice of inquiry-based pedagogies?
3. What was the influence of student age on the choice of inquiry-based pedagogy?

Context-Based Science in the Middle School: Achieving resonance between the real-world field and the field of formal science knowledge

Saturday, 9am – Room 2

Donna King
Queensland University of Technology

In Australia, there is a crisis in science education with students becoming disengaged with canonical science in the middle years of schooling. One recent initiative that aims to improve student interest and motivation without diminishing conceptual understanding is the context-based approach. Contextual units that connect the canonical science with the students' real world of their local community have been used in the senior years but are new in the middle years. This ethnographic study explored the learning transactions that occurred in one 9th grade science class studying an Environmental Science unit for 11 weeks. Data were derived from field notes, audio and video recorded conversations, interviews, student journals and classroom documents with a particular focus on two selected groups of students. This paper presents an outline of the program and discussion of the two assertions derived from the preliminary analysis of the data. Firstly, the teacher designed an integrated, coherent sequence of learning experiences that included weekly visits to the local creek where content was taught primarily in response to students' "need-to-know"; secondly, the structure of student-student and student-teacher interactions afforded opportunities for resonance or the blending of the canonical science with the context. Furthermore, in these activities evidence from student conversations showed that the students populated the classroom and real-world fields simultaneously. Research, teaching and policy implications of these results for promoting context-based science teaching are discussed.

Being Reflective Science Teachers through Collaboration, Dialogue and Critical Reflexivity

Friday, 8.45am – Room 4

Rekha Koul, Yuli Ramhawati & Darrell Fisher
Curtain University

The paper is a part of the results of a longitudinal study which aims to investigate the effectiveness of co-teaching and co-generative dialogue, in lower secondary science classes in Western Australia. Co-teaching and co-generative dialogue involves the process of collaboration, dialogue, and critical reflexivity which develops the reflective science teachers. In this research, case studies were conducted in three year nine science classrooms from three different high schools. Manifold research methods (interview, observations, reflective journals, and questionnaires) were used to develop an in-depth understanding of teaching transformation. The science teachers, the researchers/co-teacher, and the students collaboratively engaged in the process of improving teaching practices through co-teaching and co-generative dialogue. The proposed practice was implemented in classrooms of diverse cultures which provided different teaching transforming processes in science classrooms. The teachers learnt to develop the collaborations and dialogue with the researchers/co-teacher and students and reflect critically in their practices. As a result, in this study, the process of collaboration, dialogue, and critical reflexivity within co-teaching and co-generative dialogue helped the science teachers to develop their teaching beliefs, pedagogical practices, and improved teaching behaviours.

The Factors affecting Grade 10 students' conceptual change about the Atomic Model

Thursday, 1.45pm – Room 5

Anusit Kueakool & Pattamaporn Pimthong
Khon Kaen University

There are many factors which influence students' conceptual change, for example the learning environment, and other social and contextual factors. This research presents the factors affecting Grade 10 students' conceptual change about the atomic model. The participants are 46 students from an extra-large size high school who are studying the Atomic Model. The data were collected by survey, semi-structured interview, classroom observations and document analysis. The results found that the main obstruction to students' conceptual change is students' epistemological belief. Most students believed that the Atomic Model does not exist. Moreover, the students did believe what the Atomic Model is based on their teacher's explanations or the scientists. Furthermore, it has been found that both social factors and classroom environment influence students' conceptual change.

Employing Meta-cognitive Reading Strategies to Enhance Solving Abilities on Math-Word Problems for 4th Grade New Inhabitant Students

Thursday, 9.30am – Room 6

Chu-Hsun Kuo[1], Yichan Lin[2] Shueyung Wang[3] & Mei-Chen Kuo[4]
[1]MingDao University, [2]Chengkung Elementary School, [3]Fuchur Elementary School, [4]National Taichung Agricultural Senior High School

The aim of this study was to discover whether using the Meta-Cognitive Reading Strategy (MCRS) for 4th grade new inhabitant students improved their reading comprehension and mathematics word problem solving abilities. The study employed a quasi-experimental design method to gather the research data. The study target group was 4th grade new inhabitant students in an elementary school in central Taiwan. A total of 43 students participated in this study. Among them, 22 students were assigned to the experimental group and 21 students are assigned to the control group. The MCRS group was taught with the meta-cognitive reading strategy, while the control group was instructed with traditional lecturing. The MCRS curriculum was arranged for a 16-week track with a 40-minute teaching per week design. While teaching the experimental group, the study used a reciprocal teaching method to enhance students' meta-cognitive reading strategies. The findings of the study were as follows:

New inhabitant 4th grade students' reading comprehension abilities were improved slightly after completing the MCRS experimental instruction.

New inhabitant 4th grade students' mathematics word problems solving abilities are improved significantly after completing the MCRS experimental instruction.

The Formation of a Learning Community: Patterns of a Social Network in an Elementary Science Online Forum

Saturday, 11.25am – Room 6

Pi-Chu Kuo
National Pingtung University of Education

Social negotiation is one of the important processes during the construction of scientific knowledge. Based on the principle of social constructivism, peer interaction should be an emphasis in a student-centred learning environment. The aim of this study was to reveal the patterns of peer, as well as teacher-student, interactions during the early stage of formulating an online science learning community. The participants of this study were 73 upper elementary students and their science teachers from three schools. The researcher also joined the online discussion when needed to provide prompts and encourage brain-storming. The interactions were determined by coding the 3 months of discussion log including 62 posts and 2741 replies based on the frequency, direction and target of replying. Social network analysis was used to analyse the data using UCINET 6.289. According to the sociograms resulting from social network analysis, the patterns of interactions were different among the first, second, and third phases, indicating that more and more peer interactions replaced parts of teacher-student interaction, and the network was getting solid in the online learning community.

How high school students use knowledge to make decisions on global warming: An intervention study in two London high schools

Saturday, 9.00am – Room 6

Premnadh Kurup[1] & Ralph Levinson[2]
[1]La Trobe University, [2]University of London

Research demonstrates that students find it difficult to use scientific knowledge and reasoning in making decisions about socio-scientific issues unless specifically supported to do so. Decision-making on complex environmental and political issues such as global warming require people to make sense, and take account, of appropriate scientific knowledge.

This study, conducted at two high schools in 2010 in London among students aged 13-14 years old, diagnosed students' reasoning patterns and how they link scientific knowledge regarding global warming and the greenhouse effect, in their decision-making. The students were provided with a professional learning intervention to enhance their knowledge and confidence to make decisions about global warming. Questionnaires and focus group interviews were used to evaluate the impact of the intervention. The students were provided with scenarios and specific role responsibilities to argue in groups and arrive at a decision based on evidence projected in their group in a class forum. The data revealed that the intervention had enhanced both their knowledge base and their readiness to take responsible decisions about issues associated with global warming using this knowledge.

Construction of Scientific Models and Elements Characterising Collaborative Models in a Group Learning Environment

Thursday, 9.30am – Room 5

Shinyoung Lee, Eunhee Kang & Heui-Baik Kim
Seoul National University

The purpose of this study was to examine the collaborative construction of a scientific model and elements within the learning environment of small groups. Group discussion was facilitated by using triggering questions participants could answer based on their experiences of hands-on activities. An analysis of the groups' discourses revealed that almost all groups understood the importance of valves in the one-way movement of blood through the heart. Despite participating in the same activities, the groups showed different patterns of developing collaborative models of the following categories: persuasive, elaborated, and dialectic. The persuasive form of the collaborative model was developed in a group where the leader maintained an authoritative voice. On the other hand, the elaborated and dialectic categories were developed in a group where an inclusive leader encouraged participants to present their own ideas. As a result, a student's initial idea was elaborated as other ideas were added; or it was transformed into a dialectic form of collaborative model, which included emergent properties of the blood-flow system. In addition to the leader's style, the group ethos and teacher's intervention influenced the pattern of collaborative model construction through socio-cognitive interactions.

Relationships between Students' Learning Approaches, Views of the Nature of Science, and Performances in Online Discussions

Friday, 10.35am – Room 8

Silvia Wen-Yu Lee
National Changhua University of Education

The main purpose of this study was to understand the potential relationships between college students' approaches to learning biology, views of the nature of science, and the number of online postings in asynchronous discussions. This study was conducted in a college level introductory biology class in Taiwan. The research instruments included two sets of surveys: the Approaches to Learning Science Questionnaire, and the views of Nature of Science (NOS) Questionnaire. The online postings from seven weeks of discussions were coded into three major categories: initiation, simple response, and response with evidence. The results showed, first, the numbers of initiation postings were positively correlated to deep motives and deep strategies for learning biology; however, the numbers of initiation postings were negatively correlated to surface strategies. Secondly, we found positive correlations between deep learning strategies and deep learning motives with the *development* construct in NOS, but negative correlation between surface strategies and *development*. Finally, students' deep strategies and deep motives were negatively correlated to the *certainty* construct of NOS, while on the contrary surface strategies and surface motives were positively correlated to *certainty*. We discussed pedagogical implications for teaching biology through online discussions and integrating NOS into biology learning.

A Study of the Influence of Teacher Questioning on Students' Scientific Reasoning

Friday, 1.30pm – Room 4

Tsai-Feng Lee & Chao-Ti Hsiung
National Taipei University of Education

The purpose of this study is to investigate the influence of teachers' types of questioning on the performance of students' scientific reasoning. The case teacher taught one fourth-grade class (n=26) focusing on the topic of "aquatic family" (including plants, animals and environment). Data were collected by classroom observation records, videotaping, recording, and target students' interviews. Results revealed that (1) Firstly, most categories of teacher's questioning were memory, understanding and analysis (nearly 76%), then applicability (14%), with the least on evaluation and creativity (9%). (2) Secondly, the performance of scientific reasoning of the pupils tended to be analytic plus dialogue (80%), inference (10%), analogy, evaluation and integration (5% ~ 3% respectively). Meanwhile, the teacher's questioning relating to memory and understanding could allow the pupils more analytical reasoning, and the teacher's questioning relating to application and analysis could allow the pupils to use more dialogical reasoning. The possible factors affecting the teacher's questioning and the performance of scientific reasoning of the pupils were: teaching environment and instructional materials, as well as calibre of teacher. These results suggest that teacher's types of questioning may have a link to future students' scientific reasoning.

