ASERA 2010

41st Annual Conference

CONFERENCE PROGRAMME AND ABSTRACTS

30th June – 3rd July, 2010
Shoal Bay Resort and Spa, Port Stephens, NSW, Australia

THE UNIVERSITY OF NEWCASTLE AUSTRALIA

ASERA 2010

The 41st Annual Conference of the Australasian Science Education Research Association

30th June – 3rd July, 2010
Shoal Bay Resort and Spa, Port Stephens, NSW, Australia

Hosted by:

THE UNIVERSITY OF NEWCASTLE AUSTRALIA

http://www.asera.org.au/

TABLE OF CONTENTS

Welcome and Introduction 4

The History of ASERA Conferences 5

Program Overview 9

Conference Map 10

General Conference Information 11

Program of Presentations 13

Abstracts 23

List of Participants 87

WELCOME AND INTRODUCTION

Welcome to the Shoal Bay Resort and Spa, Port Stephens, NSW.

Aboriginal tribes known as the Worimi first inhabited this region, and lived mainly around the shoreline. In 1795, HMS Providence visited Port Stephens and the sailors were amazed to find five Englishmen living with the Worimi. These turned out to be convicts who had escaped from Parramatta, which is now part of Sydney. They had been shipwrecked at Port Stephens in 1790, but had been welcomed into the tribe by the Worimi.

Today, Port Stephens is a popular summer vacation area featuring beautiful waterways, white sandy beaches and extensive national parks. It is a well-known whale and dolphin watching area with crystal clear waterways and volcanic headlands. The waters are a breeding ground for seahorses, and one of Australia's best known wine growing regions, the Hunter Valley, is a short drive away. The Shoal Bay Resort and Spa is an award-winning resort located on the waterfront.

The official host of the conference is the University of Newcastle. It was established in the early 1950s with just five full-time students. It now boasts more than double that number. The university is characterised as a university of distinction, and its reputation is shaped by internationally recognised strength in research and an enduring commitment to quality teaching and learning, environmental sustainability, and equity and diversity.

We would like to thank all the people who have contributed to this conference. Professor Jenny Gore, Head of the School of Education, University of Newcastle, has kindly provided financial support for staff to help organise the conference and to attend: our thanks to Amanda Turner, Barry Prior, Paul Davies, Susan de Sain and Hywel Ellis for their invaluable assistance. In addition, we have a number of primary teacher education students who have volunteered to assist during the conference – please be nice to Alice Wood, Katie Cherrington, Bree Tamsett, Georgia McCabe, Kailey Hughes, Clare Whittaker and Monica Howard. They are ably assisted by Julie Logan, Owen Palmer & Rebekah Parkes. We would finally like to thank Amy Dodd, our function coordinator from Shoal Bay Resort and Spa, who is really cool and good to work with.

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

Dave Palmer
Vicki Parkes
Mitch O'Toole

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 Zeegars & 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 2010 PROGRAM OVERVIEW

Wednesday 30th June

4-8pm	registration desk* open
6-8pm	Welcome Reception and Conference Opening**

Thursday 1st July

8.15am	registration desk* open
8.30 – 10 am	presentation of papers (2 sessions)
10 – 10.30am	morning tea
10.30 – 12.45	presentation of papers (3 sessions)
12.45 – 1.30	lunch
1.30 – 3.40	presentation of papers (3 sessions)
3.40 – 4pm	afternoon tea
4 – 5.30	presentation of papers (2 sessions)
5.30 -7.30	RISE Editorial Board Meeting****

Friday 2nd July

8.15 am	registration desk* open
8.30 – 10.00	presentation of papers (2 sessions)
10 –10.30am	morning tea
10.30 – 12.45	presentation of papers (3 sessions)
12.45 – 1.30	lunch
1.30 – 3.40	presentation of papers (3 sessions)
3.40 – 4pm	afternoon tea
4 – 5.30	ASERA AGM**** + papers (2 sessions)
7 – 10.30pm	Conference Dinner***

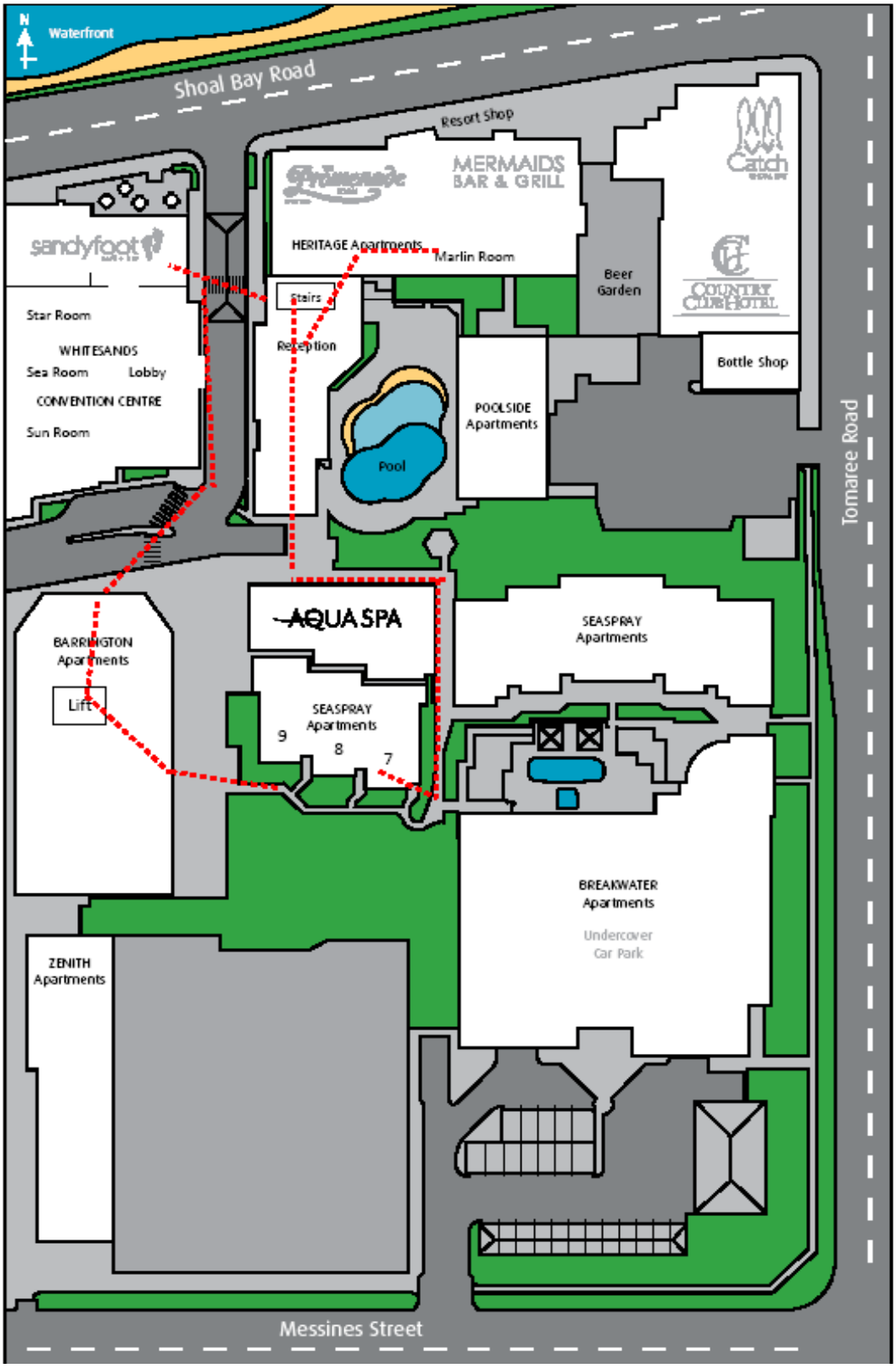
Saturday 3rd July

8.15am	registration desk* open
8.30 – 10.40am	presentation of papers (3 sessions)
10.40 – 11am	morning tea
11 – 1.15	presentation of papers (3 sessions)
1.15 – 2pm	lunch

* Lobby of the Whitesands Convention Centre
** Promenade Restaurant
*** Sea/Star Rooms
**** Sun Room

CONFERENCE MAP

The dotted lines show how to get to the rooms.



GENERAL CONFERENCE INFORMATION

Annual General Meeting
The ASERA Ltd Annual General Meeting will be held on Friday 2nd July at 4pm in the Sun Room. All members are welcome to attend.

Airport transfers on Saturday 3rd July
To return you to Newcastle Airport on Saturday, there will be shuttle buses departing from Shoal Bay Resort at 6.30am, 8.30am, 12.00 midday, 2pm and 4pm (the $20 fare applies). You should take the bus that departs about 2 hours before your flight, to allow at least 40 minutes for the trip and one hour for check-in.

Chairing Sessions
If you are presenting a paper, then you have probably been assigned to chair a session for someone else on the same day and in the same room as your own presentation. If you are presenting two papers then you could be chairing two other sessions. Please check the program of presentations. If you are not presenting any paper then you have not been assigned to chair a session.

Individual sessions last 40 minutes. This allows 20 minutes for paper presentation and 20 minutes for questions. The Chairperson should introduce the speaker and monitor the time for the speaker. If you are unable to chair a session for which you have been assigned, please arrange to swap with someone else.

Registration Desk
This will be located in the lobby of the Convention Centre (in front of the Sun, Sea and Star Rooms). It will first open on Wednesday 4-8pm. Please bring your Powerpoint presentation on a thumb drive to be checked on our hardware. The registration desk will open each following day at 8.15am.

Welcome Reception and Conference Opening
Unlike past ASERA conferences, the official conference opening will be held on Wednesday evening, at the Welcome Reception. This will be held in the Promenade Restaurant, 6-8pm Wednesday, with the Conference Opening at about 7.30pm. There will be drinks and canapés provided.

Conference dinner
The conference dinner will be held in the Sea and Star rooms at the Resort. Pre-dinner drinks will be available from 7pm, and a three-course dinner will be served at 7.30. After 10pm you will need to buy your own drinks. Live music will be provided.

If you are staying at Group B alternative accommodation (ie. Admiral Nelson Motor Inn, Peninsula Nelson Bay, Beaches Services Apartments, Leilani Serviced Apartments, Shoal Bay Beach Club Apartments, Casablanca at Little Beach, Halifax Holiday Park) a shuttle bus will pick up delegates at 6.45pm to bring you to the conference dinner. The bus will make return trips to your accommodation, leaving the

resort at 10pm, 10.30pm and 11pm. Please be ready and waiting out the front, as the bus will not wait.

Daily shuttle bus to Shoal Bay Resort: Thursday and Friday
If you are staying at Group B alternative accommodation a shuttle bus will pick you up at 8am to take you to the resort. Please be ready and waiting out the front, as the bus will not wait for you. The return trip will depart from the resort at 5.40pm.

Daily shuttle bus to Shoal Bay Resort: Saturday
On Saturday morning the shuttle bus will pick up delegates from Group B alternative accommodation at 8am to take you to the resort. You should have checked out of your accommodation and have all your luggage with you. You can store your luggage at the resort until you need to take the bus to the Airport. There will be no return trip to Group B accommodation on Saturday.

Meals
Morning and afternoon teas will be served in the lobby and the Sandyfoot Café. Lunches will be held in the Promenade Restaurant and Mermaids Bistro.

Parking
If spaces are available, you can use the resort car park. If it is full, there is limited parking on the street.

Posters
Several people are presenting posters about their research. These will be displayed at morning teas and afternoon teas near the registration desk. Please take some time to look at these and chat with the authors nearby.

RISE Board Meeting
There will be a meeting of the RISE Editorial Board on Thursday 1st July at 5.30pm in the Sun Room.

Help
Taxis are available on 49846699. If you have major problems with transport or accommodation during the conference please call Dave Palmer on 0403 474965. If you have problems with audiovisual equipment in your presentation please ring the number provided next to the data projector in your presentation room, or go to the registration desk. If you require medical or security services please contact reception at the resort.

PROGRAM OF PRESENTATIONS

THURSDAY 1ST JULY (sessions before morning tea)

	STAR ROOM	SEA ROOM	SUN ROOM	MARLIN ROOM	SEASPRAY 7	SEASPRAY 8	SEASPRAY 9
Thurs 8.30-9.10	**SYMPOSIUM:** Science teacher emotions **K Tobin, S M Ritchie, P Hudson & V Mergard** *Emotional climate, laughter and the quality of enacted science education* **S M Ritchie, K Tobin, P Hudson, W-M Roth, J Oakley & V Mergard** *Reproducing Successful Rituals in Bad Times: Exploring Emotional Interactions of a New Science Teacher.* Chair: **self-appointed**	**R M Roslan** *Analysing teacher-student interactions in a year 6 UK science classroom* Chair: **P Farrelly**	**M S Hartley** *Investigating the science – related attitudes of learners at 5 secondary schools where science clubs have been established.* Chair: **H Nakayama**	**G Chittleborough & J Cripps-Clarke** *The Pre-service science teachers experience: Building relationships among supervising teachers, coordinating teachers and university staff* Chair: **C Campbell**		**Waldrip & V Prain** *Effects of a representation-intensive approach to learning science on students' performance in assessment* Chair: **T A Chen**	**A Jones, B Cowie & A Dougahy** *A research agenda for the development of resources for the 21st century teacher* Chair: **B Palmer**
Thurs 9.15-9.55		**D Goodrum** Science by Doing – *Professional Learning Approach* Chair: **M Hanrahan**	**M Kim & J Song** *Learning fatigue in a science museum and a science classroom* Chair: **M L Wen**	**E Jantarakantee, V Roadrangka & A Clarke** *Pre-service science teachers' understanding of classroom research principles and the need of supervision about classroom research from their cooperating teachers and university supervisors* Chair: **J Robbins**	**K Thathong** *The Development of Integrated Instruction for Natural Resources Conservation Using Forest in Khok Phu Taka as The Learning Resource for Schools in Phu Wiang Areas* Chair: **M Slarp**	**P Hubber** *The Role of Representation in Teaching and Learning Ideas about Matter* Chair: **J-R Choi**	**C-D Lee & T-H Jen** *Ways of writing about work and potential energy in textbooks of Taiwanese junior high school* Chair: **M R Matthews**
THURSDAY 10.00-10.30 MORNING TEA: Lobby and Sandyfoot Cafe							

THURSDAY 1ST JULY (sessions between morning tea and lunch)

	STAR ROOM	SEA ROOM	SUN ROOM	MARLIN ROOM	SEASPRAY 7	SEASPRAY 8	SEASPRAY 9
Thurs 10.30-11.10	**SYMPOSIUM:** Enhancing Classroom discourse in primary science **M Hackling, P Smith & K Murcia** *Managing a discourse of inquiry: A new pedagogical framework* **P Smith & M Hackling** *Enhancing classroom discourse: Teaching primary science with puppets*	**H-J Kim, S-J Pak & S-M Im** *Students' Belief about Learning Physics As a Resource of Teaching Physics* Chair: **K Bingimlas**	**L J Rennie, S M Stocklmayer & J K Gilbert** *Collaboration, Communication and Complementarity: Improving Science Education* Chair: **M Oliver**	**Z-R Hong, H-S Lin, H-T Chen, H-H Wang, M-S Zheng & T-C Yu** *An Investigation of Elementary School Students' Self-expectation, Involvement, and Interests in Learning Science* Chair: **K-C Chien**	**C Greive, K de Berg & P Morey** *A study of factors associated with preservice teachers' intention to teach units on environmental issues in the primary school context* Chair: **J K Hsieh**	**C Preston** *Primary children's interpretation of food chain / web diagrams*	**D H McKinnon, L Danaia & M Cross** *Pre-service teachers' personal and general science teaching efficacy: A longitudinal case study* Chair: **H-L Tuan**
Thurs 11.15-11.55	**K Murcia & R Sheffield** *Interrogating the impact of interactive whiteboard technology on science discourse* **A Fitzgerald** *Understanding the practices of effective primary science teachers: A case study of teaching and learning in one classroom* Chair: **self-appointed**	**R Subramaniam** *A Teacher Professional Development Program to remediate misconceptions in Physics* Chair: **S Chen**	**K Doyle** *Dynamic Shifts for School Science Foundations* Chair: **I-C Chung**	**J Na & J Song** *A Review of Instruments Assessing the Understanding of the Nature of Science.* Chair: **J Donovan**	**A Hassan & N A Rahman** *The environmental conservation behaviour status among undergraduate students at Universiti Kebangsaan Malaysia* Chair: **J Song**	**P-Y Liao, W-G Yang, C-C Yeh & P-S Huang** *An exploration of the linguistic nature of the reading difficulties encountered by an Atayal student* Chair: **S-S Lin**	**J J Gomes & P Mulhall** *How do science teachers perceive student interest in science?* Chair: **J J Lee**
Thurs 12.00-12.40		**Y Lee, J-S Jeong, SG Yun & S Im** *An analysis of the visually impaired students' observation ability in physics experiments using substitute sense for vision* Chair: **Chih-Chen Chou**	**C-Y Wang** *Influence of metacognitive skilfulness on thinking problems of molecular geometry and polarity* Chair: **A Kazakoff**	**Z Zhu** *A study of Chinese secondary physics teachers' beliefs and their instructional practices regarding inquiry-based teaching* Chair: **Y Zeegers**	**J K Hsieh** *The influence on 6th graders' knowledge and attitude towards environment with out-of-school learning ~ Visiting a thermal power station* Chair: **H-Y Ting**	**M Hanrahan** *Out of this world! and into their world! Inspiring confidence in disadvantaged secondary students through teaching subject-specific literacies in a meaningful context* Chair: **F-P Hsieh**	**P Aubusson , J Griffin & G Sawle** *The professional learning preferences of primary science and technology teachers.* Chair: **C-M Yang**
THURSDAY 12.45- 1.30 LUNCH: Promenade Restaurant and Mermaids Bistro							

THURSDAY 1ST JULY (sessions between lunch and afternoon tea)

	STAR ROOM	SEA ROOM	SUN ROOM	MARLIN ROOM	SEASPRAY 7	SEASPRAY 8	SEASPRAY 9
Thurs 1.30-2.10	**K Musikul** *Exploring Thai primary students' understanding about the world before they come to science classroom* Chair: **M Hackling**	Chair: **H-J Kim**	**M Oliver, G Venville & P Adey** *Thinking Science Australia: Improving teaching and learning through science activities and reasoning* Chair: **L J Rennie**	**J-H Cheng, K-C Chien & C-Y Lin** *Using "Serial Historical Models" (SHM) to promote students' understandings of the gene concept* Chair: **Z-R Hong**	**Y W Cheong & J Song** *University Students' Understanding of Wave-Particle Duality* Chair: **J K Hsieh**	**L-T Cheng, U-L Lin, S-Y Liu & J-F Hung** *Enhancing Students' Argumentation Abilities for High Quality Decision-Making* Chair: **P Hubber**	**C-H Hsieh, H-L Tuan & C-C Chin** *An exploratory study of students' inquiry competence and science teachers' inquiry teaching performance* Chair: **D H McKinnon**
Thurs 2.15-2.55	**P Pimthong** *The Effects of Multiple Factors on Teaching for Conceptual Change in Thai Primary Science* Chair: **K Murcia**	**S Chen, W Li & W-C Su** *Is physical manipulation crucial for science learning?* Chair: **R Subramaniam**	**J-F Hung & I-C Chung** *From Teachers' Questioning To Students' Asking Questions: The Case Of Learning To Plant Anthuriums In Their School* Chair: **K Doyle**	**J Donovan** *The impact of the mass media on students' understandings of genes and DNA: Preliminary findings.* Chair: **J Na**	**A T Wang, J K Hsieh & Y Chen** *The green-energy curriculum with project-based instruction connecting high school and university educations* Chair: **C Greive**	**S-S Lin** *Exploring the Argument Skills of Sixth Graders with Different Language Abilities in a Socioscientific Context in Taiwan* Chair: **P-Y Liao**	**J J Lee & H-B Kim** *Beyond the behavior of individuals: students' engagement in project-based scientific inquiry* Chair: **J J Gomes**
Thurs 3.00-3.40	**S W Chen & W J Yang** *Research trends of science education in Taiwan from 2000 to 2009* Chair: **A Fitzgerald**	**Chih-Chen Chou & C-C Tsai** *The gap between medical science education and clinical learning: the role of educational technology* Chair: **Y Lee**	**A Kazakoff** *Using concept mapping to scaffold learning for students who experience learning difficulties in science classes* Chair: **C-Y Wang**	**Y Zeegers, K Paige & D Lloyd** *'Operation Magpie': are we engaging teachers with science, and students with their environment?* Chair: **Z Zhu**	**H-Y Ting, C-F Chiang & J K Hsieh** *The hydrogen-fuel concept immerged in chemistry curriculum based-on-inquiry for senior high students in a middle Taiwan high school* Chair: **A Hassan**	**F-P Hsieh & S-T Lee** *Utilizing a graphic organizer for promoting pupils' argumentation* Chair: **M Hanrahan**	**C-M Yang & I T-C Haung** *The Effect on Enhancing Inquiry Abilities via Step-by-Step Open-ended Inquiry Teaching Design* Chair: **P Aubusson**
THURSDAY 3.40- 4.00 AFTERNOON TEA: Lobby and Sandyfoot Café							

THURSDAY 1ST JULY (sessions after afternoon tea)

	STAR ROOM	SEA ROOM	SUN ROOM	MARLIN ROOM	SEASPRAY 7	SEASPRAY 8	SEASPRAY 9
Thurs 4.00-4.40	**SYMPOSIUM:** Improving secondary science education in Bangladesh **S T Akhter** *Curriculum emphases of secondary science education* **M M A Sarkar** *Promoting scientific literacy through secondary science textbooks* **M N A Siddique** *Promoting scientific values through secondary science teaching* **S M H Rahman** *Developing secondary science teachers' professional learning communities* Chair: **self-appointed**	**Boylan & Stephens** *Selection of senior secondary science subjects by pre-service primary teacher education students* *Chair ?*	**M Sumida, H Nakayama & J B Faustino** *Linguistic analysis on Japanese Science Textbooks* Chair: **M S Hartley**	**C Campbell** *The Early Years Framework – where is the science?* Chair: **G Chittleborough**	**J Clark** *Birds of a feather: Teacher Education students' knowledge of Sydney wildlife* Chair: **S C Almeida**	**T A Chen , I-C Huang & D Chao** *Discourse Analysis of High School Students' Debate on a Socioscientific Issue: Suao-Hualien freeway project in Taiwan* Chair: **B Waldrip**	**M R Matthews** *Science and Worldviews in the Classroom: Joseph Priestley and Photosynthesis* Chair: **C-D Lee**
Thurs 4.45-5.25		**P Farrelly** *The Learning Environment and Science in Schools: School science as an ecosystem* Chair: **R M Roslan**	**M L Wen** *A preliminary eye-movement study of science education graduate students' reading behaviour* Chair: **M Kim**	**J Robbins** *Rural and Urban Early Childhood Teachers' Knowledge in Technology Education* Chair: **E Jantarakantee**	**M Slarp** *Using children's drawings to determine conceptual understanding of ecology* Chair: **K Thathong**	Chair: **L-T Cheng**	**B Palmer** *The story of H. E. Roscoe: friendship, politics, textbooks and research* Chair: **A Jones**
Thurs 5.30 – 7.30			*RISE EDITORIAL BOARD MEETING*				

FRIDAY 2ND JULY (sessions before morning tea)

	STAR ROOM	SEA ROOM	SUN ROOM	MARLIN ROOM	SEASPRAY 7	SEASPRAY 8	SEASPRAY 9
Frid 8.30-9.10	**R Levinson** *Science education, scientific literacy and the problem of democracy* Chair: **L H Seah**	**L-L Tsai & P-Y Lin** *Can learning feminism help to retain women students to stay in science careers?* Chair: **S-C Chen**	**H Nakayama & Y Saruta** *An Analysis of The Sequences of Problem Solving in the Japanese 6th Grade School Science Textbook: In the Content Area of "Substances and Energy"* Chair: **P J Fensham**	**C-J Huang** *Teaching Socio-Scientific Issues in Taiwan via Science News Writing, Peers Discussions and Interactive Use of Website* Chair: **E J Park**	**S-Y Lin** *Students' Understandings of Metric Scale and Size of Objects in Higher Education* Chair: **A Hassan**	**E Blake, C Howitt & S Peet** *"I had a good science!" Evaluation of a new science incursion into kindergarten classrooms* Chair: **K Buaraphan**	**C V McDonald, D Heck, R Cooper & C Christensen** *Exploring the influence of an argumentation professional development program on inservice secondary science teachers' views of nature of science* Chair: **S-F Lin**
Frid 9.15-9.55	**D Corrigan, R Cooper & S Keast** *Expert Science Teachers Notions of Scientific Literacy* Chair: **B White**	**D V Smith** *Gender and Science, individuals and essentialism: avoiding dichotomies.* Chair: **J-P Jong**	**Y-W Lin & S-T Lee** *The Inquiry of the Differences of Pupils' Reading Characteristics in Different argumentation-based texts* Chair: **J J Watters**	**C Yuenyong & P Narot** *Local Learning Enrichment Network (LLEN) in Khon Kaen Province: Two Years of Developing Science Teacher Network* Chair: **M Lee**	**W-C Chou, H-C She & L-Y Huang** *Explore the eye movement regarding to the cognitive process of concrete and abstract biology conceptions* Chair: **M Z Ismail**	D. Fittell *Student autonomy enhancing science learning: Observations from a Primary Connections implementation* Chair: **P Reis**	**L Danaia, D H McKinnon, Q Parker, D Frew & M Fitzgerald** *Space to Grow: The Faulkes Telescopes and improving science engagement in schools* Chair: **H-S Lin**
FRIDAY 10.00-10.30 MORNING TEA: Lobby and Sandyfoot Café							