Developing and Validating a Science Activity-based Learning Environment (SALE) Instrument for the High Scope Program in Taiwan

Friday, 12.45pm – Room 5
(Joint Session with other presenters)

Chung-Yen Lin, Chun-Yen Chang, Hsieh-Hai Fu & Sheng-Ting Huang
National Taiwan Normal University

Our study proposes an investigation into the effects of a new curriculum on students' learning; for research purposes, the reformed-based High Scope science curriculum was experimentally implemented into 8 regular science classes. A learning environment instrument named Science Activity-based Learning Environment Instrument (SALE) was therefore developed in order to examine high school students' perceptions of innovative science classrooms. The questionnaire consisted of two subscales: student-centred and teacher-centred learning environments. Preferred as well as actually perceived outcomes of both teachers and students were surveyed. Participants included 134 10th grade students and 128 11th grade students. These participants were enrolled in eight science classes taught by two different teachers. The instrument was found to be a reliable and valid measurement for assessing an activity-based science learning environment. There was a noticeable gap between students' preferred and perceived learning environments on both subscales. However, students' actual perceived learning environment was much more oriented toward teacher-centred settings than towards student-centred situations. The results of the current study shed light on the benefit of inquiry-based teaching as the next step in new curriculum development.

Integration of communication skills for 5E Inquiry Teaching for Ninth-grade students on Circuit unit Learning Effect

Thursday, 9.30am – Room 1

Jang-Long Lin[1], Jun-Yi Chen[2] , Huey-Por Chang[1], Hsiao-Wen Li[1] & Ying-Chi Chang[1]
[1]National Changhua University of Education, [2]National Chiayi University

A quasi experimental design is adopted in this research to explore the pedagogical efficacy of "5E inquiry teaching modules with incorporated communication skills" in the teaching of circuit unit-related courses for ninth-grade students. This research incorporates communication skills into the 5E inquiry teaching modules, targeting students as subjects in a school in central Taiwan. Among four classes that conform to normality in terms of academic performance, two classes are randomly selected, respectively, as the experimental and control groups. Students in the experimental group receive the teaching method of "5E inquiry teaching modules based on incorporated communication skills", while students in the control group use the traditional textbooks, supplemented by experimental teaching demonstration. The students are then required to take the post-tests one week after the teaching. The collected research results include Worksheets, 3C literacy scale, classroom observation record, interviews and achievement pre-test and post-test.

The results show that the pre-test achievement test scores demonstrate that students in the experimental group obtain significantly better academic efficiency in learning circuit unit-related courses than their counterparts in the control group. The qualitative analysis on the 3C literacy scale pre-test and post-test results also demonstrate the efficacy of this teaching modules on improving students' inquiry and communication skills.

What are the Impacts of Dynamic Representations on Students' Answering Behaviour in the Two-tier Test in Electricity?

Friday, 1.30pm – Room 1

Jing-Wen Lin, Yu-Lun Wu & Yen-Ching Lin
Taipei Municipal University of Education

This study adopted two formats of a two-tier test to diagnose sixth-graders' alternative conceptions in electricity. One was a static representation, and the other a dynamic representation. The major purposes of this study are to: (1) explore students' alternative conceptions or knowledge deficiencies; (2) investigate the impacts of dynamic representation to their answering behaviour. Sixty-two students were matched by the score on an achievement test in electricity, and divided into two groups for the representation format. Each participant was individually interviewed using the two-tier test. A confidence rating was also used to indicate the strength of a student's conceptual understanding. This study identified six typical responses, four being robust alternative conceptions in high confidence. In addition, answering behaviour might be changed by a dynamic representation. The confidence of the lower score students is reinforced. It is also shown in the interview data analysis that lower score students might figure out the context of items with the assistance of dynamic representation. In contrast, that higher score students are confused with an inconsistent hint while it is different from their internal representations.

Development of Distributed Leadership in a Professional Learning Community: A Case Study of a Vocational High School. Developing an Innovative Biomass Energy Curriculum in Taiwan

Friday, 10.35am – Room 5

Meng-Yu Lin, Ying-Yi Chen & Wu-Lung Chung
National Miaoli Agricultural and Industrial Vocational High School

During 2008 to 2010, the school where the researchers serve joined a national science education project and developed an innovative biomass energy curriculum. This study aims at investigating the professional learning community formed by 13 teachers involved in the project, especially the process of creating and developing professional leadership through their interaction. Research methods include interviews, focus group discussion and documentary analysis. Data analysis shows that the process of developing the learning community can be divided into two stages. The former one can be described as "Exploration-Planning-Research" and the latter one is "Coordination-Implementation-Development". Some changes can be found between these two stages and they are as follows: (1) Collaboration: The focus of the learning community shifted from an emphasis on achieving the goals of the team to an individual reflection on his/her role in the community. (2) Professional development: In the beginning, the community members relied on the professionals to strengthen their capacity, and gradually they were able to give teaching demonstrations and promote the innovative curriculum. (3) Curriculum Innovation: At first, the teachers managed to follow an inquiry teaching approach closely, and then they found it more important to change students' learning styles in order to enhance their learning results.

Investigating Gender Differences in Scientific Literacy in Media (SLiM)

Saturday, 11.25am – Room 2

Pei-Ling Lin & Chun-Yen Chang
National Taiwan Normal University

Gender difference in scientific literacy and achievement has been an important issue for science education, with many researchers pointing out that gender would be the influential factor of scientific performance. In this study, we focus on the relationship between student's gender and their Scientific Literacy in Media (SLiM) performance. What is the difference in participant's SLiM performance between different genders? Through the analysis of t-tests, a significant difference was found between males and females. To explain the results, we also undertook further analysis to clarify the gender difference in science preference. Our finding indicated males prefer science more than females, and this may provide more chances, and give more motivation, for male understanding of scientific terms in the media. As a result, males may be more familiar with scientific terms than females. This familiarity can explain why males on average have better performances on SLiM than females do.

Controversy between Environmental Protection and Economic Development: Undergraduates' Opinions in Taiwan

Friday, 1.30pm – Room 8

Show-Yu Lin
Aletheia University

In the 21st century, many everyday goods are produced by the petrochemical industry. Currently in Taiwan, as in many developing countries, there is a huge controversy in relation to environmental sustainability and continued economic development, due to the building of a petrochemical plant. Many citizens are concerned about this project. The purpose of this study was to investigate undergraduates' opinions of this plan. Qualitative and quantitative methods were used to analyse participants' responses. In terms of building a local petrochemical plant, most students protested against the idea, and few of them supported the project. Their views focused on the environmental impact: such as air and water pollution; the health risk of local people; conservation of local dolphin pods; wetland reserves, etc. They also addressed Taiwan's continued economic development, that the project would provide people good job opportunities, especially during the period of recession economic. However they suggested that – the economy will develop first then a negative environmental impact will follow – thus highlighting the conflict between environmental protection and economic development. The results of this study may provide a valuable contribution to science curriculum design on social science issues, especially to fostering their love and sustainability of Taiwan, and the Earth in science education.

An Interpretive Examination of High School Biology Teachers' Use of Diagrams

Friday, 9.30am – Room 6

Yang Liu & David F. Treagust
Curtin University

Scientific diagrams are widely used in school science and are critically important in science teaching. This article reports on an interpretive examination of five biology teachers' use of diagrams to teach high school biology. Classroom observations were conducted and data were collected over seven months. Scientific diagrams used in biology teaching were classified as: iconic, schematic, and charts and graphs. Iconic diagrams include photographs and line drawings that depict concrete or real objects; schematic diagrams simplify complex situations with a concise depiction; charts and graphs provide a set of quantitative data. Of interest in this study were those attributes of different diagrams in displaying visual information that was able to convey unambiguous meaning of the biological content knowledge. This research describe: 1) how the three different types of diagrams were selected in teaching a number of secondary biology concepts involved in the human respiratory system and the circulatory system, 2) those characteristics of diagrams which best enabled students' understanding and 3) how diagrams helped teachers explain abstract concepts and led students into in-depth learning. Teachers used iconic diagrams to introduce a new biological topic and develop the biological context for the learners; iconic and schematic diagrams were used interchangeably to facilitate instruction and examine students' learning; teaching with diagrams often involved analogical explanations.

An Interpretive Examination of High School Biology Teachers' Use of Diagrams

Friday, 12.45pm – Room 5
(Joint Session with other presenters)

Yuan-Li Liu & Yueh-Hsia Chang
National Taiwan Normal University

Educational reform in Taiwan has increasingly emphasized the inquiry-based approach of science teaching. This study, as part of the High Scope science curriculum program, aimed at investigating teachers' practices and their conception myths about inquiry-based science teaching. 5 high schools participated in the High Scope science curriculum program, and a total of 20 teachers taught the newly developed Bio-Energy Curriculum Modules developed for this study. Quantitative and qualitative study methods were employed in data collection and analysis, including questionnaires, semi-structural interviews, classroom observations, student learning reflections, and documents analysis. In the preliminary stage of data analysis, reported results were based on data analysed from 4 science teachers along with 160 students in one school. The results showed that the teachers' teaching practice in the program was inclined to the "nested inquiry-based" approach (where first, students acquire related basic concepts and skills under teacher's direct guidance and the students were then engaged in hands-on activities, by themselves, for collecting data and solving problems). The study also found that the teachers felt reluctant about promoting the inquiry-based teaching comprehensively in the current school systems. Three teachers' conceptions about inquiry-based teaching were identified: (1) too much time needed for inquiry activities, (2) excessive time spent for teaching preparation; (3) applicable learning topics were limited.

Development of Pedagogical Content Knowledge for Teaching Nature of Science: Incremental Growth Versus Growth in Perspectives

Friday, 9.30am – Room 4

Man-Sum Lo
The University of Hong Kong

Developing students' understanding of the Nature of Science (NOS) has become an important science curricular goal, hence the imperative to develop teachers' Pedagogical Content Knowledge for teaching NOS (i.e. PCKnos). Yet there is little research in this area. This study attempts to fill the gap by tracing the PCKnos development of ten pre-service teachers in a teacher-training program. As a course requirement, the student teachers were required to make progressive commentaries on two videos of NOS teaching in authentic classroom situations at different stages (on entry, in the middle and at the end) of the program. These progressive comments represent the PCKnos possessed by the student teachers at different stages of the program. They were validated and clarified in follow-up interviews where factors contributing to PCKnos development were also probed. Results indicate that there were two types of PCKnos development: Incremental Growth and Growth in Perspectives. The former involves addition of bits and pieces of knowledge along the same perspective, but the latter involves a change in perspective (e.g. from teacher-centred to student-centred). In the paper, representative narrative vignettes of PCKnos development will be used to illustrate the two different types of PCKnos development and the contributing factors involved.