FRIDAY 2ND JULY (sessions between morning tea and lunch)

	STAR ROOM	SEA ROOM	SUN ROOM	MARLIN ROOM	SEASPRAY 7	SEASPRAY 8	SEASPRAY 9
Frid 10.30-11.10	**B White** *Student perceptions of what helps them learn science* Chair: **L Xu**	**S M Bickford & N Longnecker** *Maximising benefits of field trips and guest speakers in secondary science education* Chair: **L-L Tsai**	**R Fawns, C Redman & S Rodrigues** *Researching lesson plans, language games and texts of identity in teaching Science: How do student teachers know their lesson plan is working? And how can teacher educators know?* Chair: **C Castaño**	**C E Scarff** *A Critical Stand of My Own: Responsible Environmental Science Education and Quality Thinking* Chair: **J Archer**	**S-K Lee, M-K Shin & G Lee** *Primary science teachers' epistemological understandings of school science practices* Chair: **C Howitt**	**L Liang** *Investigating science teachers' PCK and its role in achieving understandable learning for students* Chair: **L Halim**	**Y-S Hsu, W-S Chang, H-K Wu & F-K Hwang** *An Online Lesson Embedded with Metacognitive Strategies for Students' Conceptual Change and Inquiry Skill Development* Chair: **C-H Hung**
Frid 11.15-11.55	**L-L Tsai** *Toughness, Caring, and Smoothness: Gender culture and scientist identities in three women-led laboratories in Taiwan* Chair: **R Levinson**	**S-C Chen & H-C She** *Using Eye-Tracking System to Explore the Cognitive Retrieval Process of Physical Concepts* Chair: **F Haslam**	**W Giles** *Ways of knowing and doing: Science for preservice teachers in a remote community* Chair: **Y-W Lin**	**C-K Liu & M-H Chiu** *Modeling processes of the atomic structure in chemistry textbooks and their implication* Chair: **M R Logan**	**M McKinnon** *Primary teachers and science: Beliefs and influences* Chair: **C-T Hsu**	**R Cooper** *Experienced Science Educators Developing Pedagogical Content Knowledge* Chair: **T P McClafferty**	**J M O'Toole & K McKoy** *What's hot (or not)? A five-year review of journals in science education* Chair: **L Danaia**
Frid 12.00-12.40	**G Venville, S Bickford, M Oliver, N Longnecker & L Rennie** *Science careers outreach: One size doesn't fit all* Chair: **R Cooper**	**J-P Jong, M-H Chiu, C-K Chang & S-A Bai** *A secondary analysis study of a survey of Taiwanese students' conceptions of the behaviour of gas particles utilizing cognitive map approach* Chair: **D V Smith**	**J J Watters** *School administrators' perceptions of beginning secondary science and mathematics teachers.* Chair: **N Kaewkrisorn**	**K Boddey & K de Berg** *An Introductory Study of Nursing Students' Confidence in Basic Chemistry: The Impact of a Three-Day Chemistry Bridging Course* Chair: **C E Scarff**	**T S M Meerah** *Professional Development of Primary Science Marginalized Teachers* Chair: **H-E Chu**	**A Hume & A Berry** *Using CoRes for laying the foundations of future PCK development in pre-service chemistry teacher education* Chair: **K Paige**	**K-T Yang, T-H Wang & M-H Chiu** *Is Interactive Whiteboard Effective for Junior High School Students with Different Cognitive Styles in Learning Biology?* Chair: **D King**
FRIDAY 12.45- 1.30 LUNCH: Promenade Restaurant and Mermaids Bistro							

FRIDAY 2ND JULY (sessions between lunch and afternoon tea)

	STAR ROOM	SEA ROOM	SUN ROOM	MARLIN ROOM	SEASPRAY 7	SEASPRAY 8	SEASPRAY 9
Frid 1.30-2.10	**SYMPOSIUM:** A more complete vision: Multi-theoretic research into science classrooms **D Clarke** *The Danger of a Single Story: The Possible Contribution of Theoretically Inclusive Research Design to Science Classroom Research* **L Xu** *"Like the table is made of wood, so the particle is wood" Border crossing in a Grade 7 science classroom* **L H Seah & C Hart** *Analysing science classroom language at a grammatical level: What this approach tells us about the language demands in learning science* **J Arnold** *Identity Projects and Practice in a Science Classroom: A Case Study of Students' Reflexive Positioning* Chair: **self-appointed**	**V Prain & R Tytler** *Theorising how and why student construction of representations supports learning in science* Chair: **J Woolnough**	**C Castaño** *The role of science education in reducing violence towards others* Chair: **H Nakayama**	**D Winter, C Astall & L Conner** *Exploring Changing Attitudes and Achievement In Science Through The Integration Of A Novel Multimedia Resource*	**C Howitt** Planting the seeds of science*: Development and evaluation of a new early childhood science resource* Chair: **S-K Lee**	**L Halim & S Z S Zakaria** *Environmental attitudes and the underlying values: the Malaysian case* Chair: **L Liang**	**C-H Hung & C-Y Lin** *The nature of students' explanations about homeostasis* Chair: **C V McDonald**
Frid 2.15-2.55		**J Woolnough & C L Moore** *Embedding PCK in Science Curriculum Using Content Representations*. Chair: **V Prain**	**P J Fensham** *The Science Curriculum; Expertise decline and bureaucratese rise* Chair: **W Giles**	**J Archer & D Palmer** *What is the difference between attitudes and motivation?* Chair: **C-K Liu**	**C-T Hsu** *The case study of the alternative conceptions and mental models of a night school student on two units: "air pressure" and "sea and land breeze"* Chair: **M McKinnon**	**T P McClafferty & L J Rennie** *Teachers' Professional Learning in a Renewable Energies Unit – Science and Technology Education Leveraging Relevance (STELR) Pilot Project 2009* Chair: **R Cooper**	**D King, A Bellocchi & S Ritchie** *Making Connections Again: A Student's Experiences of Assessment in Context-based and "Traditional" Curriculum Approaches* Chair: **Y-S Hsu**
Frid 3.00-3.40		**F Haslam & P Hubber** *Teacher voice: Effects on teaching and learning when focusing explicitly on representations.* Chair: **S M Bickford**	**N Kaewkrisorn, T Bunterm, J Wattanathorn & S Muchimapura** *Effect of Project– Based Learning on Stress Level* Chair: **R Fawns**	**M R Logan** *Listening to the students' voice in science education: Teaching practices that stimulate interest in, engagement with, motivation towards, and a positive attitude to, science.* Chair: **K de Berg**	**H-E Chu, K C D Tan & D F Treagust** *Investigating Year 11 students' conceptual understanding of fundamental thermal concepts using multiple levels of analysis* Chair: **T S M Meerah**	**K Paige & D Lloyd** *Educating for Sustainability as central pedagogical practice for engaging pre-service Primary/Middle Years educators with science* Chair: **A Hume**	**S-T Lee, F-P Hsieh, Y-W Lin & P-J Chen** *The Investigation of Students' Reading Strategies in Science Argumentative Text* Chair: **K-T Yang**
FRIDAY 3.40- 4.00 AFTERNOON TEA: Lobby and Sandyfoot Café							

FRIDAY 2ND JULY (sessions after afternoon tea)

	STAR ROOM	SEA ROOM	SUN ROOM	MARLIN ROOM	SEASPRAY 7	SEASPRAY 8	SEASPRAY 9
Frid 4.00-4.40			*ASERA AGM*	**M Lee & S Lee** *The necessity of a physics and mathematics connected course for analyzing experimental data* Chair: **C-J Huang**	**A Hassan & S I S S Abdulah** *The application of constructivism approach in the environmental education through fieldwork strategy* Chair: **S-Y Lin**	**K Buaraphan** *Metaphorical Roots of Beliefs about Teaching and Learning Science and Their Modifications in the Standard-Based Science Teacher Preparation Programme* Chair: **E Blake**	**S-F Lin, S-C Lieu, W-H Chang, S Chen, M-T Huang & W-L Chen** *Affording Elementary Teachers by a Research-based Nature of Science Teaching Material* Chair: **K McKoy**
Frid 4.45-5.25				**E J Park, S-K Lee, K Kim & C-J Kim** *Examining student staff and student visitors in terms of their perceptions of a science festival* Chair: **C Yuenyong**	**M Z Ismail & A Hassan** *The relationship between environmental education activities and environmental practices among students : a case study in Kuala Jengal primary school, Terengganu, Malaysia* Chair: **W-C Chou**	**P Reis** *The development of an ecologically valid science curriculum in the Democratic Republic of São Tomé and Príncipe* Chair: **D. Fittell**	**H-S Lin, Z-R Hong, K-K Yang & Y-C Chen** *Using collaborative reflections to support teachers' inquiry-based instruction* Chair: **Y-W Lin**
Frid 7pm-10.30	*CONFERENCE DINNER*						

SATURDAY 3RD JULY (sessions before morning tea)

	STAR ROOM	SEA ROOM	SUN ROOM	MARLIN ROOM	SEASPRAY 7	SEASPRAY 8	SEASPRAY 9
Sat 8.30-9.10	**PAPER SET:** beliefs of teachers in Thailand. **S.Chatmaneerungcharoen, K. Phanwichien & G. Erickson** *Interpretive Case Study: Elementary Science Teacher's Needs and Awareness on Pedagogical Content Knowledge for Teaching and Learning Science related to Science Educational Reform*	**M D Shahrin K S Moorthy** *Pre-service primary teachers' handling of data* Chair: **N Yutakom**	**H C Liang, J C Liu & S I Li** *Traumatized students' motivation, interest and self-confidence of science in Taiwan* Chair: **L Moore**	**H H H M Said, I P-A Cheong & M H Johari** *Year 10 & 11 students' alternative conceptions of alternative energy* Chair: **H Jho**	**S-M Yang & Y-T Wu** *The relationship between Taiwanese university students' cognitive structures and their informal reasoning regarding the use of genetically modified foods* Chair: **C Howitt**	Chair: **H-L Chiu**	**O Hompromma, P Suwannoi, K Thathong & C Yuenyong** *Grade 10 Thai students' analogy for explaining rate of reaction* Chair: **Chin-Cheng Chou**
Sat 9.15-9.55	**S Pitiporntapin, *K* Phanwichien, G Erickson & D Anderson** *Views on Science Teaching about Animals based on Science, Technology, Society, and Environment (STSE) Education of Bangkok Elementary Science Teachers*	**P Chaiso** *Promoting science teacher mentors conducting action classroom research* Chair: **C-C Yu**	**G Hoban & W Nielsen** *The 5 Rs: A Conceptual Framework to Encourage Student-generated Animations (Slowmations) of Science Concepts* Chair: **J L Bencze**	**T Soyjak & C Yuenyong** *Value Judgment of Grade 10 Thai Students' Normative Decision Making during Learning about Newton's Law of Motion through the Science Technology and Society (STS) Approach* Chair: **M M A Sarkar**	**H L Wu & M-Y Chang** *Analysis on TIMSS 2003 Test Items for Grade 4 Science and Elementary Science Curriculum in Taiwan* Chair: **C Jakab**	**K Otrel-Cass, B Cowie & E Khoo** *Collaborative learning practices in science classrooms: Possibilities and boundaries using computers and the Internet* Chair: **D Fitzgerald**	**S C Fang, C Hart & D Clarke** *Toward a conceptual understanding of the mole concept* Chair: **M. Linich**
Sat 10.00-10.40	**K Punbo, S Khan & L Meesuk** *Thai Chemistry Teachers' Understanding and Their Teaching for Critical Thinking* **P Suttakun, J Mayer-Smith & B Vajarasathira** *Thai elementary teachers' understanding of and teaching about the nature of science* Chair: **self-appointed**	**J Smith** *The ghosts of science past and the Frankenstein effect: Influences on pre-service teachers efforts to teach primary science.* Chair: **L Darby**	**Y Tao** *Chinese and Australian Year 3 Children's Conceptual Understanding of Science* Chair: **P-C Chuang**	**D Treagust, J Crowley & M Mocerino** *Why does research in schools not change the practice of science teachers?* Chair: **M Kateifides**		Chair: **R Connor**	**Chin-Cheng Chou** *Probing the perception of undergraduate students to the nature of scientific models* Chair: **O Hompromma**