Attitudes, interest, motivation and student engagement: Exploring the connection between these constructs in the context of science education

Friday, 1.30pm – Room 7

Marianne Logan
Southern Cross University

There has been an urgent call for educators to 're-think' the way science is presented in schools (Holbrook, 2007; Tytler, 2007) and there has been little change in this presentation over the decades, particularly in secondary schools despite the strong drive for pedagogical reform in a number of countries (Wilson, Taylor, Kowalski & Carlson, 2010). In many Australian schools traditional teacher-centred lessons are presented, where students have little input into theory lessons or direction of practical lessons and science lessons often lack relevance to the lives of students (Goodrum et al, 2001). This style of science is unlikely to lead to sustained interest in, a positive attitude to, motivation towards, or engagement in, science for students in the 21st Century. This paper examines the literature relating to the constructs: attitude, interest, motivation, and student engagement. Although quite separate, the literature also reveals much overlap between these constructs. The connection between these constructs is explored in terms of the value for practicing teachers and implications for the classroom.

Pre-service Primary Teacher Preparedness and Confidence to Teach Science Following a University Methods Course

Friday, 3.20pm – Room 2

Beverly Lowe
University of the Sunshine Coast

Low levels of knowledge, preparation and confidence about science have been identified in empirical literature as factors that influence the quality of science teaching in primary schools. This study examines the self-reported perceptions of personal science content knowledge, teaching methods and confidence to teach science among first year pre-service primary teachers enrolled in a Bachelor of Education program. The project uses a mixed methods design over multiple phases including a repeated survey and optional interviews. During phase one of the study, students were surveyed about their science background and experiences. The results indicated a relatively low level of participation in science at both primary and secondary school. Students also indicated a relatively low level of interest in teaching science. Given these low levels of experience and interest, findings suggest that rather than igniting any passion for science, those experiences have a negative impact on the students' desire and confidence to teach science. This poses a major concern for the future of science education in primary schools. An agenda to address the problems include remediation in teacher education programs in the short term, and longer term programs in schools to produce more science-literate students entering the teaching profession.

Conceptual Change by Metaphorical Change: How understanding science is based on imaginations

Friday, 2.15pm – Room 4

Sabine Marsch[1], Kai Niebert[2] & David Treagust[3]
[1]Universität Leipzig, [2]Leibniz Universität Hannover, [3]Curtin University

Teaching scientific conceptions and competences is the main focus of science educators. Based on conceptual change research, several theories have been developed describing teaching and learning of different scientific phenomena. Additionally the epistemological role of analogies and metaphors came into the focus of science education research in recent years. Studies dealing with analogies and metaphors in science education show ambivalent results: A lot of studies indicate that imaginations teachers use to explain scientific topics are not adopted by their students (Harrison & Jong, 2004) or not understood in the anticipated way (Harrison & Treagust, 2006). Studies that use experientialism as a cognitive metaphor theory obtain very optimistic results in the development of imaginations for teaching science (Niebert & Gropengießer, 2010; Riemeier, 2005; Zabel, 2009; Marsch, 2009). To interpret these ambivalent data, we exemplarily reanalysed selected studies dealing with analogies and metaphors for teaching microbiology and system thinking. Therefore the results of a metaphor analysis (Schmitt 2005) were interpreted based on the theory of experientialism (Gropengießer, 2007; Lakoff & Johnson, 1980).

Engineering Education: Linking Science, Engineering and Technology

Thursday, 9.30am – Room 7

Nicoleta Maynard & Rekha Koul
Curtain University

This presentation reports on the findings of first phase of an Engineering Education action research project. Project aims at developing interest and understanding among primary school students in engineering and technology as potential career choices in order to redress the inadequacy of trained professionals in the fields of Engineering and Technology to satisfy increasing demand. Research team in collaboration with students, teachers and school administrators worked on developing possible engineering curriculum modules that can be used to extend existing science curricula in primary schools. Participating students completed pre-assessments and post-assessments that included questions about general engineering and technology concepts. Analysis of data reveals that students have a limited understanding about engineering and technology. Post assessments indicated statistically significant difference in student understanding after their exposure to engineering curriculum. All participating and researchers worked together as a caring, trusting team sharing unique talents and resources to provide an improved learning environment for students to develop their understanding. This research further demonstrated a successful development of a body of research that enhanced excellence in teaching and learning of engineering and technology concepts by primary school students.

Backward-faded scaffolding, the 5 Es, and inquiry-based pedagogies: Approaches adopted in the Space to Grow Project

Friday, 10.35am – Room 1

David H McKinnon
Charles Sturt University

The Space to Grow ARC Linkage funded project is being implemented in Year 9 and 10 science and Year 11 and 12 physics classes in 37 schools over a three-year period and provides students and teachers with access to the two 2-metre research-grade Faulkes Telescopes. The project is producing learning materials that engage students with real science that encourage a depth of understanding and which support teachers in teaching science, in particular, astronomy.

This paper will present the educational materials designed for the project and in particular unpack the educational design that underpins the Space to Grow teaching and learning materials. Specifically, the educational design employs the 5E framework, backward faded scaffolding and inquiry-based approaches to learning astronomy. One of the teaching modules, Star-Cluster Photometry, will be shared to illustrate the ways in which these approaches have been employed and to highlight the embedded professional development to support teachers in implementing the project. The materials encompass a range of resources (e.g., PowerPoint presentations, movies, student investigation guides etc). The module has a number of exit points to cater for different levels of interest and ability. Feedback from teachers and students who have trialled the materials will also be presented.

Identity Learning, Culture Shock and Border Crossing into Effective Teaching in Indigenous Science Education

Thursday, 4.15pm – Room 7

Michael Michie
University of Waikato

Teachers of science, particularly those who teach indigenous students, often find themselves teaching across two cultural borders (Aikenhead, 1996, 1997): a border between school science and everyday life which indigenous students may share with their non-indigenous peers, and a border between western science and their indigenous knowledge and worldviews. This paper focuses on the ability of teachers to also cross these borders to enable them to educate their indigenous students. It makes use of a theory of identity learning developed by Geijsel and Meijers (2005) and supported by others such as Pillsbury and Shields (1999) which focus on teachers working in border situations, particularly at the western/indigenous border. It considers the identity learning through culture shock experienced by teachers living and working in indigenous communities.

An exploration of the impact of 'Thinking Science' professional development on the pedagogy of participating teachers

Friday, 11.15am – Room 1

Susan Millar & Mary Oliver
University of Western Australia

There is widespread concern about the student retention in science education. Research indicates that one contributing factor to this situation is the predominant use, by science teachers, of pedagogy which does not

involve students in the learning process. The purpose of this research is to contribute to our understanding of how to improve the quality of pedagogy in science classes by investigating the impact of the Thinking Science professional development model on teachers' general approach to pedagogy in their classes. To assist in the acquisition of new pedagogical skills, teachers are provided with a high quality classroom resource and long term support, including classroom coaching.

The investigation is carried out using Grounded Theory, a pragmatic approach to mixed method research. Qualitative data is collected to investigate the beliefs, attitudes, pedagogical skills and other relevant behaviour of stakeholders. Quantitative data from Science Reasoning Tasks is used to assess the cognitive development of students.

Exploring the Use of Narrative within Multimedia Chemistry Simulations: Engendering Motive and Problematising

Friday, 8.45am – Room 1

Catherine Milne[1], Jan Plass[1], Bruce Homer[2], Trace Jordan[1], Ruth Schwartz[1], Mubina Kahn[1] & Dixie Ching[1]
[1]New York University, [2]Graduate Center City University of New York

Our goal is to design interactive dynamic multimedia simulations that scaffold student understanding and use of levels of representation—observable, explanatory, and symbolic-within topics associated with kinetic molecular theory.

Narrative was used to introduce everyday phenomenon (like the smell of popcorn for the diffusion simulation) that could be explained using a particle model and to create for students a need to ask 'why' questions that could be explored through the particle model. This narrative approach was compared with exposition in both usability design studies using eyetracking and classroom experiments. However, the usability studies indicated that some students thought they understood why they could smell popcorn so we introduced within narrative challenges designed to *problematize the everyday* to encourage student goal-directed action within the simulation. Our presentation will report the findings from both classroom (of 8 classes) and usability studies. The data was drawn from pre- and post-test outcomes, data captured from students' interaction with the simulation including time on task and interaction (e.g. mouse clicks) and eyegaze. Results suggest *narrative* provides structure for introducing observable phenomena, generating *motive* (need to know) and so engaging students, and facilitating transitions between representations. Our findings have implications for the design of all instructional material.

How Do Japanese Students Perceive Sustainable Development?: A Case Study on the Image of Sustainable Development among Young People

Thursday, 11.15am – Room 7

Shiho Miyake
Kobe College

The United Nations Decade of Education for Sustainable Development (ESD) began in 2005. There are three dimensions in the relationship between ESD and other 'adjectival' educations, including the socio-cultural dimension, the environmental dimension, and the economic dimension. The question then arises: Which of the issues associated with these dimensions is strongly linked to students' images of SD (Sustainable Development) today? This paper reports the results of an investigation of SD images among Japanese students

using the word association method. As a result, Japanese students' images of SD seem to be best represented by the words 'Recycle' and 'Eco'. It is also found that students tend to avoid use of disposable items and to take environment-friendly action. On the other hand, they are not much interested in human rights, medical issues, or social systems. The result of this survey reveals that of the three dimensions, Japanese students tend to be most interested in the environmental. They apparently do not discern concrete images relating to the socio-cultural dimension and the economic dimension. Therefore, when considering concrete ideas regarding the requirements for ESD in higher education facilities in the future, it may be necessary to develop an educational program that reflects a balance among these three dimensions.

Representations of Indigenous Knowledge in South African Grade 9 Natural Science textbooks

Saturday, 9.00am – Room 5

Matlhodi Moloto & Elaosi Vhurumuku
University of the Witwatersrand

In South Africa, following the demise of apartheid, the integration of indigenous knowledge (IK) into mainstream science education became a buzzword. This has been accompanied by science education curriculum reform and curriculum documents (e.g. Revised National Curriculum Statement, 2005) appearing in post-apartheid South Africa advocating learners' understandings of the interactions among indigenous knowledge, science, technology and the environment. This reform has necessitated the production of new textbooks. While this has happened no effort has been made to analyse the representations of IK carried by the new textbooks now in use in the classrooms, with the aim of ascertaining relevance and compatibility with the new vision. This paper reports the results of a study that used *content analysis* to investigate the representations of IK included in three of South Africa's Grade 9 Natural Science textbooks. It also analysed the manner in which these ideas are represented. The results show that, generally, the representation of IK in the three textbooks was minimal. It was also found that the authors present IK as homogeneous to all of South African communities without recognizing the cultural diversities of the different groups forming the South African society. Recommendations for textbook development are suggested.

Science Ideas: The Bigger the Better

Thursday, 9.30am – Room 2

Pamela Mulhall, Maurizio Toscano and Jacinta Duncan
University of Melbourne

Student teachers are often daunted by the amount of content they need to teach. Recent research has found it useful to frame teachers' pedagogical content knowledge (PCK) in terms of big ideas. In this paper, we explore the distinction between big ideas in science and big ideas in science teaching. On the basis of this distinction, we argue that helping student teachers to conceptualise their teaching in terms of big ideas for teaching science is a useful tool for developing their PCK.