SATURDAY 10.40- 11.00 MORNING TEA: Lobby and Sandyfoot Café

SATURDAY 3RD JULY (sessions after morning tea)

	STAR ROOM	SEA ROOM	SUN ROOM	MARLIN ROOM	SEASPRAY 7	SEASPRAY 8	SEASPRAY 9
Sat 11.00-11.40	**R Tytler & L Darby** *The student as scientist: Schools developing a culture of open investigation* Chair: **S.Chatmaneerungcharoen**	**N Yutakom** *Thai Science Cooperating Teachers' Views about Science Teaching and Learning and Their Teaching Practices Resulting from a Professional Development Program* Chair: **M D Shahrin**	**L Moore, V Dawson, K Carson & D Tompkins** *Teaching Earth and Environmental Science in Years 11 and 12 in Western Australia* Chair: **H C Liang**	**H Jho & J Song** *Students' understanding of the nature of science through classroom arguments about socio-scientific issues and its comparison with debates on the web board* Chair: **H H H M Said**	**C Howitt & E Blake** *Using structural holes and social capital to develop a model of collaboration and creativity between scientists/engineers and teacher educators* Chair: **M Toscano**	**H-L Chiu & H-J Wang** *The self-generated analogy and scientific creativity* Chair: **F Haslam**	**M. Linich** *Genetics education within the Australian National Curriculum* Chair: **S C Fang**
Sat 11.45-12.25	**C Campbell & G Chittleborough** *The BHP Billiton Science Teacher Award: Promoting quality teaching* Chair: **S Pitipornpatin**	**C-C Yu, H-L Tuan, C-C Chin, P-Y Cheng & C-C Lai** *The development of a conceptual change based website to enhance science/math teachers' inquiry teaching competence* Chair: **P Chaiso**	**J L Bencze & E Sperling** *Student-teachers' Actions on Socioscientific Issues, Increasingly Informed by Their Primary Research* Chair: **G Hoban**	**M M A Sarkar** *Nature of science portrayed in the science textbooks: The case of Bangladesh* Chair: **T Soyjak**	**C Jakab** *Children using 'molecules' for thinking* Chair: **H L Wu**	**D Fitzgerald** *Using Spatial Science to Teach Secondary Science* Chair: **K Otrel-Cass**	**K Bingimlas & M Hanrahan** *A framework for ICT-supported learning and teaching environments for primary science in Saudi Arabia*
Sat 12.30-1.10	**W Jobling** *Science and design technology: Lessons for rural and regional Australian schools from South East Asia.* Chair: **P Suttakun**	**L Darby** *Teaching out-of-field? Yes, but not really.* Chair: **J Smith**	**P-C Chuang & M-H Chiu** *The Effect of Teachers' intention on the change of their perception of the Nature of Models* Chair: **Y Tao**	**M Kateifides** *On the same page: standardized models of global knowledge* Chair: **D Treagust**	**M Toscano** *The Work of Art: The Work of Science* Chair: **S-M Yang**	**R Connor** *The effect on primary school teachers' views on the nature of science through participation in a reform-based professional development program.* Chair: **D Winter**	

SATURDAY 1.15- 2.00 LUNCH: Promenade Restaurant and Mermaids Bistro

ABSTRACTS

Improving secondary science education in Bangladesh

Symposium, Thursday 4.00pm, Star Room

Syeda Tahmina Akhter, Md. Mahbub Alam Sarkar, Mohammad Nure Alam Siddique & S M Hafizur Rahman
Monash University

Symposium Overview: Since the independence of Bangladesh in 1971, science education has been reformed several times following western models. The reforms included development of new curricula, training of teachers, and the publication of new government sponsored textbooks. However, stakeholders remained unhappy with the outcome of these reforms. Due to the lack of academic research by science educators, the reasons for the unsatisfactory outcome of the reforms have not been identified. Being science educators in Bangladesh, we identified four different problem areas in science education in Bangladesh and undertook research accordingly with a view to obtaining a holistic picture of secondary science education in Bangladesh which will guide us in designing and implementing science education reform in future. In this symposium we present partial findings from our ongoing research studies which will reveal valuable information regarding (1) science curriculum emphases, (2) representation of Science Literacy in textbooks, (3) struggles of teachers in understanding and promoting values and (4) developing Professional Learning Communities among science teachers to change the culture of science teaching practices in Bangladesh. From this symposium, participants will obtain a coherent and substantive picture of current issues in secondary science education in Bangladesh which represents a developing country in Asia. We want our works to be presented in a single symposium session because we expect a better feedback of our ongoing works and we believe that the presentation of an overall approach to research in this field is important. Each of the four issues is briefly described below.

Curriculum emphases of secondary science education

Symposium, Thursday 4.00pm, Star Room

Syeda Tahmina Akhter
Monash University

Like many other countries in the developing world, science education in Bangladesh tries to follow the western world in reforming science education. Since the 1950's, a number of reform movements brought revolutionary changes in the science curriculum of western countries. The Science, Technology, and Society (STS) movement recognised a contextualised science teaching-learning approach. Both 'Science for All' and 'Scientific Literacy' focus on preparing **All** students for making informed decisions on science related matters in their personal and social lives. Now-a-days, science education throughout the world promotes 'Scientific Literacy' which has been characterized as consisting of four inter-related aspects: contexts, knowledge of and about science, competencies and attitudinal aspects of science. This paper examines how these aspects are emphasized in the secondary level science curricula in Bangladesh. Analysis of curriculum indicates that junior secondary science curricula (grades VI-VIII) places emphasis on application of science in learners' contexts. Secondary science (grades IX-X) follows a path of curriculum differentiation which means that a group of students study 'valid science' (Physics, Chemistry and Biology) to build a solid foundation for further science study whereas other students study an application focused General Science. The analysis also reveals that all science curricula at secondary level communicate an incomplete and inaccurate view of science.

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

Thursday 8.30am Seaspray 7

Sylvia Christine 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.

What is the difference between attitudes and motivation?

Friday 2.15pm, Marlin Room

Jenny Archer & Dave Palmer
University of Newcastle

Much of the research on attitudes towards science has suffered from a lack of clear definition of terms. As a result, motivation is often regarded as a type of attitude. In this position paper, the authors will argue that "motivation to learn" is a different construct to attitudes, beliefs and values. Past research will be used to illustrate the problem and to provide definitions and examples that make distinctions between attitudes and motivation.

Identity Projects and Practice in a Science Classroom: A Case Study of Students' Reflexive Positioning

Symposium, Friday 1.30pm, Star Room

Jenny Arnold
The University of Melbourne

This paper explores themes emerging in classroom videotapes of a middle years science classroom from a case study of student identity and agency using discursive psychology. The research was conducted in response to the widespread problem of student disengagement with science in the middle years of schooling (Goodrum, Hackling & Rennie 2001; Osborne 2003; Aikenhead 2005; Tytler 2007; Tytler, Osborne et al. 2008) and related calls for research into the way in which students develop identities in and through school science (Roth and McGinn 1997; Brickhouse 2001; Lemke 2001; Stables 2003; Kozoll and Osborne 2004; Roth and Barton 2004; Aikenhead 2005; Zembylas 2005; Tytler 2007). The classroom at the focus of the study was video recorded by the International Centre for Classroom Research in Melbourne for 'The Causal Connections in Science Classrooms' research project for a complete unit of work on 'The States of Matter'. The purpose of the paper is two fold: firstly, drawing on Harre's model of Identity Projects, to present findings from the study showing one student's reflexive positioning in dialectic relation to local practice; and secondly to discuss the implications of the findings for research and practice in science education. In particular the paper supports work by Davies (2008) and Zembylas (2001, 2005) by questioning science classroom practice in which student expression of interest and desire is neither published nor conventionalised.

The professional earning preferences of primary science and technology teachers.

Thursday 12.00, Seaspray 9

Peter Aubusson[1], Janette Griffin[1] & Glen Sawle[2]
[1]University of Technology Sydney
[2]NSW Department of Education and Training

The teaching of primary science and technology is in the hands of teachers. Much has been said about the need to support teacher professional learning and how it should be achieved. However, the science and technology professional learning preferences of these teachers is less well understood. This paper reports a survey of the professional learning preferences of 173 primary school science teachers in NSW. Most considered themselves to be keen teachers of science and technology. A mix of teachers from all regions as well as Rural, Regional and City schools were represented in the sample. Perceptions of school readiness and capacity to delivery science and technology education varies. School based strategies are highly desirable but throughout the state teachers have a great deal in common, suggesting a state-wide rather than piecemeal approach may be advantageous. Teachers express high preference for professional learning which is collaborative, sustained, practical and closely linked to the actual teaching of learning of science and technology in their school. They want to have

choice and control over the content and type of professional learning. They appreciate input from experts and sequences of workshops as part of their professional learning experience.

Student-teachers' Actions on Socioscientific Issues, Increasingly Informed by Their Primary Research

Saturday 11.45am, Sun Room

J. Lawrence Bencze & Erin Sperling
University of Toronto, Canada

Humans are facing many challenges associated with fields of science and technology. Arguably of most concern is Climate Change, but other issues include: health concerns with manufactured foods; inadequate testing of pharmaceuticals; and, engineered product obsolescence. Many of these problems may be related to businesses' perhaps excessive orientation towards profit-generation. Progress has been made in addressing such issues, however, by encouraging students to consider complex socioscientific issues, take positions about them, and develop plans of action to address them. We contend, however, that commitment to and directions for actions may be enhanced when students self-generate data relevant to the issues. In the study reported here, we concluded — based on constant comparative analyses of qualitative data — that student-teachers' tendencies towards promotion of socio-political activism depends on several factors. We emphasize here that a significant such factor is student-teachers' increasing trust in their self-directed *primary*, as opposed to secondary, research findings that indicated socioscientific problems. Knowledge duality theory helped us support our claims, in that deep and long-lasting commitments can arise from personalized reciprocal relationships between phenomena and representations of them. This research appears to have implications for science teacher education, science education, and the wellbeing of individuals, societies and environments.

Maximising benefits of field trips and guest speakers in secondary science education

Friday 10.30am, Sea Room

Sophia M. Bickford & Nancy Longnecker
University of Western Australia

From the outside, the interaction of teachers, students and presenters during a field trip or guest speaker activity may seem straightforward. In fact, effective delivery of an informal science experience requires collaboration among a diverse network of stakeholders. This talk presents a PhD proposal for mixed methods research on how relationships between teachers and informal science institutions shape the benefits of guest speaker and field trip programs serving secondary science classes. Case studies of a science centre outreach program and a national park-based field trip program will illuminate the degree of alignment in goals, expectations and actions among teachers and informal science staff and how that alignment shapes program outcomes. A state wide survey of secondary science teachers will be used to describe the current role of field trip and guest speaker programs in Western Australia, providing context for the case studies. The research is motivated by a desire to help schools and informal science institutions maximise the educational benefit of their collaboration. In addition to building upon the conceptual framework of alignment, data will be analysed from multiple theoretical perspectives to provide maximum insight for application to both theory and practice.

A framework for ICT-supported learning and teaching environments for primary science in Saudi Arabia

Thursday 1.30pm, Sea Room

Khalid Bingimlas & Mary Hanrahan
RMIT University

This paper presents a part of the findings of my PhD research relating to teachers' perspectives about effective science education with the use of new technologies in Saudi primary schools. The aim of this paper is to present a framework for learning and teaching environments. A questionnaire was constructed based on the literature and refined during interviews with teachers. This resulted in 24 items describing effective learning and teaching environments. The items mainly were based on constructivism. Data collection was conducted in Riyadh city through surveying 241 science teachers. Factor analysis of the questionnaire resulted in four factors: *an Engaging and Interactive Teaching Approach, Autonomy in Learning, Purposeful Assessment and Feedback* and *Community of Learners*. These factors can work together to present a framework of effective learning and

teaching environments particularly for primary science education. Details of this framework will be presented. Utilising the interview analysis from my previous research helped in evaluating the role of ICT in primary science. Several different models relating ICT to the framework will be presented. The framework could guide the development of science education in the Saudi Arabian context and might be applicable to other educational systems around the world, particularly in developing countries.