Multimodal Representations of Science in Interactive Whiteboard Classrooms

Thursday, 1.45pm – Room 3

Karen Murcia
Edith Cowan University

Today's digital educational technologies, such as the interactive whiteboard, have the potential to support and extend the modes of representation integrated into primary school science classrooms. It is argued that understanding the nature of scientific knowledge requires learners to engage with, understand and translate multimodal representations of science concepts (Lemke, 1998). Learning and teaching science is dependent on conceptually linking different representational forms such as experimental, numeral, figurative and verbal. This presentation shares the process and findings from a school based research project that examined how primary school children learned science with an interactive whiteboard. Action research methods were used to structure the project and support two year 6 teachers from a Western Australian metropolitan independent boys school as research collaborators.

Examples of activites from their classrooms are used to illustrate how the children were observed learning science and demonstrating understanding through the multimodal representations afforded by the use of interactive whiteboard technology.

Analysis on questioning terms in the Japanese Primary School Science Textbooks

Thursday, 3.35pm – Room 4

Hayashi Nakamaya[1], Yuji Saruta[2] & Manabu Sumida[3]
[1]University of Miyazaki, [2]National Institute for Educational Policy Research, [3]Ehime University

Japanese primary school science starts implementing the new Course of Study in April 2011. In the Course of Study, it is clearly stated that one of the overall objectives of primary school science is to develop pupils' problem-solving abilities. In order to find out in what way Japanese pupils are expected to develop these abilities, this study focuses on the questioning terms in Japanese primary school science textbooks (grades 3 to 6) of one publisher. 806 questions were extracted from the textbooks. Among these questions, 263 questions were grouped as "how" questions, and about 150 as "yes-no" and "whether or not" questions. Other groups were "where"(36), "which"(30), "what"(29), "why"(29), and "when"(4), leaving the rest of the questions ungrouped due to the nature of difficulty of grouping.

While anticipated questions in science are "what", "why", and "how" questions, the study revealed that the number of "why" and "what" questions in the textbooks was rather small. Instead, "how" questions were dominant in textbooks. This result might relate to the fact that investigation has been regarded as an important activity in the Japanese primary school science. However, since the importance of linguistic activities is gathering momentum, it will be worth paying more attention to "why" questions.

Metaphors of Climate Change: An educational reconstruction of global warming based on students' and scientists' metaphors and analogies

Friday, 12.45pm – Room 4

Kai Niebert
Leibniz Universität Hannover

Translating public concern for global warming into every-day action requires knowledge about the causes of climate change. An analysis of students' conceptions on global warming shows that they often differ from scientists' conceptions even after instruction. The aim of our study is an evidence-based and theory-guided development of learning environments on key aspects of global warming.

Based on students conceptions collected in an interview study (n=16), we developed different learning environments using the model of educational reconstruction, and evaluated them in teaching experiments (n=24). The data were gathered with video, transcribed and investigated by qualitative content analysis and metaphor analysis.

The analysis shows that all students and scientists use metaphors to understand climate change. Guided by Lakoff's cognitive metaphor theory we found different thinking patterns for the causes of global warming: Global warming caused by a man-made imbalance in the carbon cycle, man-made CO_2 and man-made vs. natural CO_2, as well as warming by more input and warming by less output.

Our teaching sequences on global warming aimed at a conceptual reconstruction based on students' metaphors. By uncovering the – mostly unconsciously – used metaphors, we gave students access to their conceptions and let them experience the mental models behind their metaphors.

Laptop Ubiquity: A Case Study of Science Teachers' Response to the Digital Education Revolution

Friday, 11.15am – Room 7

Wendy Nielsen & Alex Miller
University of Wollongong

Since the introduction of laptop computers across Australia for all Year 9 students, teachers have scrambled to make meaningful use of the learning potential represented by the introduction. This study asks, how have teachers responded to the ubiquitous presence of student laptop computers? This paper is the result of a one-year case study with two highly qualified and experienced high school science teachers that considers their efforts to implement laptop computers in Year 9 and Year 10 science programs. Out of theoretical perspectives in cultural historical activity theory, the study shows that these teachers are committed to developing and delivering technology-rich lessons and furthering the potential represented by the computers in terms of engaging "21st century learners." They are, however, faced with challenges that represent significant barriers to developing the learning potential. These include: 1) student reluctance to engage with the computers as a learning tool amid generally low levels of cognitive engagement; 2) unanticipated changes to classroom management due to laptop introduction; and, 3) classroom and school connectivity along with computer durability and discontinuous technical support. More than two years into the introduction of laptop computers, teachers are still very much in a transition period from "before laptops" to "after laptops."

Scaffolding numeracy in science using a visual description of mathematical knowledge

Friday, 12.45pm – Room 3

David Nutchey
Queensland University of Technology

Science activities provide a myriad of opportunities to intentionally develop a student's numeracy, including their flexible use of multiplicative ideas. The development of knowledge regarding the movement of simple machines is one such example. In this study, a series of activities presented to pre-service teacher education students was considered. Firstly, a visual description of the organisation of multiplicative ideas was generated. Then, the sequence of science activities conducted by the students was overlaid upon the organisation of mathematical ideas. This has allowed for an analysis of how the science activities explored the multiplicative ideas, and what potential there might be for improving these activities so as to better scaffold the necessary mathematical ideas needed for the successful achievement of each activity's intent. It is anticipated that future development of tools for the creation of such visual descriptions of mathematical knowledge will help not only the teaching of mathematics, but also provide other disciplines, such as science, guidance regarding the development of mathematical thinking within their own curricula.

Using Cogenerative Dialogue to Transform Teaching Practices and Emotional Climate in a Beginning Science Teacher's Classroom

Thursday, 11.15am – Room 1

Jennifer L. Oakley[1], Stephen M. Ritchie[1] & Kenneth Tobin[2].
[1]Queensland University of Technology, [2]City University of New York

Engaging learners in the science classroom is a challenge for many beginning science teachers. This ethnographic case study examines how cogenerative dialogue (cogen) can be used as a catalyst to produce teaching practices that enhance student engagement in a beginning science teacher's classroom. The teacher in this study embraced cogen as a means to cogenerate, with her students, a shared understanding of what was happening in the classroom during science lessons. These understandings were used as resources to transform the interactions between the teacher and her students and influence the emotional climate of the classroom. Implications for the wider use of cogen in Australian school settings will be discussed.

Enhancing Teachers' Knowledge for Teaching Chemistry with Multiple Representations in Nigerian Senior Secondary Schools

Saturday, 9.45am – Room 4

Bolanle Olaleye, Mark Hackling & Karen Murcia
Edith Cowan University

The quality of teaching and learning of chemistry in Nigerian schools has been of great concern to the country's government, parents and teachers. Students find learning chemical concepts difficult and boring and the academic performance of students is relatively poor. Learning chemistry concepts tends to be by rote and memorising of content. This study focussed on enhancing teachers' pedagogical knowledge and beliefs for

using multiple representations in teaching chemistry through a professional learning program. Participating teachers attended a series of professional learning workshops and engaged with learning activities on how to construct, interpret and use multiple representations to teach chemistry concepts. A mixed methods case study research design was used to study the impact of the professional learning intervention. This paper reports impacts of the professional learning intervention on teachers' use of multiple representations in the classroom and on students' interest in and engagement with chemistry learning.

What is motivation?

Friday, 4.00pm – Room 8

David Palmer
University of Newcastle

This is a position paper that is intended to describe the nature of motivation. Although motivation is generally agreed to be the phenomenon that causes learning behaviour there is a lack of consensus as to its exact nature or characteristics, as different authors have interpreted the term motivation in different ways. This indicates a need to clarify the nature of the construct. In this paper, it is proposed that motivation is not an enduring predisposition, or a transient state of mind, and nor is it a collection of beliefs. Instead, it is best viewed as a mostly subconscious, executive process in which internal and external factors are continually monitored to determine when learning behaviours will be activated and de-activated. The internal and external factors include interests, attitudes, self-efficacy beliefs, achievement goals, expectations, values, attributions, psychological needs, basic physical needs, emotions, teacher characteristics, management techniques, pedagogical techniques, peers and distractions. When an appropriate combination of factors is present, then learning behaviours such as focussing attention, concentrating and thinking are activated. To support these arguments, evidence is provided from studies in education as well as recent advances in neurobiology.

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e-Assessment in the senior secondary years: What do my students actually know and understand?

Friday, 4.00pm – Room 5

Debra Panizzon, Katrina Elliott & Martin Westwell
Flinders University

Assessing process-related learning outcomes in science in an authentic way is extremely difficult. Being able to re-start and replicate protocols, conduct time-bound investigations involving rates of change or other simulations of molecular events are all possible in an electronic environment. The e-assessment project discussed here was initiated to improve the quality of assessment used with Years 11 and 12 students in *Contemporary Issues and Science* in South Australia. Importantly, this work was not about taking multiple-choice or extended response items and placing them on the computer. Critically, it was about developing interactive items using a range of electronic tools that were completed on computers to provide students with authentic assessment tasks that assessed their scientific understandings and achievement of a range of learning outcomes. During the two years of the project, data were collected from students (via survey and focus interviews) and teachers (via interviews and during workshop sessions). Student responses to all items were also captured electronically producing detailed evidence about students' thinking at points in time. This paper provides an overview of the project and discusses some of the major insights around assessment emerging from an initial analysis of the two-years of data.

Assessment of secondary students' understanding of circular motion using a learning cycle based on the integrated mental model theory

Friday, 12.45pm – Room 7

Jiyun Park[1], Gyoungho Lee[2], Jongho Shin[3] & David F. Treagust[1]
[1]Curtin University of Technology, [2]Seoul National University, [3]Seoul National University

Understanding the complex reality of teaching and learning in science classrooms is a prerequisite for planning instructional programs to improve student learning of science concepts. Recently, in science education, an integrated mental model theory, which reflects various factors affecting student learning of science concepts, has been developed. However, practical instructional guidelines and specific practices based on this theory have not yet been implemented.

Therefore, in this study, we have enacted a teaching model based on the integrated mental model theory and investigated its impact on students' understanding. Fifty-three 11th grade students from an industrial high school in Korea were taught about the concept of circular motion. The results of the study showed that the new teaching model was effective in the progression of students' mental models of circular motion in terms of Correctness, Coherence, and Completeness. In addition, students' understanding of concepts of physics, their epistemological beliefs and motivational beliefs regarding learning physics have improved following the teaching model approach. We discuss theoretical and practical implications of this study.

Serving-up the Peirian Waters: A Role for Science Communication in Formal Science Education

Friday, 10.35am – Room 7

Sean Perera
Australian National University

Science communication, over the last two decades, has shifted its onus from public understanding to public engagement. These efforts are paralleled in science education, which strives to promote continued student engagement with science. However, this endeavour is deterred by traditional forms of pedagogy employed popularly in middle school science. While, it is believed that teachers' inadequate understanding about science inhibits their use of inquiry-based pedagogy, professional development based on constructivist principles attempts to remedy this problem.

The present study investigated the constructivist basis for a model of short-term professional development, which has not been addressed in the literature. I demonstrate that it is possible to engage teachers in active construction of scientific knowledge through short-term professional development and offer a feasible approach to effective professional development based on the one-day workshop model.

While the workshops did facilitate conceptual change in the teachers, it was found that the constructivist principles which were incorporated into the workshops' design and delivery were underpinned by science communication practices. The conclusions emphasise the need for greater involvement of science communication in science education reform.

Pre-service teachers' lesson plan during a learning management in chemistry course

Saturday, 11.25am – Room 3

Pattamaporn Pimthong
Khon Kaen University

This research was to study pre service teachers' lesson planning practices by analysing the lesson plans they wrote. The participants were seven diploma students (who graduated with a B.Sc. (chemistry) before coming to the Faculty of Education). These participants enrolled in a learning management in chemistry course which took place over seven weeks (six hours/week). In this course the students were asked to develop chemistry lesson plans. All lesson plans were read and commented on by the instructor (researcher). The results showed that the pre service teachers had difficulties with several aspects of lesson planning namely questioning, instructional strategies, learning activities and assessment. Two ways of solving these difficulties was giving feedback from an experienced instructor and encouraging the pre service teachers' self-reflections.

Teaching and Learning Mathematics and Science in a Second or a Third Language

Thursday, 4.15pm – Room 5

Zuraini Ramli
Deakin University

This study focuses on the teaching and learning of mathematics and science in English in Malaysia, where English is a second or a third language for both teachers and students. Guided by one main research aim, that is to investigate the role of language in students' construction of meaning in mathematics and science classes taught in a second or third language, this study employed qualitative methods, involving a multiple case study and an interpretive research paradigm. Participants involved in this research are mathematics and science teachers and Year 8 students from two public secondary schools in Malacca, West Malaysia. A number of approaches to data collection were employed including classroom observations and video recording. Data were gathered mainly from classroom video-recording, supported by video-stimulated recall interviews of teachers and students, classroom observation and sample student work. The paper discusses the theoretical frames guiding the analysis. A number of preliminary findings will be presented, supported by transcript data, concerning the interaction between language choice and the prevailing pedagogy practised in the classrooms, the circumstances that shape language choice, and the role of artefacts/representations in framing language choice and students' meaning making.

The Worldly Perspective: Seeking Balance and Connection in Science Curriculum

Saturday, 10.45am – Room 3

Leonie Rennie[1], Grady Venville[2] & John Wallace[3]
[1]Curtin University, [2]University of Western Australia, [3]University of Toronto

In 1949, Ralph Tyler asked 'What educational purposes should the school seek to attain?' That we are still struggling with the answer is illustrated by the variety of curriculum evident in various countries and the diversity of views existing about their suitability. Do students need strong disciplinary knowledge to cope in

today's changing world, or do they need interdisciplinary knowledge – after all, the world's problems are interdisciplinary. Should they learn about local issues, or focus on issues of global significance, like sustainability? As educational researchers trying to make sense of the diverse approaches to curriculum, we suggest taking what we call a Worldly Perspective on curriculum. This perspective enables us to understand two significant dimensions of curriculum – the balance between disciplinary knowledge and integrated knowledge, and the connection between local types of knowledge and global types of knowledge. Thus we suggest that the answer to Tyler's question concerns balance and connection. In this presentation we describe the components of our Worldly Perspective and why we think that a curriculum with balance and connection offers the best chance of providing our youth with the knowledge they need to negotiate and improve the global community in which they live.

'That's got me really thinking': technology in early childhood

Thursday, 4.15pm – Room 6

Jill Robbins
Monash University

In 2009, the Australian Government published the first national learning framework for early childhood (DEEWR, 2009). In this, technology is described as being not only computers and digital artefacts, but also a 'diverse range of products' as well as 'processes, systems, services and environments' (ibid, p.46). However, in a series of interviews with Victorian rural and urban early childhood professionals to determine their understanding of technology and technology education (Robbins, 2010) it was found that most believed technology involved mainly the use of computers. Further, most believed that they implemented very little (if any) technology education in their teaching. Additional questioning, however, indicated that they all routinely provide rich and varied technological experiences for children, and are, in most cases, actively supporting children's technological thinking. This paper, informed by sociocultural theory, will go beyond the teachers' conscious knowledge of technology to examine some of the technological practices and experiences they are providing for children. Significantly, it will discuss how the interviews lead to a re-conceptualisation of thinking about technology for many of them. This, in turn, has implications in relation to one of the practices promoted in the national framework - that of increased use of intentional (or deliberate, purposeful and thoughtful) teaching.

Interactive Whiteboards: teachers' perspectives of potential pedagogical benefits and issues in teaching science for young children

Saturday, 11.25am – Room 7

Sharon Russo & Wong Kung-Teck
Monash University

Interactive whiteboards (IWBs) have made a very rapid penetration into Australian schools since 2003. Many Australian junior primary teachers have accepted them as core teaching technology for teaching young learners. This paper reports on selected findings from a recent Australian study which highlighted a number of issues raised by teachers in regards to using IWBs when teaching Science to five and six year olds. In-depth interviews with participating teachers to explore their perspectives about the benefits and issues of IWBs science classroom were carried out. Two typologies emerged in the study: the use of IWBs as a tool to enhance teaching and as a tool to support learning. The most mentioned features of IWBs for teaching were flexibility and versatility, multimodality and modelling of ICT skills. The most frequently raised issue was the need for adequate training in order to make full use of IWBs. The research suggests that those potential

pedagogical benefits are more likely to occur where teachers are able to appreciate that interactivity with IWBs requires new pedagogical approaches.

Teaching for promoting scientific literacy: A case study

Friday, 3.20pm – Room 1

Mahbub Sarkar & Deborah Corrigan
Monash University

This paper reports on the way a science teacher in Bangladesh teaches for promoting scientific literacy and the way students perceive their science learning. The report particularly focuses on some selected values related to scientific literacy the teacher considered in teaching and the way she intended to relate school science to students' everyday life. Data were gathered through observing her teaching in Grade VIII General Science class, interviewing her twice – one before and one after the class observation, and interviewing her students in a focus group. Analysis of these data reveals that the teacher adopted an explicit approach to promote some of the selected values, while for promoting some other values she adopted a more implicit approach; it was however, important to note that irrespective to these approaches, her students mostly could perceive these values. The analysis also indicates that she intended to present science to students as something relevant and important to their everyday life and students mostly perceived their learning of science as important and relevant; a part of the learning, however, was not viewed as important to students wishing not to study science at the upper level. These findings may have significance to understand a science teacher's effort to promote scientific literacy with the limitations of content knowledge, insufficient resources, overloaded and rushed curriculum, and traditional assessment system.

Teaching and learning about ethical inquiry into socio-scientific issues

Saturday, 9.00am – Room 3

Kathryn Saunders
University of Waikato

One aspect of developing scientific literacy in high school students requires assisting them to make informed decisions about socio-scientific issues (SSI). However research indicates that many secondary science teachers lack the support, confidence and pedagogical knowledge to address SSI in their classrooms. This paper reports on a project that developed a pedagogical model that scaffolded teachers through a series of stages in exploring a socio-scientific issue with students and supported them in the use of pedagogical strategies and facilitated ways of ethical thinking. The model was trialled and co-constructed with four teachers and it extended traditional approaches of ethical thinking to propose pluralism as a framework of ethical thinking from which multiple identities including cultural, ethnic, religious, gender perspectives could be explored. The research utilised an interpretative case study approach and multiple sources of data were collected and used to write descriptive case studies. A cross case analysis was carried out to explore the patterns and relationships between the cases. These data were used to address the usefulness of the model. Positive teacher and student outcomes validated the model as a pedagogical tool that supported science teachers to improve their practice and move students towards greater scientific literacy.

A study of the public perception on global warming and attitudes toward science and technology of Taiwanese adults

Thursday, 1.00pm – Room 5

Paichi Pat Shein[1], Kun-Chang Wu[2], Chun-Yen Tsai[3], Yuh-Yih Wu[4], David Chao[5] & Tai-Chu Huang[6]
[1]National Sun Yat-Sen University, [2]Ruei Fong Elementary School, [3]Cheng Shu University, [4]National Kaohsiung Normal University, [5]National Sun Yat-Sen University, [6]National Sun Yat-Sen University

The main purpose of this research was to investigate the public perception on global warming and public attitudes toward science and technology (S&T) in Taiwan. It was the first time an extensive study on civic scientific literacy had been conducted in Taiwan. The questionnaire, entitled "Survey of Civic Scientific Literacy", was designed and administered to 4,448 selected participants. All participants were chosen based on a Probability Proportional to Size sampling method to ensure a sample representative of Taiwan's general population. The data were collected and analysed using a two-step cluster analyses, chi square analyses, and one-way ANOVA. The results indicated that the public's perception of global warming could be divided into 4 groups: 1) high level perception, high level information (positively concerned), 2) low level perception, low level knowledge (none of my business), 3) low level knowledge, high level information (well-informed), and 4) high level perception, high level knowledge (highly literate). Among these 4 groups, people in the positively concerned group exhibited the most positive attitudes toward S&T. While people in the 'none of my business' group showed the most negative attitudes. Some suggestions for science education policy makers were proposed according to the results obtained in this study.

Secondary students' beliefs and willingness to act to reduce global warming: An international study related to transport options and its consequences for science education

Thursday, 3.35pm – Room 3

Keith Skamp[1], Eddie Boyes[2], Martin Stanisstreet[2], Manuel Rodriguez[3], Georgios Malandrakis[4], Roseanne Fortner[5], Ahmet Kilinc [6], Neil Taylor[7], Kiran Choker[8], Dua Shweta[8], Abdullah Ambusaidi [9], Irene Cheong[10], Mijung Kim[11], Hye-Gyoung Yoon[12]
[1]Southern Cross University, [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]Sultan Qaboos University, [10]Universiti Brunei Darussalam, [11]National Institute of Education, [12]Chuncheon National University of Education

Global warming is one of the world's major environmental problems. The aim of this research programme has been to examine, using a specially designed questionnaire, links between beliefs about the efficacy of certain *specific* actions to reduce global warming and a willingness to undertake them. These links have been quantified using novel derived indices. This paper concentrates on students' views (N>10,000; 11 countries) about using public rather than private transport and being prepared to use smaller, more fuel-efficient vehicles, as contributions to reducing global warming. The results allowed us to compare the *Believed Usefulness of Action* and the *Degree of Willingness to Act* of students across the eleven countries. One particular relationship between these two values has been probed by constructing a derived index, the *Potential Effectiveness of Education*. This index is a measure of the extent to which enhancing a person's belief in the effectiveness of an action might increase their willingness to undertake that action. Interpretations are proffered for differences across countries including significant correlations with a range of social and other indicators. By comparing the values of this and other indices for different actions and across different

countries, educators should be able to identify actions to be targeted that are more likely to produce changes in actions.