"I had a good science!" Evaluation of a new science incursion into kindergarten classrooms

Friday 8.30am, Seaspray 8

Elaine Blake[1], Christine Howitt[1] & Sara Peet[2]
[1]Curtin University of Technology
[2]Scitech

The Early Childhood Outreach Program (ECOP) is a new addition to Scitech's successful Western Australian Outreach Program, being delivered for the first time during 2009. The ECOP is an incursion in the form of a 1-hour workshop of hands-on, engaging and everyday science activities for 2-4 year old children and their educators. The aim of the program is to provide an avenue for scientific discovery through play for children. The ECOP consists of five activity centres: light, sound, movement, animals and mathematics. Data collection, between March and November 2009, included observations of workshop delivery into kindergartens, adult questionnaires, children's drawings, longitudinal feedback from children, and a focus group interview of Scitech presenters. The program was found to be highly successful in introducing and engaging young children in science. Vital aspects of the program which contributed towards its success included the provision of age-appropriate activities that provided both structured and unstructured play, the active role of adults within the program that included modelling activities, the important place of questioning throughout the entire program, and the portability and flexibility of the equipment to set up quickly and effectively in a range of spaces.

An Introductory Study of Nursing Students' Confidence in Basic Chemistry: The Impact of a Three-Day Chemistry Bridging Course

Friday 12.00, Marlin Room

Kerrie Boddey & Kevin de Berg
Avondale College

Many students commencing a nursing course have not studied chemistry since year 10 and typically struggle with basic chemistry concepts associated with nursing practice. Intervention strategies such as chemistry bridging courses have been used at our institution for over twenty years but only anecdotal evidence of their success has been noted. The study reported here is an attempt to rectify this situation. Sixty-five of a potential one hundred and twenty-six nursing students voluntarily enrolled in a pre-semester three-day chemistry bridging course as preparation for a health science unit comprising basic chemistry and introductory microbiology. A seventeen-item five point Likert scale questionnaire was constructed as a measure of confidence in basic chemistry and administered prior to the bridging course and again prior to the health science unit. A paired samples t-test indicated a significant increase in confidence to the mean level reported by the students who did not participate in the bridging course. The impact of gender, age, campus of study, prior chemistry experience, and reported level of enjoyment of chemistry on confidence is also examined.

Metaphorical Roots of Beliefs about Teaching and Learning Science and Their Modifications in the Standard-Based Science Teacher Preparation Programme

Friday 4.00pm, Seaspray 8

Khajornsak Buaraphan
Mahidol University, Thailand

Beliefs are a psychological construct potentially driving a person to make decisions and act. Teachers' beliefs are complex and deeply rooted in their belief systems. In this study, I utilised an alternative technique, the metaphor construction task (MCT), to uncover beliefs about teaching and learning science held by 110 pre-service science teachers who participated in the standard-based teacher preparation programme. Two dominant metaphor categories which emerged were the teacher as nurturer/ cultivator and as knowledge provider. I also utilised the MCT incorporated with in-depth interviews to track how and to what extent 30 volunteers changed their metaphors after one semester participating in the standard-based programme. The results revealed that more than a half of the participants described a major change of metaphor. The main path of metaphor change was from the teacher as nurturer/ cultivator to the teacher as knowledge provider categories. Teachers' beliefs

are metaphorically rooted and culturally influenced, and can be changed. The implications regarding the utilisation of MCT, modification of teacher beliefs, and science teacher education are also discussed.

The Early Years Framework – where is the science?

Thursday 4.00pm, Marlin Room

Coral Campbell
Deakin University

Australia is embarking on the implementation of Early Years Frameworks at both national and state levels and it is a significant that we investigate the place of science education for our children 0-5years of age. Where does science education fit into these frameworks? A document analysis of both the national (Australia) and state frameworks (Victoria) will highlight the guidance given to early years practitioners in terms of science education. By comparison, many countries in the western world have trialled and implemented early childhood frameworks. Through an investigation of the frameworks in place in England, a comparative analysis of the introduction of science in early childhood settings is provided. The research in England was comprised of case studies of four centres and data collected through interview with stakeholders from government and educational fields. The research will show how, with a slight change in wording, we can be more inclusive of science as a natural part of early childhood education.

The BHP Billiton Science Teacher Award: Promoting quality teaching

Saturday 11.45am, Star Room

Coral Campbell & Gail Chittleborough
Deakin University

The BHP Billiton Science Teacher Award is one of the most prestigious awards for science teachers. It recognises and values the time and effort that teachers give to the profession and to students conducting scientific research projects. This paper draws on data collected during an evaluation of the BHP Billiton Science Award scheme to identify the characteristics common to these innovative teachers in science. The data is drawn from interviews with eight award-winning teachers and interviews with the judges of the award-winning teachers. Every award- winning teacher had introduced innovative ways of engaging students in science through open ended investigations which was often embedded in their curriculum. Quality teaching was evident in their practice - valuing students owning their work, doing authentic science investigations, showcasing their work and developing critical thinking skills. The teachers often had a good understanding of the award schemes operating in their state, informing and mentoring their students of the opportunities – building a culture within the school. These enthusiastic teachers were humble and commonly did not seek recognition for themselves; however they believed the recognition of their students' efforts was important. Many teachers were active in the professional organisations. This paper will argue that science competitions can positively influence the curriculum, the teachers approach to teaching science, especially including local contexts, and student attainment.

The role of science education in reducing violence towards others

Friday 1.30pm, Sun Room

Carolina Castaño
Deakin University

Traditionally science has promoted the acquisition of the skills to understand scientific processes and concepts which has left little space to establish a different relationship with nature than the one in which it is only seen as a resource for humans. Many studies now suggest that the way we see and relate with nature could be one of the causes of our present social and environmental crisis. Moreover, some studies suggest that greater awareness of the natural world may help to ameliorate anti-social behaviours which have become an increasing problem not only in our society but also in the school settings. Using an action research approach this study explores how science education can contribute to the amelioration of violent behaviours towards humans and non-human species in a Colombian school with a population of socio-economically disadvantaged students and high levels of violence. Interviews with students, open-ended questionnaires answered by participants and observations were conducted and triangulated. Results suggest that science education can have a positive impact in the attitudes of these children, promoting compassion towards non human animals and ameliorating the aggressiveness among them.

Promoting science teacher mentors conducting action classroom research

Saturday 9.15am, Sea Room

Porntip Chaiso
Kasetsart University, Thailand

The objective of this research was to help science teacher mentors develop competency in conducting action classroom research, hoping that they could transfer this experiences to student teachers while they work cooperatively with student teacher advisors. Twenty-four science teacher mentors participated in a professional development program. The program approach was to encourage participants to do action research, reflect on their own teaching, exchange their experiences with others teacher mentors once every month. The researcher as teacher's advisor provided supervision through workshop, classroom observation, feedback on classroom teaching, set goal for classroom action research that would improve their teaching, conduct research, and seminar on research results. This research data were collected by means of observation, learning record, focus group and teacher mentor and student teacher survey. This research results showed that participants were satisfied with the program and they had learnt through practice the action research process. Participants were quite confident that they could transfer their experience in conducting classroom research to their student teachers. Student teacher survey showed that they thought most mentors could moderately advice them to do classroom action research. Things that mentor teachers could advice them at the least level were collecting data, analyzing data and interpreting.

Interpretive Case Study: Elementary Science Teacher's Needs and Awareness on Pedagogical Content Knowledge for Teaching and Learning Science related to Science Educational Reform

Paper Set, Saturday 8.30am, Star Room

Siriwan Chatmaneerungcharoen[1], Kantimanee Phanwichien[1] & Gaalen Erickson[2]
[1]Kasetsart University, Thailand
[2]University of British Columbia, Canada.

The case studies reported on in this presentation are part of a professional development program that focuses on enhancing teacher's pedagogical content knowledge (PCK) through a co-teaching model. The purpose of this study was to investigate three upper elementary science teachers' understanding, needs and awareness of PCK. Data sources consisted of classroom observations, semi-structured interviews, questionnaires and document analysis. Inductive analysis was used to analyze the data. Findings indicate that the three teachers experienced some problems regarding: articulating the purposes for teaching science, designing appropriate assessment and instructional activities, and understanding the science content and how the learner learn science in the curriculum reform. Even though the three teachers realized that many aspects of their teaching practice needed to be altered to address the curriculum reform in science teaching, the areas of greatest need were to develop a better understanding of articulating the purposes for teaching science, the curriculum content and broaden their teaching approaches. The implication of this study are that institutions responsible for producing and developing science teacher should create and provide professional development program for enhancing the teacher's PCK and to help them create classroom learning environments that are in accordance with the curriculum reform documents.

Learning from peer coaching: The change of a teacher's understandings of inquiry teaching

POSTER

Jun-Yi Chen
National Chiayi University, Taiwan

In recent years, the documents of international science curriculum reform have declared that it is essential to implement inquiry teaching in science classes. However, in Taiwan, many teachers have not prepared themselves for infusing inquiry teaching into their science classes. The purpose of this study is to investigate the change of teacher's understandings about inquiry teaching in the context of peer coaching. The case teacher was invited and prompted to discuss, design, implement and reflect on inquiry teaching. The data were gathered by observation, interviews, regular meetings and document. Three particular periods were identified through the

coding for process and continual analysis, included exploration, practice and refinement. It was found that the case teacher took guide inquiry to replace hands-on activity. Several difficulties were overcome and the model of inquiry teaching fit with Taiwan's school culture. Additionally, the peers' experience and suggestions were the crucial information to promote the case teacher to change his ideas and teaching practice about inquiry teaching.

Using Eye-Tracking System to Explore the Cognitive Retrieval Process of Physical Concepts

Friday 11.15am, Sea Room

Sheng-Chang Chen & Hsiao-Ching She
National Chiao-Tung University, Taiwan

The present study examined college students' cognitive process of retrieving physics conceptions through either picture or text presentation. The dependent variables included subjects' correct scores of understanding the physics conceptions as well as data of subjects' eye-movement behaviour. Of the thirty-one subjects participated in this study, thirteen physic majors, eleven chemical and seven biological majors. In addition, twelve were females and nineteen were males. There are 21 physics conceptions presented in pictures, and the other 21 physics conceptions presented in text. Forty-two physical concepts cover four physical domains: mechanics, optics, thermodynamics and electromagnetism. All of physics concepts were presented either in pictures or texts on computer screen. The participants were instructed to respond their answers after pictures or texts disappeared while eye movement also was collected. Results showed students with incorrect conceptions allocated greater amount of visual attention (number of fixation and total inspection time) than to the correct conceptions while the materials presented in pictures. Similarly, the students with incorrect conceptions had greater amount of visual attention (number of fixation, total inspection time, mean fixation duration) than to the correct conceptions while the materials presented in text. It implies that students would allocate more attention to the materials while they do not understand the conceptions, regardless pictures or texts.

Research trends of science education in Taiwan from 2000 to 2009

Thursday 3.00pm, Star Room

Shih Wen Chen & Wen Jim Yang
National Taiwan Normal University, Taiwan

The purpose of this study aimed to analyze the research trends of science education in Taiwan from 2000 to 2009. A total of 634 paper articles from 8 main journals that Taiwan researchers frequently published were analyzed by four categories: research topic, article type, study subject, and methodology. The results found that science teaching was the most common research topic in Taiwan science education, including instructional materials and strategies, pedagogical content knowledge, and teacher cognition. Then was science learning, such as teacher-student or peer interactions, learning environments and the factors affecting learning. Cultural, social, and gender equity issues was the least. Moreover, empirical study was most frequently conducted in this field, on the other hand, theoretical paper were received relatively least attention among science researchers. Study subject usually focused on 1-12 grade students. The public and kids are not the common participants. In addition, quantitative method of test or questionnaire was the mainstream in science research methodology in the past decade. The combination of quantitative and qualitative method was the following. However, qualitative methods like interview or drawing and writing data were gradually increasing in the latest five years in Taiwan.

Is physical manipulation crucial for science learning?

Thursday 2.15pm, Sea Room

Sufen Chen, Weihao Li & Wei-Chen Su
National Taiwan University of Science and Technology, Taiwan

This project investigated high school students' learning by two modes of experimentation — physical and virtual laboratories. Physical laboratory was referred to microcomputer-based laboratory (MBL), where students collected and analyzed data using probes and handheld computers. In the online simulation-based laboratory (SBL), students manipulated objects and variables to conduct experiments on desktop computers. Both MBL and SBL involve hands-on activities, manipulating either physical or virtual materials. The participants were two classes (N=81 11th graders) at an urban public high school in Taipei. They were

randomly assigned to the MBL and SBL settings. The participants conducted two experiments and completed pre- and post-tests, questionnaires and interviews. The results of ANCOVA showed that students of both groups performed equally well and had remarkable gains on pretest-posttest of learning achievement, effect size d =.66-1.41. Regarding enjoyment of scientific inquiry, self-efficacy of scientific inquiry, and views about nature of science, both groups had no significant difference after the experiments. Although the MBL group often skipped the background information on the lab manual to data collection, both groups behaved similarly in the other sections. This study concluded that online simulation is as effective as physical experiment in learning physics concepts, attitudes toward science and views about nature of science.