If you're ecoliterate and you know it, clap your hands!

Friday, 3.20pm – Room 3

Melissa Slarp
The University of Sydney

Can a five year old child understand complex ecological concepts? In today's climate of environmental concern, can we educate our future generations in ecology from their very first day in the classroom? Ecoliteracy is defined as the ability to interact with the environment in a sustainable manner (Orr, 1992). This project hypothesized that Kindergarten children possess a higher level of ecoliteracy than currently acknowledged by the NSW curriculum. To test my hypothesis I designed and implemented a teaching intervention which focuses on ecological concepts. A total of 25 Kindergarten students were tested across two schools. Ecoliteracy was measured using a pre- and post-testing protocol. I developed a coding matrix to analyse the data collected from children's drawings and interviews, and implemented follow-up interviews to retest the students five months later. Students displayed significant increases in ecoliteracy post-intervention and maintained these levels 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 curriculum developers and teachers in developing science curricula and implementing the curricula to promote science and ecoliteracy in primary schools.

Does replacing a beaker and spatula with a bowl and spoon make science learning and teaching any more authentic and real-life, and any less other worldly, for primary science teachers and students?

Saturday, 9.00am – Room 1

Julian Smith
University of Tasmania

This paper previews the findings of a current PhD thesis (Smith 2008-2011), which presents the argument that in the area of primary science the relations between knowledge and learning are problematical for pre-service teachers. The research is founded on two questions of interest to the PhD researcher i). What does it mean to support science? And ii). What does it means to support beginning teachers in the area of primary science? Drawing on data from 45 pre-service teachers, 23 in-service teachers and 20 teacher educators, a critical discourse analysis approach applied to respondents' perspectives on the attributes of *good science teaching,* found that in all cases the respondents posited *if/then* associations between *authentic, real-life* activities and *hands-on* experiences and meaningful engagement in science. This finding is presented as the overarching discourse *experience counts* and is presented as commensurate with dominant constructivist and socio-cultural education theorists' viewpoints. Conversely, this finding may be incommensurate with ontological and epistemological precepts of supporting science when alternative theoretical perspectives on the relations between knowledge and the learning are considered. This theoretical tension is discussed as having implications for views on curriculum, pedagogy and teacher agency in the area of primary science.

Are we teaching girls to fish?: Community-university collaboration for youth food justice education

Friday, 11.15am – Room 4

Erin Sperling & J. Lawrence Bencze
University of Toronto

This study represents a pilot project of an ethnographic study engaging youth in research-informed activism around socio-scientific issues (SSI). Through facilitated action research, a community organization (CO) and a post-secondary institution collaborated on a voluntary eight-month after-school program for youth that included topics from food preparation and health, to social and environmental justice. A key aim of the study was to engage participants (n=10) in social activism, based on skills, content knowledge, and youth-led research relevant to the topics of the project, and to track the process and outcomes. Data analyses, using constructivist grounded theory, included participatory observation field notes, transcriptions of focus group and individual interviews, project documents and artefacts. While the outcomes are encouraging, with youth displaying orientations towards activism, certain challenges to the culmination of the project became apparent. From a Freirian perspective, these may be attributed to divergent pedagogical practices, including hesitation by the CO to support youth-led research, and a focus on didactic pedagogies, despite outward social justice intentions. The authors use actor-network theory to understand the challenges to community-university partnerships, such as differing stakeholders a006Ed structures, and how they may be negotiated and overcome, toward a more socially just youth partnership program.

Designing Reform-Based Science Materials on the Development of an Experienced Teacher's Teacher Knowledge

Friday, 10.35am – Room 3

Ming-Chin Su & Che-Ming Tsai
National Taiwan Normal University

School teachers are assumed to be developers of learning materials in current curriculum reform in Taiwan. The embodiment of designing and enacting materials is expected to empower teachers. Examining to what extent, and in what way, science teachers change their teacher's knowledge during developing and enacting learning materials can shed light on the effects of this professional development approach. A team of three experienced science teachers and a science educator developed two modules of learning materials about 'The Solar Cell and Energy Policy.' One module adopted a problem-based learning approach while the other followed a conventional comprehension approach. For data collection 16 two-hour group discussions and three individual interviews over a duration of four months were used. Based on the constant comparative analysis of transcripts, an explanatory model was proposed to describe the discursive nature of professional growth of an experienced teacher during his participation in developing and enacting both modules. We concluded that the science teacher developed more complete conceptions of various pedagogical content knowledge domains. He suggested refocusing teaching content and redefining teaching goals to match students' needs and background. Moreover, he clarified the notions and scope of misconceptions, and valued the notion of student-centred as a guiding principle of designing learning materials.

Simple Explicit Animation (SEA) Approach In Teaching Organic Chemistry

Friday, 4.00pm – Room 3

Othman Talib[1], Mokhtar Nawawi, Wan Zah Wan Ali[1], Rosnaini Mahmud[1] & Tengku Putri Norishah Tengku Shariman[2]
[1]Multimedia University, [2]University Putra Malaysia

In University Putra Malaysia, lecturers used the Simple Explicit Animation (SEA) approach to visually present the breaking and forming of chemical bonds in an explicit way. This study examined how SEA was used as a supplementary material in a first year Organic Chemistry course and its effect on the performance of students. Using pre and post-test design, the study involved a comparison between an experimental group of students (n=18) who followed instructions that integrated SEA in a blended mode and a conventional group of students (n=17) who followed instructions based essentially on conventional teaching. To further investigate the appropriateness of SEA for Organic Chemistry instruction, a questionnaire was distributed amongst another group of students (n=20) who had used SEA as a self-accessed learning tool. The research results suggest the potential of using SEA as an instructional material based on the improved post-test performance of the experimental group which is almost equivalent with the post-test performance of the conventional group, which is F(1,32)=.37, eta squared .03. Furthermore, descriptive analysis of the questionnaire answered by the self-accessed group showed positively the appropriateness of SEA as a self-access learning tool from the aspects of improving understanding, increasing interest and curiosity, and explaining difficult and abstract concepts in Organic Chemistry.

The Legends of Alkhimia

Thursday, 11.15am – Room 2

Kim Chwee Daniel Tan, Yam San Chee & Ek Ming Tan
National Institute of Education

Computer games can provide immersive environments for players to experience scientific phenomena and their behavior according to the related theories, providing the context for players to make sense of scientific concepts involved. Inquiry-based learning is also facilitated as players have to explore, discover, form hypotheses, experiment and make decisions based on the outcomes generated in the game in the pursuit of an overall goal. Thus, science-based computer games allow the player to learn to be a scientist, to think and act like one, instead of merely learning about science. This paper describes the development of a multi-player game, the Legends of Alkhimia (LoA), and its associated instructional strategies to facilitate scientific inquiry by lower secondary (Grades 7 and 8) students, as well as the learning of chemistry concepts such as the particulate nature of matter, separation and purification techniques, and reactions of acids and bases in the context of the game. Students' and teachers' reactions to the game in two pilot studies are discussed together with students' understanding of separation and purification techniques, as determined by a diagnostic test, after completing the LoA programme. Challenges in terms of design, pedagogy, curricular goals and assessment are also discussed.

The concept of hypothesis testing: Misconceptions and categories of understanding

Friday, 4.00pm – Room 7

Charlotte Taylor
University of Sydney

The ability to conceptualise experimental design and testable hypotheses is epistemologically fundamental to thinking and practising as a scientist (McCune and Hounsell 2005). Previous studies of undergraduate student hypothesis development (Taylor 2006, Taylor and Meyer 2010) characterised the ways in which students conceptualise the 'what' and the 'how' of hypothesis testing. This study aimed to collect empirical data on students' thinking about hypotheses as they arrive from high school and after a semester-long course involving opportunities to discuss, write, and test hypotheses. A phenomenographical analysis (Marton 1981) was used to determine the critical features of understanding across the cohort, and the extent to which each student progresses, regresses, or remains in a transitional state of understanding. I provide empirical data on the qualitative differences in the way students view the hypothesis and procedures for testing it, and present analyses of changes in understanding of the critical features of the hypothesis following various learning activities. These findings are discussed in a broader context of curriculum design and developing students' capacity to think and practise in the discipline (Becher and Trowler 2001, McCune and Hounsell 2005).

Instructional Context, Motivation and Strategies in Teaching Genetics for Conceptual Change

Saturday, 10.45am – Room 7

Phairoth Termtachatipongsa
Khon Kaen University

The research aimed to study context and strategies for Grade 12 genetics teaching. The study explored students' scientific concepts about genes and chromosomes; their level of understanding; their conceptual change relating to genes and chromosomes; and their motivation toward instructional contexts.

The research method consisted of 3 phases. The first phase studied context and teaching strategies. The target group included 17 teachers, from different schools, 170 students and 5 experts. Secondly, the action research phase was carried out in a classroom for the development and improvement of genetics teaching strategies. The third phase, evaluation of genetics teaching strategies, was done by using a nonequivalent control group design, with the experiment group taught by the development and improving teaching strategies. The control group was taught by traditional style. The means of pre-test and post-test of Grade 12 students' understanding about genes and chromosomes were compared between and within groups in order to evaluate the genetics teaching strategies.

The findings revealed that teachers and students perceived genes and chromosomes as abstract concepts, and teachers often lacked the instructional media and scientific devices to gain students' understanding. Students' understandings ranged from misconception to completely understanding genes and chromosomes, but after intervention, more students understood completely in the experimental group.

Integrated learning activities in national resources conservation according to the Philosophy of Sufficiency Economy for students

Friday, 2.15pm - Room 8

Kongsak Thathong and Ngamnit Thathong
Khon Kaen University

The purposes of this research were: 1) to develop an integrated, learner-centred subject map and lesson plans for natural resources conservation in line with the Philosophy of Sufficiency Economy, 2) to study the opinions of teachers and students towards the project and related activities and 3) to study the result of growing teak trees on students. The participants were 37 teachers and 417 students, 2 researchers and 5 research assistants. The procedural instruments were a prototype integrated, learner-centred subject map and lesson plans, teak seedlings and the participants. Various instruments were employed for data collection and quantitative and qualitative data were used to investigate the effectiveness of the project.

The results were as follows: 1) the integrated, learner-centred subject map, which combines 8 subjects together for forest resources conservation was developed 2) 8 lesson plans for forest resources conservation activities were developed 3) the satisfaction of teachers and students towards the project and the integrated teaching and learning activities was at a high level 4) the survival rate of teak seedlings was 71.22 percent 5) most of the students were aware of the importance and benefit of the teak trees toward the society and themselves and 6) the students have developed a sense of responsibility and also become aware of the importance of forest resources conservation.

Emotions and Mindfulness in Science Education

Thursday, 10.35am – Room 1

Kenneth Tobin[1], Stephen M. Ritchie[2] & Senka Henderson[2]
[1]City University of New York, [2]Queensland University of Technology

Mindfulness is receptive attention to and awareness of in-the-moment experience of events. Using data from a beginning teacher's classrooms we relate mindfulness to the incidence of happiness, anger, and fear. We use digital video recorders to capture a variety of activities and then initiate event focused social inquiry. Facial expressions were analysed using software to classify facial emotions as neutral, happiness, anger, sadness, fear, and disgust. This analysis was complemented by ethnographic work, conversation analysis and prosody analysis. We found that when emotional energy was high, mindfulness was hard to discern. Conversely, when emotions were neutral, mindfulness was most evident in the practices of the teacher and students. We assert that in classes where emotions run high they are communicated effectively to teacher and students like an emotional contagion, with possible deleterious effects. We present implications for science teacher preparation and the induction of new teachers into the science teaching profession.

"It made me proud": Students' Positive Emotional Responses to Writing Stories about a Socio-scientific Issue

Thursday, 11.15am – Room 4

Louisa Tomas
James Cook University

In order to understand better the role of affect in learning about socio-scientific issues (SSI), this mixed methods study investigated Year 12 students' emotional arousal as they participated in an online writing-to-learn science project about the socio-scientific issue of biosecurity. Students wrote a series of hybridised scientific narratives, or BioStories, that integrate scientific information about biosecurity with narrative storylines, and uploaded these to a dedicated website. Throughout their participation in the project, students recorded their emotional responses to the various activities (*N*=115). Four case students were also video recorded during selected science lessons as they researched, composed and uploaded their BioStories for peer review. Analysis of these data, as well as interview data obtained from the case students, revealed that pride, strength, determination and interest were among the positive emotions most strongly elicited by the project. These emotions reflected students' interest in learning about a new socio-scientific issue, and their enhanced feelings of self-efficacy in successfully writing hybridised scientific narratives in science. At the same time, this study also highlights the need for further research into students' emotional responses to SSI activities as they unfold, in order to capture students' emotions as they are experienced at particular moments in time.

The Study of Grade 6 Student Conceptions about Evaporation Using Rock Salt Farm Community Resources and the Inquiry Cycle (5E).

Friday, 11.15am – Room 8

Thidarut Tongdee & Pattamaporn Pimthong
Khon Kaen University

The purpose of this research was to study the Grade 6 student conceptions about evaporation using a rock salt farm community resources and the inquiry cycle (5E). The participants were a class of Grade 6 students (19 students) from a small school in the rock salt farm community, Roi Ed provinces, Thailand. The data were collected by pre and post concept surveys, semi-structured interviews, and document analysis. In the pre survey, most students (89.47%) held alternative conception that the change of state from liquid to gas is the freezing of water. To encourage the students to reach for scientific conceptions, rock salt farm community resources were used as the learning resources for students. The students had opportunities to observe and work with a rock salt farmer as well as learn from the science teacher. The result was that 73.68% held scientific conceptions about evaporation in the post survey. Most students said they were happy to learn science from things around them.

Students' Multiple Representations for Learning Physics

Friday, 2.15pm – Room 7

David Treagust, Yen-Ruey Kuo, Marjan Zadnik, Salim Siddiqui & Mihye Won
Curtin University

Science educators generally agree that science should be understood as a multi-modal discourse, linking verbal, visual, experimental, and mathematical modes. This case study with first year non-major students in an Australian university over two years investigated how students demonstrated their use of multiple representations to help them understand concepts of introductory physics. Following an action research cycle, we asked students to respond to two questionnaires on the topic of thermal physics and optics. To assess students' conceptual understanding using four different representations (words, diagrams, formulas, and graphs), we asked them to use as many representations as possible in the questionnaires. The analysis of students' answers on the questionnaires revealed that only explicit prompting resulted in a significant increase in students' ability to present a concept using different representations. However, a large number of students were unable to use more than one or two representations to answer the questions effectively no matter the format of the questions. This study concludes that in order to guide students to make use of multiple representations in learning physics, teachers need to explicitly help students use multiple representations in class for their conceptual learning.

Fostering Non-Science Track Students' Knowledge-Based Decision-Making of Solar Energy Policy

Friday, 1.30pm – Room 3

Che Ming Tsai & Huei-Chih Chang
National Taiwan Normal University

Recent curriculum reform envisions scientific literacy for all. One of the indicators is for students to make knowledge-based decisions. This qualitative study investigated how non-science track students benefit from learning science through the problem-based instruction. Two classes of 11^{th} graders from a boy's senior high school in a metropolitan city participated in the teacher researcher's development and trial of two curriculum modules that covered the same core science knowledge and illustrated the solar cell module deployed in the school campus as an appealing context. One class learned about solar energy and related energy policy through the problem based instructional approach, the other class through the conventional comprehension approach. Collected data included one survey of students' prior knowledge and experiences about solar energy; revised concept maps for developing learning materials to address students' misconceptions; pre- and post- tests of open-ended short answer questions and essay questions to probe students' understanding of electro-photo effects and decision-making of energy policies, and videotapes. The analysis results indicated that students in the problem-based instruction exhibited sustained interests and willingness to gain deep understandings about energy issues as well as applying quality science knowledge to reflect upon related policies. Implications for educating non-science track students are discussed.

Scaffolding Students' Qualities of Arguments by Online Argumentation System

Thursday, 10.35am – Room 6

Chun-Yen Tsai
Cheng Shiu University

This study focused on scaffolding students' argumentation through an online argumentation system which was based upon the Cognitive Apprenticeship theory. One hundred and eighty-nine students participated in several activities during one semester. The qualitative analyses adopted in this study were based upon the Toulmin Argument Pattern. To assess the participants' quality of arguments, researchers coded the participants' responses in five areas: 1) claim (C), 2) data (D), 3) warrant (W), 4) backing (B), and 5) rebuttal (R). The data was coded by two researchers and the results of two coding analyses revealed a satisfied inter-rater reliability. The results showed that the participants in the experimental group improved their qualities of argument while the participants in the control group did not. In the experimental group, the participants having low ability improved their qualities of arguments from C to C-D-W patterns. The participants who demonstrated an intermediate ability improved their qualities of arguments from C-W to C-D-W-R patterns. The participants having high ability improved their qualities of arguments from C-D-W to C-D-W-B-R patterns. Thus, this online system was revealed to be a useful tool for the argumentation instruction because it helped students think more clearly and argue more logically.

Representations of the nature of science in South African Grade 9 Natural Science textbooks

Thursday, 2.30pm – Room 3

Elaosi Vhurumuku
University of the Witwatersrand

In South Africa, post apartheid science education curriculum reform has necessitated the production of new textbooks designed to promote the visions and aims of a new science curriculum (Department of Education, Revised National Curriculum Statement, 2005). The development of learners' understandings of the nature of science (NOS) is an important goal of this curriculum. While textbooks provide important pedagogical pathways for developing learners' NOS understandings, no study has been done in South Africa to analyze the representations of NOS by the science textbooks popularly used in science classrooms. This paper reports the results of a study that used *content analysis* to investigate the ideas about NOS included in three of South Africa's Grade 9 Natural Science textbooks. It also analyzed the manner in which these ideas are represented. Seven tenets of the NOS were selected for analysis. The results show that the tenets "science is empirical"' and 'the difference between observation and inference' get better representation compared to the other investigated tenets. However, overall; for the three textbooks this representation is largely implicit and naive. Explicit and informed representations were found to be minimal or non-existent. Recommendations for textbook development are suggested.

Using student reasoning through representations to develop conceptual understanding of Newton's laws of motion

Friday, 2.15pm – Room 1

Bruce Waldrip[1] & Vaughan Prain[2]
[1]Monash University, [2]La Trobe University

There is growing research interest in the challenges and opportunities learners face in representing scientific understandings, processes and reasoning. Our paper reports on a teacher focus on students' thinking and reasoning as they engaged in a sequence of representational challenges on the topic of motion. Students verbalized initial understandings of key terms, and then negotiated with partners the meanings of their explanations. They then tested the adequacy of their descriptions and claims through guided inquiry using simple everyday equipment. In each lesson, the teacher prompted students to test and justify the adequacy of their verbal and subsequent multi-modal representations through new questions, or activities, to challenge and clarify some of their views. The activities and questions required students to refine or modify 2D or 3D representations of their emerging claims. In each case, after the students had resolved different representational accounts within groups, the class discussed these representations in teacher and/or student-led discussion. Data from classroom observations, transcripts of discussions, and interviews with students and teachers, suggest the value to students' learning in this topic through reasoning about representational adequacy.

From the frying pan into the fire: Mid-career science professionals transitioning to teaching

Thursday, 1.00pm – Room 7

James J. Watters
Queensland University of Technology

Recruiting and retaining quality science teachers is a major issue highlighted in numerous reports. The beginning years of teaching are crucial as the teacher refines his or her knowledge of teaching and joins the professional community. The aim of this paper is report the experiences of 15 highly subject matter qualified beginning science or mathematics teachers as they transitioned from a professional career to that of science/maths teaching. The participants were all dissatisfied with their existing career and considered a shift to teaching might bring personal rewards and a sense of achievement missing in their current work. Data drawn from classroom observations, extensive interviewing of the beginning teachers and surveying of their students over a three year period revealed those circumstances that supported or discouraged continuation in teaching. Of the 15 teachers only eight remained in service at the beginning of the third year. A dominant feature emerging from the study was the leadership role played by administrators and support provided by colleagues. The degree of job autonomy, learning opportunities, supervisor support for job success, co-worker team support for job success, and involvement in management decision making and workplace flexibility were dominant features that contributed to retention of these teachers.