Discourse Analysis of High School Students' Debate on a Socioscientific Issue: Suao-Hualien freeway project in Taiwan

Thursday 4.00pm, Seaspray 8

Tai An Chen[1], Iris-Chu Huang[1] & David Chao[2]
[1]National Kaohsiung Normal University, Taiwan
[2]National Sun Yat-sen University, Taiwan

This study uses discourse analysis to analyze a socioscientific issues debate during a High Scope Program in a local high school in Taiwan. The High Scope Program provides an authentic learning context for students to understand how the development of new technologies has impacted society. This program emphasizes the students' ability to make decisions on socioscientific issues in order to become better involved and informed citizens. An Oregon style debate was used to stimulate student discussion regarding the agonizing dilemma of the Suao-Hualien freeway project. The debate is perceived as being a socio-discursive interactive event. Toulmin's model (1958) was used to analyze the students' argumentation. Eight tenth grade students participated in this debate. The major data source of this study included videotapes and students' notes. Analysis of data revealed that all of the affirmative students included a stated claim. But, only three of these students included a warrant of support, and only one mentioned a rebuttal. All of the students taking a negative position mentioned data support for their stated. Two of these participants used a warrant, and two of these students included information about a rebuttal. Backing arguments were not mentioned within the discourse.

Using "Serial Historical Models" (SHM) to promote students' understandings of the gene concept

Thursday 1.30pm, Marlin Room

Jung-Hui Cheng, Kuan-Chiao Chien & Chen-Yung Lin
National Taiwan Normal University, Taiwan

"Genetics literacy" has been one of the most important objectives in genetics learning today, and the gene concept is crucial to genetics. However, former research showed that students of all ages do not develop good understandings about the gene concept – although many of them know that the gene is made of DNA and hold the image of the double-helix structure, they fail to make connections between the structure and the functions of the gene. Therefore, the aim of this study is to develop a new teaching module, by using the "Serial Historical Models" (SHM) of gene function, which is revised from Gericke & Hagberg (2007), to promote high school students' understandings about the gene concept. Thirty 10th graders were involved and the teaching experiment lasted for three months with a total of twelve class periods. Both qualitative and quantitative data were collected and analyzed. Results showed that during the instructions students' gene concepts parallel the developments of historical models, many students showed a better understanding after instructions, a two-dimensional framework was developed from the data to probe students' levels and mechanisms of gene function. To conclude, this study offers a new model in genetics teaching and a new framework to evaluate students' gene concepts.

Enhancing Students' Argumentation Abilities for High Quality Decision-Making

Thursday 1.30pm, Seaspray 8

Li-Ting Cheng, Uy-Len Lin, Shiang-Yao Liu & Jeng-Fung Hung
National Kaohsiung Normal University, Taiwan

Argumentation abilities include the coordination of evidence and theory to support or refute an explanatory conclusion, model or prediction. Attempting to justify the decision, explicit consideration of the function or

purpose, and of the comparative effectiveness of alternatives are the characteristics of high quality decision-making. This study examined interaction patterns in the forms of argumentation patterns and decision making strategies students employed while dealing with socio-scientific issues. One hundred and five junior college students (16-17 years old) received instruction on science and technology issues for eight weeks. In a cooperative learning environment, students worked in groups to collect information relative to the issues, including causes, potential consequences, possible solutions and actions they committed to deal with the issues. An open-ended questionnaire for evaluating the quality of decision-making was developed based on Ratcliffe's (1997) framework. Results of this study showed that students who had better argumentation ability were more likely to present higher quality of decision-making. However, most students tended to collect evidence to support their original options; only few of them (3%) searched counterviews and analyzed them to enrich their reasons. Research suggests that argumentation skills need to be taught explicitly to students and developed their collaborative argumentation as a means of improving their decision-making quality.

University Students' Understanding of Wave-Particle Duality

Thursday 1.30pm, Seaspray 7

Yong Wook Cheong & Jinwoong Song
Seoul National University, Korea

Educational issues in quantum mechanics have been less investigated than in Newtonian mechanics. In particular, only a few studies have investigated wave-particle duality, although it is at the core of conceptual structure of quantum mechanics. We qualitatively investigated undergraduate students' understanding of the wave-particle duality in an upper-division quantum mechanics course with written questionnaires and semi-structured interviews concerning topics such as photoelectric effect, Compton scattering, and two-slit interference pattern of electrons. Analyzing the responses, we repeatedly found characteristic patterns in both their conception and reasoning. Students did not properly model the physical context or direct adequate attention at the conflict between the wave- and particle- property. Thus, they did not elaborate their conception about duality, which is necessary to resolve the conflict. We also discuss implications of our findings and make some suggestions for instructors.

The Pre-service science teachers experience: Building relationships among supervising teachers, coordinating teachers and university staff

Thursday 8.30am Marlin Room

Gail Chittleborough & John Cripps-Clarke
Deakin University

The professional experience in a school community provides a powerful teaching and learning environment for pre-service teachers and the university courses provide essential foundational knowledge for becoming teachers. There is often little or no integration or knowledge of the two learning environments despite having the common goal of developing the pedagogical skills of the pre-service teachers. In an attempt to better inform the structure and organisation of the professional experience program, the initial experiences of 17 students were monitored over 8 months as they undertook their first, second and third professional experiences in schools. This data was used to identify the factors that impact on the pre-service teacher's professional experience. The students were in the third year of a four year Bachelor of Science /Bachelor of Teaching course. The factors that impacted on the pre-service teacher's professional experience included the quality of the relationships among supervising teachers, university staff and the pre-service teachers, the pre-service teachers' subject matter knowledge, their prior experiences, the cultures within school and organisation of the practicum. In this paper we identify tensions between the demands of the science degree, the teaching degree and the school experience and argue for mediation and improved communication between the two learning environments - at university and at school.

The self-generated analogy and scientific creativity

Saturday 11am, Seaspray 8

Houn-Lin Chiu & Hsien-Jui Wang
National Kaohsiung Normal University, Taiwan

Many important science discoveries were made through self-generated analogies, such as Rutherford's discovery of atomic structure. The main purpose of this study was to improve students' abilities of generating analogies and explore whether their scientific creativity will progress after the ability of generating analogies

improved or not. A six-sections curriculum based on Teaching with Analogies Model has been implemented on thirty eighth graders for seven months. A science creativity questionnaire was administered to the students before and after the instruction. Students' self-generated analogies after each section were collected to be analyzed quantitatively and qualitatively. The results showed that the abilities of generating analogies and scientific creativity of the students were improved significantly particularly the students who generated the best quality analogies improved their scientific creativity the most.

A Case Study on Articulation of Science Teachers' Tacit Knowledge While Repeating to Teach the Same Contents in Different Classes

Thursday 4.45pm, Seaspray 8

Jong-Rim Choi, Sun-Kyung Lee & Chan-Jong Kim
Seoul National University, Korea

The notion of 'teacher as learner' has emerged as an important construct in extending perceptions of quality in science teaching and learning. The notions of 'science teacher as learner' offers one way of exploring the uneasy tensions of practice that emerge as science teachers attempt to better align their teaching with their expectations. Some researchers found that teachers had difficulty translating their knowledge into practice. This point about translating knowledge into practice highlights an issue indicative of science teacher as learner - making the tacit explicit. The purpose of this study is to understand how teachers' tacit knowledge in their teaching can be revealed and developed while they teach the same contents in different classes. The qualitative research method was used in this study. Data were collected from their teaching plans and classroom observations, recordings, several in-depth interviews, stimulated-recall interviews. All the data were transcribed and analyzed interpretively, and then, the results of the analysis were checked by each participating teacher. The results of this study could provide helpful insight for how teachers might develop and reflect in their teaching.

The gap between medical science education and clinical learning: the role of educational technology

Thursday 3.00pm, Sea Room

Chih-Chen Chou[1] & Chin-Chung Tsai[2]
[1]China Medical University Hospital, Taiwan
[2]National Taiwan University of Science and Technology, Taiwan

Science education in medical schools often faces a gap between theoretical knowledge in medical science and clinical practice. Educational technology has gradually integrated into medical learning. The purpose of this study was to explore medical students' difficulties for learning in clerkship and how they perceived the role of educational technology in overcoming the difficulties. Three focus group interviews were conducted, with 12 senior medical students for each group (n = 36) in Taiwan. These students had experiences of blended learning, combining technology-enhanced learning with face-to-face teaching in clerkship. Based on students' interview results, they thought that in the clinical setting, the physicians were too busy to provide good instruction for clinical learning. The content of lecture-based instruction usually did not match the need of departmental rotation in clerkship. The students, when reflecting their experiences about the blended learning, believed that educational technology can solve this problem, as it can provide more stable instructional quality and re-usable learning resources. It also allows more learner control, serving as pre-view or review purposes, and should be designed by presenting core concepts. However, they recognized the importance of blended learning, highlighting the need of face-to-face discussion for bridging medical science knowledge and clinical practice.

Probing the perception of undergraduate students to the nature of scientific models

Saturday 10.00am, Seaspray 9

Chin-Cheng Chou
Hungkuang University, Taiwan

Studies have shown that models play an important role in teaching scientific subjects. Through models, students can learn to understand scientific knowledge more easily. This study was to develop questionnaires which help to evaluate how students perceived "model" itself and how much they have understood the scientific models they have learned. Likert Five-Point Scale was applied on 306 undergraduate students (37.9% male and 62.1% female) with a reliability at α=0.7729. Preliminary results revealed students have following perceptions on scientific models: (1) only 47% agreed models reflect inproportionally to objects yet 84.6% agreed structure

mapping between models and objects; (2)69.2% agreed the presentation of symbols to models but 87.3% agreed the presentation of images or figures to models; (3) 87.3% agreed the changing possibility of models and 83% agreed multiple models can explain the same objects. Details will be discussed later.

Explore the eye movement regarding to the cognitive process of concrete and abstract biology conceptions

Friday 9.15am, Seaspray 7

Wen-Chi Chou, Hsiao-Ching She & Li-Yu Huang
National Chiao Tung University, Taiwan

This study explored the eye movement pattern while participant involved in the cognitive processing of abstract and concrete biology conceptions. There were thirty one undergraduate students participating in this study, and all of them were majored in science. The concrete concepts were displayed in picture mode, and the abstract concepts were presented in text mode. All of the students were instructed to view the two categories and answer the implicative biology concept of the picture or word description. The dependent variables included subjects' correct responses of the biology conceptions as well as data of subjects' eye-movement behavior. Students' eye movements were collected while they are viewing and responding the learning materials. Results indicated students with incorrect conceptions significantly allocated greater amount of visual attention (total duration, mean fixation duration) than to the correct conceptions, for the concrete biology concepts. The students with incorrect conceptions significantly allocated greater amount of visual attention (total duration, fixation number) than to the correct conceptions, for the abstract biology concepts. It demonstrates that students would allocate greater attention (total duration, or fixation number or mean fixation duration) to the materials while they do not understand the conceptions, regardless abstract or concrete conceptions.

Investigating Year 11 students' conceptual understanding of fundamental thermal concepts using multiple levels of analysis

Friday 3.00pm, Seaspray 7

Hye-Eun Chu[1], Kim Chwee Daniel Tan[1] & David F. Treagust [2]
[1]Nanyang Technological University, Singapore
[2]Curtin University of Technology

This research was conducted to investigate students' understanding of fundamental thermal concepts in everyday contexts. The 19 multiple choice items in the questionnaire used in this study were entirely based on everyday contexts with scientific terminology avoided and required written justifications for student's choice of responses. The items involving fundamental thermal concepts about heat, temperature, heat transfer and conduction were based on a previously developed questionnaire and from students' alternative conceptions derived from the literature. The questionnaire was administered to 240 Year 11 Singapore students and 24 students were interviewed to obtain additional information about their conceptual understanding and probe the reasons they gave. Also, their attitude towards studying physics was determined. From the multiple levels of analysis, several alternative conceptions of thermal concepts were revealed and the influence of students' attitude towards studying physics on the students' conceptual understanding were indicated.

The effect of teachers' intention on the change of their perception of the nature of models

Saturday 12.30pm, Sun Room

Pei-chi Chuang & Mei-Hung Chiu
National Taiwan Normal University

This study is to explore the changes of high school teachers' perceptions of the nature of scientific models in the context of a model-based science-technology-society (STS) curriculum development after taking a modeling workshop. The curriculum was developed by six teachers: five biology and one history teacher who was also the group leader. Four instruments were used: a Likert scale questionnaire at the beginning and at the end, semi-structured interviews, records of teachers' study meetings, and analysis of the teaching material developed. The results revealed the teachers' perceptions of the nature of models were regressed during the period of study. The interview data and meeting records showed the teachers had little interest in adopting modeling theory into their curriculum and were more focused on STS. The examination of teaching materials implied the teachers did not apply the modeling theory fully in their model-based STS curriculum. The teachers intentionally worked more

towards developing an STS curriculum ignoring the modeling theory. The final result of the study is a suggestion that we might have to provoke the teachers' interest in scientific models before they can make positive changes in their perceptions of the nature of models.