Social Engagement and the Effectiveness of Online Meeting for Science Teacher Professional Development

Friday, 11.15am – Room 3

Meichun Lydia Wen[1] & Pi-Chu Kuo[2]
[1]National Changhua University of Education, [2]National Pingtung University of Education

The main purpose of this study was to discuss the role of social engagement in the effectiveness of online meetings for science teacher professional development. To save time and the cost of transportation, three in-service elementary science teachers and their mentor, who is an junior science educator/faculty in a university, participated in this online meeting mainly focused on the topics and materials of discussion-based science courses. The interaction data collected and analysed in this study were the online messages during the 8 weeks of online meeting. There were 12 discussion strings and a total of 1138 messages during this period of time. The messages were read and coded by one of the authors according to Ke and Xie's (2009) online learning interaction model. Descriptive statistics and Chi square tests were used to examine differences across categories and other variables. The results indicated that the level of social engagement is strongly correlated with their performance in allocentric elaboration and coordination, suggesting that although the main purpose of online meeting is to accomplish a specific collaborative task, a certain percentage of social interaction or off-line conversation can also promote the effectiveness of online meeting.

Reframing Science Education for a Flexible Learning Context: Making Science Matter

Thursday, 2.30pm – Room 7

Kimberly Wilson
James Cook University

Edmund Rice Education Australia Flexible Learning Centres (EREAFLCs) operate within a social inclusion framework to 'walk with' young people who have disengaged from the traditional schooling system. To cater for the needs of diverse young people, the centre's aim is to provide a holistic and integrated curriculum that allows students full access to a broad and comprehensive educational experience. This research project came to life through inquiry on behalf of the FLC Network as to how they might partner with academics to expand and develop the science education component of their curriculum in a manner authentic to the guiding principles of the network. Practical implementation of the research project has seen young people engage in units of work thematically united through an emphasis on education for sustainability – encompassing both the environmental and social components of this approach. Topics have included an environmental wetlands regeneration project, a community garden project, alternative energy/solar oven building projects and a reef ecosystem project. Significant outcomes of these projects have been an increase in student participation and attendance, expansion of students' social capital networks and evidence of increased student awareness of the connection between actions of the self and community and environment well-being.

Community Action as Learning for Scientific Literacy: A Deweyan Approach

Thursday, 1.00pm – Room 6

Mihye Won[1] & Bertram C. Bruce[2]
[1]Curtin University of Technology, [2]University of Illinois at Urbana-Champaign

In order to cultivate scientific literacy, science educators have tried to include students' personal and social experiences in science learning. We studied how one such effort played out in an alternative high school in a low-income, immigrant community in Chicago area.

The school has a unique history of engaging students in various community actions.

Recognizing an urban agriculture as a way to support their community's basic needs, the community leaders and students designed and implemented a social ecology curriculum. Students learned about plants, hydroponic and soil-based gardening, diet and health, and their cultural heritages. They made their traditional dishes with the harvested vegetables and shared them with the community. Although the students did learn science to address their community issues, the project was not without difficulties.

We used John Dewey's theory of inquiry to help us to understand the issues of implementing such activities. While contemporary educators often disregard Dewey's philosophy as old-fashioned, we found that re-examination of his philosophy afforded an opportunity to explore the integration of students' experience into school activities and how we should go about to implement it most effectively. We then suggest a way to re-establish school science to enrich and empower students' lives.

Nanoscale science teaching in an informal setting: An investigation of the relationship between pedagogical approaches and students' situational interests

Thursday, 3.35pm – Room 7

Kun-Chang Wu[1], Paichi Pat Shein[2], Pei-Yu Hsieh[2], Jui-Chou Cheng[3], Dong-Hwang Chen[4] & Tai-Chu Huang[2]
[1]Ruei Fong Elementary School, [2]National Sun Yat-Sen University, [3]National Kaohsiung Normal University, [4]National Cheng Kung University

The purpose of this research was to enhance K-12 students' learning of nanotechnology in science education. A new program called "Integrating Nanotechnology into K-12 Science Curriculum (INSC)" was designed to promote students' situational interest in nanoscience in particular and science in general at the Science and Technology Museum in Taiwan. A questionnaire entitled "The Questionnaire of Situational Interest" (SI) was designed and administered before and after the program. Situational interest consisted of two forms—triggered-SI and maintained-SI. Students responded to 12 questions in a 5-point Likert scale. The sample consisted of 99 high school students, 110 secondary students, and 98 primary students in southern Taiwan. The results indicated that 1) The K-12 INSC course program resulted in a significant and overall improvement in the quality of students' situational interest. 2) Students' triggered-SI and maintained-SI both increased significantly across different academic settings**.** In particular, the high school students exhibited the largest growth in the maintained-SI-value. 3) Students were divided into 3 sub-groups according to their high, medium and low scores of situational interests prior to the program. Both high- and low-scored groups benefited from the INSC programs with an increase in situational interest, especially for low-scored groups. 4) A high percentage of students, especially primary students, commented that the hands-on activities increased

their participation in learning. Some suggestions for learning and teaching of nanotechnology education will be proposed.

The Challenges of Making Sense of the Microscopic World in a Secondary Science Classroom

Thursday, 2.30pm – Room 1

Lihua Xu & David Clarke
University of Melbourne

Despite its importance, many studies have found that students experienced great difficulties in understanding the ideas behind the particulate nature of matter and its associated concepts (Driver*, et al.*, 1985; Driver & Project, 1994). Based on the perspective of Distributed Cognition (Hutchins, 1995), our analysis focused on social interactions between classroom participants and their interactions with physical, conceptual and symbolic artefacts. Student understanding was examined as performed in their actions and displayed in their written work. This paper examines a group of students' attempt to make sense of the particulate ideas and to explain several phenomena such as melting, boiling, expansion, and contraction in their classroom. It appears that even though the Particle Theory had been introduced as a model in the classroom that can be used to explain many changes undergone by matter, the students tended to use the macroscopic properties to explain the microscopic ones, rather than the opposite. We propose that the notion of substance could be the key to unlock the macroscopic-microscopic relationship and its introduction could potentially help the students to see how the particle model could be applied in a variety of situations.

What does it mean to be Scientifically Literate?: A comparative investigation of science curricula from Australia, China, and Finland

Friday, 3.20pm – Room 7

Lihua Xu
University of Melbourne

As an internationally well-known educational slogan, scientific literacy is central to debates about aims and purposes of school science (e.g. Millar, 2005) and is examined in both national and international assessments (e.g. NAP-SL, PISA). Despite its widespread use, there are many different meanings and interpretations associated with the concept of scientific literacy (Hurd, 1998; Laugksch, 2000; Norris & Phillips, 2003). This study attempts to explore the meaning of scientific literacy through a comparative investigation of the intended science curricula from Australia, China, and Finland. The key documents analysed in this study include Victorian Essential Learning Standards, Chinese Science Curriculum Standards, and Finnish National Core Curriculum. Curriculum standards statements from each document were analysed using a two-category system: topic coverage and performance expectation (Porter & Smithson, 2001). The results of the study demonstrate similarities and differences in both the organization and the emphasis of each curriculum, revealing the extent to which scientific literacy is culturally grounded. This study has significant implications for science curriculum development and science education as a whole.

Elementary Teachers' Acquisition of Pedagogical Content Knowledge from Curriculum Materials: A Case Study of Japanese Pre-service and In-service Teachers

Thursday, 3.35pm – Room 1

Etsuji Yamaguchi, Shigenori Inagaki & Tomoyuki Nogami
Kobe University

Curriculum materials promote not only student learning but also teacher learning. Rather than focusing on "innovative learning" (critiquing or analysing curriculum materials) as of one axis of adaptive expertise as previous researches have done, our research focuses on "effective learning" (acquiring knowledge from curriculum materials) as another axis. Previous researches cover high and poor quality curriculum materials, and emphasize the metacognitive aspect of the teachers' learning. In contrast, our research covers high quality curriculum materials only, and focuses on teachers' acquisition of important knowledge directly or immediately from the materials. This research tries to investigate whether or not Japanese pre-service and in-service elementary teachers are able to acquire pedagogical content knowledge (PCK) from high-quality curriculum materials. It was found that the number of teachers falling under the category of "teacher who can acquire PCK" was much lower than those falling under the category of "teacher who cannot acquire PCK" in the case of pre-service teachers, while the reverse was found to be true in the case of in-service teachers. Finally, we discuss some elements required for pre-service and in-service elementary teachers' learning environments.

The Impact of Self-Regulated Learning on Cell Concept Learning for Seventh Graders

Friday, 3.20pm – Room 5

Kun-Yuan Yang [1], Chun-Tao Tsai[2] & Miao-Li Changlai [3]
[1]Chung Yuan Christian University, [2]Ping Jen Junior High School, [3]China University of Technology

The purpose of this study was to investigate the impact of self-regulated learning (SRL) on seventh graders' cell concept learning by quasi-experimental design and qualitative analysis. 32 students of the experimental group (incorporating SRL) and 34 students of the control group participated in the research. Results of the research showed that the effects of SRL were significantly better than those of lecture-based learning on a Two-tier Diagnostic Test of the World under Microscope (TTWM) and Self-Regulated Learning Inventory (SRLI). The correlation between scores of TTWM and SRLI was significant for experimental group students. Twelve prior cell alternative conceptions for experimental group students were improved after they finished SRL activities.

Postgraduate Science Teacher Students' Representations of Pedagogical Content Knowledge

Friday, 9.30am – Room 8

Chokchai Yuenyong
Khon Kaen University

The paper aimed to examine postgraduate science teacher students' representation of pedagogical content knowledge (PCK). Participants included 273 postgraduate science teacher students of 7 universities (5 universities located in northeastern, and 2 universities in southern, Thailand) who were awarded scholarships under the Project for the Promotion of Science and Mathematics Talented Teachers (PSMT). Their

representations of PCK were interpreted through the tasks from Loughran, Berry, Mullhall's (2006) Content Representation (CoRe) when they attended the workshop for developing teachers' characteristics. The paper will discuss various representation categories of PCK among different universities. This may have implications for science teacher education in Thailand.

Design and implementation of a problem-based learning laboratory course and an investigation of its effectiveness

Friday, 4.00pm – Room 2

Heojeong Yoon & Ae Ja Woo
Ewha Womans University

Laboratory activities have rich potential benefits; however current laboratory instructions in Korea are criticized because they do not attain the authentic purpose. Problem-based learning (PBL) was known to be effective to improve scientific thinking ability, scientific attitude and self-regulated learning skills. We proposed a PBL laboratory course as a substitute for the typical method for both high school and university students. We investigated the changes in students' scientific attitude, self-regulated learning skills and perception towards the course after their participation in the program. For high school students, it was designed as an after-school program and implemented for nine weeks. Online discussions and experiments were performed during class hours. For college students, it was designed as a substitute for an existing laboratory course, and implemented for one semester. Students of a typical analytical chemistry laboratory course were used as a comparative group for statistical analysis. PBL was shown to be an effective pedagogical approach to improve scientific attitude and self-regulated learning skills. Most students showed positive responses toward the program, however some of them mentioned difficulties when solving problems at the beginning, and lack of time. This was done for only a small number of high school and university students, therefore further research is required in order to confirm the effectiveness of the program.

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