Birds of a feather: Teacher Education students' knowledge of Sydney wildlife

Thursday 4.00pm, Seaspray 7

Julie Clark
Australian Catholic University

The environment figures strongly in curricula at both primary and high school levels, especially in HSIE and Science and Technology. In the National Curriculum draft statement for Science (2010) knowledge of living things and the interrelationships occurring in local ecosystems is included for middle primary. We questioned whether our primary teacher education students had a knowledge of their own local urban area that was sufficient to guide their students in local environmental studies. This research aims to uncover the level of knowledge of local biodiversity of university students in the Sydney region. Further surveys have also been conducted with other target groups. A questionnaire was designed based on the recognition, naming and lifestyle information about common animals and plants of the Sydney basin. The questionnaire is in three parts. This paper looks only at the third set of questions based on the identification of common urban species. This sample of primary teacher education students was found to have, with a few exceptions, a limited knowledge of the species in their local environments.

The Danger of a Single Story: The Possible Contribution of Theoretically Inclusive Research Design to Science Classroom Research

Symposium, Friday 1.30pm, Star Room

David Clarke
University of Melbourne

Complex social settings such as science classrooms require research methodologies that respect and reflect the multiple perspectives and agencies enacted there. A step in this direction was undertaken with the introduction of "complementary accounts" (Clarke, 1998, 2001), in which the multiple perspectives of classroom participants were elicited and analysed by a research team employing a variety of theoretical frameworks. A more recent study (Causal Connections in Science Classrooms) employed a research design that purposefully anticipated parallel analyses employing distributed cognition, variation theory, systemic functional linguistics, and positioning theory to generate and analyse data from a common data source. The implementation of such a research design has highlighted a range of methodological and theoretical issues. Three of these issues are addressed in this paper: (i) the blurred distinction between data source, data, and analysis; (ii) the compatibility of the findings from parallel analyses drawing on a common data source, but employing different theoretical frameworks; and (iii) the nature of research synthesis and its role in advancing community knowledge. The overarching issue concerns the danger of relying on any single theory for the explication of settings as complex as classrooms. Specific examples will be used to catalyse discussion about these issues.

The effect on primary school teachers' views on the nature of science through participation in a reform-based professional development program.

Saturday 12.30pm, Seaspray 8

Rick Connor
University of New South Wales

A key contributor to a teacher's pedagogical content knowledge for teaching science is their understanding of aspects of the nature of science. Primary school teachers participated in a reform-based professional development program that targeted a number of these aspects. Pre- and post-test were conducted utilising the Views of the Nature of Science VNOS Form (D). Major themes in teacher responses at pre- and post-tests were identified and tabulated in frequency distribution graphs. The responses from a control cohort who participated in a standard professional development program were also recorded for comparison. The data indicates positive trends in teacher knowledge and understanding in aspects of the nature of science specifically targeted in the reform-based model.

Experienced Science Educators Developing Pedagogical Content Knowledge

Friday 11.15am, Seaspray 8

Rebecca Cooper
Monash University

This paper will report on the way experienced science educators articulate and further develop their pedagogical content knowledge (PCK). The paper will draw on data from science educators who have been working on projects that generated discussions about their PCK as well as facets underpinning PCK. Data was collected from journal entries of the science educators, field notes from researchers in general science education classes and comments on a collaboratively written document. The data were analysed to identify aspects of the science educators' thinking that helped them to better understand and articulate changes in their PCK. The analysis also considered the science educators changing ideas about what constitutes a change in PCK and some underpinning facets of it. It was found that by having to articulate their understanding of some of the facets of PCK, experienced science educators could better discuss the development of their own PCK. The science educators indicated that working collaboratively caused changes in their PCK. The analysis also identified that discussion about models of PCK, highlighted differences in the PCK of the science educators and led to a clearer picture about how it could be developed by individuals, even in a collaborative environment.

Expert Science Teachers Notions of Scientific Literacy

Friday 9.15am, Star Room

Deborah Corrigan, Rebecca Cooper & Stephen Keast
Monash University

This paper will report on the way expert science teachers' conceive of scientific literacy in their classrooms, what values related to scientific literacy they hold and how this conception and underpinning values affects their teaching practice. Three perceived expert science teachers who teach both at senior and middle school levels and across the range of sub-disciplines (one senior biology, one senior chemistry and one senior physics) were interviewed about their understanding of scientific literacy and how this influenced their teaching practice. The 3 teachers were video recorded teaching a junior science class and a VCE science class. The data were analysed to identify values that underpin their conceptions of science and science education. Particular attention has been paid in the analysis to the matching of the verbalised conceptions and values with their practice of teaching science. This paper will report on these data.

Space to Grow: The Faulkes Telescopes and improving science engagement in schools

Friday 9.15am, Seaspray 9

Lena Danaia[1], David H. McKinnon[1], Quentin Parker[2], David Frew[2] & Michael Fitzgerald[2]
[1]Charles Sturt University
[2]Macquarie University

The Space to Grow ARC Linkage Project aims to both engage senior secondary students in real science and support teachers in implementing science. The project is being conducted through Macquarie and Charles Sturt Universities with the support of partners including CEO Parramatta and Bathurst, DET Western Region and Las Cumbres Observatory Global Telescope Network. The project team draws together astronomers, educational researchers and technology specialists. The project is being implemented in Year 10 science and Year 11 and 12 physics classes in 37 schools over a three-year period. Students will have access to the Faulkes Telescopes (two 2-metre, robotically operated, research-grade telescopes) to conduct real science investigations and emulate the process a real astronomer follows in terms of applying for telescope time, obtaining images and analysing the scientific data. The purpose of this paper is to outline the Space to Grow Project. The student activities, interactive teacher resources, social networking site, website and embedded professional development program developed for the project will be shared. Furthermore, the multiple-baseline, multiple-probe research design employed to investigate the impact of the project on students and teachers will be described. Finally, the pre-occasion results from the first data collection period will be presented.

Teaching out-of-field? Yes, but not really

Saturday 12.30pm, Sea Room

Linda Darby
RMIT University

Quality education requires an adequate supply of teachers; however, shortages of suitably qualified teachers, particularly in mathematics and science, have led to an increase in the number of teachers teaching out-of-field, particularly evident in rural and regional settings. A SiMERR funded project, "*Teacher Identity In and Across Subjects*" (TIIAS) Project, investigated how teachers of mathematics and science developed coping strategies as they negotiated subject boundaries. Interviews with teachers and other school staff at three rural and regional schools explored meanings and issues associated with the notions of "out-of-field" and "in-field" teaching, the effects that such teaching had on teachers' perceptions of confidence and competence, and how such perceptions contributed to professional identity. Preliminary analyses has shown that, while some teachers considered themselves "just filling in" and had limited or no identity related to the out-of-field subject, other teachers saw such teaching as opportunities to "pursue an interest" and their identity expanded to being a teacher of that subject, with their commitment manifested through seeking professional development and self improvement due to personal interest in the subject or for the sake of their students, or participating in innovation. Consistent with other research, teachers identified a lack of content knowledge and pedagogical content knowledge as being key issues, but other factors were identified as contributing to whether they identified their practice as being out-of-field, such as access to boundary objects. The paper will propose an empirically based theoretical framework that re-conceptualises the practice of teaching out-of field.

The impact of the mass media on students' understandings of genes and DNA: Preliminary findings.

Thursday 2.15pm, Marlin Room

Jenny Donovan
University of Western Australia

This study builds on prior research which demonstrated that students in years 5-7 are ready to learn about genes and DNA, but may have already acquired misconceptions about genetics. These include thinking that genes are totally different from DNA, and that genes are what make you resemble your family, whereas DNA is what makes you unique and identifiable. Upon presentation of this prior research, the usual audience response was to "blame" the media for their poor portrayal of these concepts. The aim of this research was to explore whether this claim can be substantiated, by sampling students in different parts of Australia, establishing their conceptions, asking them where they believe their knowledge came from, and also looking more directly at their response to certain media messages. Although in its relative infancy, the study has sampled two distinctly different populations, from a country city in Queensland and an isolated region of South Australia. This presentation will share this early data and preliminary findings. The two populations do vary in the amount of exposure to the mass media, and in the conceptions held by the students.

Dynamic Shifts for School Science Foundations

Thursday 11.15am, Sun Room

Katherine Doyle
Queensland University of Technology

Literature indicates that tensions transpire between traditional science teaching practices and accepted early childhood teaching practices. This contention prompted investigation into means and models of pedagogy for learning foundational science language, knowledge and processes in early childhood. Bernsteinian pedagogical discourse theory coupled with Halliday's Systemic Functional Linguistics framed an examination of effective science pedagogical practices for early childhood via an explanatory case study. Data were collected from demonstrated visible and invisible pedagogies, teacher/student interpersonal relationships, and technical and everyday language used in teacher and student science talk in a preparatory school classroom. Their analysis established the socio-linguistic characteristics that promoted science competencies in young children. Results indicated techniques on which to capitalise in order to facilitate young children's acquisition of science meanings. Significantly, teaching within the studied setting diverged from perceived notions of common early childhood practices and the benefits of dynamic *shifting pedagogies* were validated.

Toward a conceptual understanding of the mole concept

Saturday 9.15am, Seaspray 9

SuChi Fang, Christina Hart & David Clarke
University of Melbourne

The mole concept is one of the fundamental concepts in secondary chemistry. However, it is also one of the most problematic concepts for both teachers and students. This study was intended to identify the critical features for learners to achieve a conceptual understanding of the mole. The analysis of the study involved two phases. In the first phase, essential aspects of a conceptual understanding of the mole were identified through critical review and reflection on the concept itself and the relevant literature. Based on the findings in phase one, we analyzed how the mole was taught and learned in one year-11 Victorian chemistry classroom. Classroom data included videotaping records and interviews. Phase one results showed that a conceptual understanding requires both a good comprehension of the scientific definition of the mole and appreciation of the connection between the relative mass and the scientific definition. However, we found that these two critical features were not explicitly addressed in the lessons. Most students formed incomplete notions of these two features. Relevant issues regarding teaching and learning the mole concept emerging from this study are discussed. The study's findings also have some implications for the teaching of the mole concept.

The Learning Environment and Science in Schools: School science as an ecosystem

Thursday 4.45pm, Sea Room

Pamela Farrelly
University of Melbourne

The environment encountered by students is emerging as a major influence in science learning (Merritt, 2008). Adolescents coming into science classroom situations are discerning about the facilities they have to use in classrooms (Merritt, 2008; Posner, 1989), in terms of their age, functionality and relevance to the learning experience. The people students associate with in classes, teachers and peers, also influences the science learning experience. To date, little research has considered the impacts that people and structures within school environments may be having on student learning in secondary science classroom and student appreciation for science. Educational reforms are generally concerned with changes to curriculum and assessment strategies and, more recently, with teaching and learning strategies including recent middle years reforms (Pendergast, 2006; Ganeson and Ehrich, 2009). Student learning and appreciation for science, however, is not influenced by curriculum alone. Students experience a complex working environment that is operating with influences on multiple levels: the individual, the local classroom and the community (Nuthall, 2007). My research project seeks to better understand the learning environment and its relation to student perceptions of science. This will be done by considering both the material and sociological factors that interact within this space.

Researching lesson plans, language games and texts of identity in teaching Science: How do student teachers know their lesson plan is working? And how can teacher educators know?

Friday 10.30am, Sun Room

Rod Fawns[1], Christine Redman[1] & Susan Rodrigues[2]
Universities of Melbourne[1] & Dundee[2]

To know if any plan is working we need to be thinking about the how and the what, the participation and the acquisition, or the social and the psychological, in the same sentence. As researchers in science education we have fairly recently, sotto voce, expanded our behavioural and cognitive psychological enquiries into a discursive psychology which attends simultaneously to the person and context. Taking this programme of enlarging the paradigm of psychological research in science education research further required a resolution of the metaphysical or ontological problems associated with cognitive science, that arise inconsideration of such basic matters as self-consciousness, agency and identity formation, which it sees as individualist constructs. The inadvertant reinvention of Cartesianism by cognitive science, involved a muddle about the nature of language which was seen essentially as a mental calculus. The language in the lesson plan becomes a mental calculus about projected purposes. Wittgenstein had a solution that has been ignored. The project then in this research is to suggest how we can begin to conceive of the act of lesson planning as an identity project and selfhood in young teachers of science without the threat of solipsism, that a view of self is all that can be known to exist, and the myth of ³self² as a diaphanous homunculus hidden within. By the same token we seek to formulate a

concept of a teacher¹s agency without the myth of pure will or the belief that they are what the best authorities tell them they are.

The Science Curriculum; Expertise decline and bureaucratese rise

Friday 2.15pm, Sun Room

Peter J Fensham
Queensland University of Technology/Monash University

The content for the school science curriculum has always been a contest between conflicting interests. After an early abortive attempt to introduce science as useful knowledge in the lower levels of schooling, the purpose of science in schooling became the preparation of future science-based professionals. The contest for what this meant in content terms was between two groups of experts – academic scientists and senior science teachers – with the authority of the former usually becoming determining. The ALPHABET curricula produced in the 1960s and 70s was the end of this simplified purpose. The failure of these curricula to meet the needs of modern society and of late 20th C students reopened the contest, and science educators were a significant new group of contestants. As a result the STS movement in the 1980s offered an alternative definition of science for schooling. The promise of this alternative was defeated in the 1990s, not as a result of a contest between scientific experts, but by the powerful role of bureaucrats who had suddenly became dominant in the contest. The paper will finish by discussing the ways in which the current process for developing a national curriculum for Science in Australia has extended this bureaucratic influence in the contest.

Student autonomy enhancing science learning: Observations from a *Primary Connections* implementation

Friday 9.15am, Seaspray 8

David Fittell
Queensland University of Technology

This case study involved a detailed analysis of the changes in beliefs and teaching practices of teachers who adopted the *Primary Connections* program as a professional development initiative. When implementing an inquiry-based learning model, teachers observed that their students learnt more when they intervened less. By scaffolding open-ended inquiries they achieved more diverse, complex and thorough learning outcomes than previously achieved with teacher-led discussions or demonstrations. Initially, student autonomy presented perceived threats to teachers, including possible selection of topics outside the teachers' science knowledge. In practice, when such issues arose, resolving them became a stimulating part of the learning for both teachers and students. The teachers' observation of enhanced student learning became a powerful motivator for change in their beliefs and practices. Implications for developers of PD programs are (1) the importance of modelling student-devised inquiries, and (2) recognising the role of successful classroom implementation in facilitating change.

Understanding the practices of effective primary science teachers: A case study of teaching and learning in one classroom

Symposium, Thursday 10.30am, Star Room

Angela Fitzgerald
Edith Cowan University

Teachers are key players in the reinvigoration of science education. Unfortunately, the spotlight is often shined on the shortcomings associated with teaching and learning in science. If the status and quality of science education in schools is to improve, efforts need to be made to better understand the classroom practices of effective science teachers. In a step towards better understanding, this doctoral study gathered evidence examining what two effective primary teachers were doing to promote student understanding of science over a unit of work. Evidence of their effective science teaching was gathered primarily through a video ethnographic approach and was supplemented with teacher and student interviews, and student work samples. This paper focuses on Lisa and her science teaching approach. Lisa supported student learning in science in several ways. She skilfully managed classroom discourse and provided numerous opportunities for students to represent their understandings in multi-modal forms. Lisa's awareness of her students' learning needs enabled her to closely monitor and provide feedback on the development of their science understandings over the unit. Her teaching approach fostered an inclusive science learning environment, engaged her students' interest in science, enhanced their use of literacies of science and assisted in their conceptual growth.

Using Spatial Science to Teach Secondary Science

Saturday 11.45am, Seaspray 8

Dennis Fitzgerald
Deakin University

The emphasis of this research will be on determining the extent to which Geographic Information Systems (GIS), as a representational tool, contributes to students' conceptual understanding of the sciences. A series of lessons will be prepared involving students gaining skills in the use of the specific technologies, handheld GPS units and GIS software and then their use as part of a student designed inquiry project using the environment of a local park. The introduction of new teaching approaches and technologies is often a complex although potentially very rewarding experience. This research will look at the use of a mediating tool, GIS in the science classroom, as a means of improving students' cognitive development with a practical, project based, inquiry learning. This tool uses maps as a representation of the natural environment and will allow students to analyse spatially based data. Thus the role of GIS as a representational tool in mediating learning will be examined. The methods to be used in this research will include Cultural Historical Activity Theory.

Ways of knowing and doing: Science for preservice teachers in a remote community

Friday 11.15am, Sun Room

Wendy Giles
Charles Darwin University

This paper discusses the reciprocal learning that occurred when preservice teacher education was delivered in situ at a remote Indigenous community. The federally funded project, *Growing Our Own*, is designed to increase the numbers of indigenous teachers in our schools, and help to lessen the turnover of staff in remote communities. In the process of delivering preservice teacher education units in one of the largest and most remote Indigenous communities in Australia, the lecturers are discovering that the science knowledge of the local Teacher Assistants is extensive, and can be used in a very constructive way to add relevance and context to science learning in the classroom. While completing an assessment task for their university studies, the preservice teachers demonstrated an amazing understanding of their environment, and were willing to share this with their lecturer. The results in the classroom were also impressive.

How do science teachers perceive student interest in science?

Thursday 11.15am, Seaspray 9

Jui Judith Gomes & Pam Mulhall
The University of Melbourne

Declining enrolment in post compulsory science is a complex issue and its implications are of concern. This leads us to the following dilemmas: What influences science teachers' perceptions of pedagogy that will engage their students? What are our science teachers' thoughts about the topics that their students like or do not like in science? How do our teachers know if the students are enjoying their science lessons? What perceptions do our year 9 science teachers have about their students' future choice of science as a subject in the post compulsory years? This qualitative study explored these questions to deepen our understanding of science teachers' perceptions about their students' interest in science. Interviews were conducted with teachers and some of their year 9 students to explore perceptions of students' interest in different science topics, and of teaching approaches used to teach those topics. This paper will present data from research in progress which compares students' likings in terms of topic and teaching approach and teachers' perceptions of student likings.

***Science by Doing* – Professional Learning Approach**

Thursday 9.15am, Sea Room

Denis Goodrum
Australian Academy of Science

It is recognised that teachers are the key to educational innovation through professional learning. What is the most effective way of developing professional learning? This presentation explores the professional learning approach adopted by the *Science by Doing* project. *Science by Doing* believes the most effective and self-sustaining approach to professional learning is undertaken by the science department in a high school. Research

suggests leadership is vital so the approach is built around the head of department. To support a science department a series of innovative professional learning resources have been conceived. The approach is being tested in 28 Australian schools in 2010. Preliminary findings will be provided.
The titles of the initial five modules are:
• *Leading for change*
• *Inquiry-based teaching*
• *Effective questioning*
• *Assessment*
• *Student learning*
The modules have a strong visual appeal, requiring user interaction and consisting of three parts:
• Booklet that explains the ideas and research;
• DVD that demonstrates the ideas and skills; and
• Interactive CD for the user to practice the skills shown in the DVD.

A study of factors associated with preservice teachers' intention to teach units on environmental issues in the primary school context

Thursday 10.30am, Seaspray 7

Cedric Greive, Kevin de Berg & Peter Morey
Avondale College

155 preservice primary teachers completed a questionnaire that sought measures of their 'knowledge' of environmental issues, their 'attitude' toward the environment, their current practice of 'care' for the environment, their 'confidence' in preparing lessons on environmental topics and their 'intention' to teach units of environmental science. Confirmatory factor analysis was used to reduce this data to scales that represented these measures. The processes of structured equation modelling employing the techniques of Analysis of Moment Structure (AMOS) affirmed a robust model that linked 'knowledge', 'attitude', 'care' and 'confidence' to the dependent variable of 'intention' in such as way as to explain 49% of its variance. This model indicated a strong and positive relationship between 'knowledge' of and 'attitude' to the environment. While the effect of 'knowledge' on the remaining variables was indirect, it was mediated by 'attitude'. Despite this, the composite effect of 'knowledge' of environmental issues upon the 'intention' to teach environmental science was not insignificant. This was largely due to the strong and positive relationship between 'attitude' and 'intention'. The model also indicated that those participants expressing greater 'confidence' in their ability to prepare lessons involving environmental topics, also indicated stronger 'intentions' to teach units on environmental science.

Managing a discourse of inquiry: A new pedagogical framework

Symposium, Thursday 10.30am, Star Room

Mark Hackling, Pru Smith & Karen Murcia
Edith Cowan University

A key principle of inquiry-based science education is that the process of inquiry must include opportunities for the exploration of questions and ideas, as well as reasoning with ideas and evidence (IAP, 2007). Classroom talk enables teachers and students to work on ideas, reason with evidence and develop understandings. Effective teaching and learning of science therefore involves teachers managing a discourse that engages students in inquiry and learning. This paper outlines the role of talk in supporting science learning, distinguishes between types of discourse, argues that types of talk need to be matched to phases of scientific inquiry, and develops a pedagogical framework that supports a discourse of inquiry. This new synthesis of the 5Es phases of inquiry (Bybee, 1997) and the instructional purposes of these phases (Hackling, Peers & Prain, 2007) with Mortimer and Scott's (2003) communicative approaches and discourse strategies advocated by Alexander (2006) and Mercer (2008) provides a framework to guide the management of classroom discourse so that it supports inquiry-based science education.

Environmental attitudes and the underlying values: the Malaysian case

Friday 1.30pm, Seaspray 8

Lilia Halim[1] & Sharifah Zarina Syed Zakaria [2]
[1]Univesiti Kebangsaan Malaysia
[2]Institute for Environment and Sustainable Development, Malaysia

This study examines the values associated with different environmental attitudes of 109 Malaysian secondary school students. This paper reports as part of a larger survey on Malaysian students' environmental awareness. Two open ended questions were posed to the students from urban and rural schools regarding the environmental problems that they concern most and why. Their responses were coded according to the three categories of environmental concerns; egoistic, altruistic and biospheric. The urban school students displayed more egoistic concerns compared to the rural students. On the other hand the rural students showed more altruistic and biospheric concerns compared to the urban students. The predominating Muslim culture in the rural area might lend itself to enhancing the biospheric concerns. Another implication is to teach the environmental values explicitly by relating the students more to the nature and local environmental problems.

Out of this world! and into their world! Inspiring confidence in disadvantaged secondary students through teaching subject-specific literacies in a meaningful context

Thursday 12.00, Seaspray 8

Mary Hanrahan
RMIT University

Students cannot be expected to participate in learning science when they lack the necessary skills. These skills include the subject-specific literacy skills, especially for disadvantaged students at the junior secondary level. In this paper, with a particular focus on teacher discourse practices, I compare the approach taken in one astronomy lesson and one geology lesson as the respective teachers sought to engage classes containing many disadvantaged students. Both classroom observation and interviews were used to inform the study and critical discourse analysis provided detailed examination of the teacher talk. Among other findings, I observed that both teachers placed a particular emphasis on the presentation of science as the awe-inspiring study of what is actually happening at this moment in time, on communicating the value of what they were teaching in both scientific and social terms, and on teaching the literacies necessary for learning in their particular area of science. From a practical perspective this paper demonstrates aspects of teacher discourse practices which appear to engage students at this level, some of them common to both teachers and some particular to each teacher.

Investigating the science–related attitudes of learners at 5 secondary schools where science clubs have been established.

Thursday 8.30am Sun Room

M.S. Hartley
University of the Western Cape, South Africa

This paper reports on the attitudes of learners that participated in the science clubs at five schools in the rural part of the Western Cape Province in South Africa. The Science Learning Centre for Africa at the University of the Western Cape implemented this project in collaboration with the education department curriculum advisory service. The objectives of this study were to (1) establish the attitudes of learners towards science as a learning area after participating in the school's science club for at least one year and (2) to determine if their involvement in science club activities led to an improvement of learner participation and achievement in science classes. Five of the 25 schools involved in this project were selected by the education department officials. These schools served as case studies to assess the impact of the project on the learners at these schools. The Test for Science-Related Attitudes (TOSRA) and interviews with learners and educators were used for data collection purposes. The study indicated that learners have a very positive attitude towards science with many of the learners and educators acknowledging the role of the science club at their schools as a strong motivating factor.

Teacher voice: ***Effects on teaching and learning when focusing explicitly on representations.***

Friday 3.00pm, Sea Room

Filocha Haslam & Peter Hubber
Deakin University

The research presented in this paper is about the ideas and beliefs of four Middle Year teachers of science about the use of an explicit representational approach to teaching and learning to enhance understanding of key science ideas. A representational focus to teaching science is one that allows student construction, interpretation and negotiation of different representations that underpin the science concepts and processes to be learnt. Achieving an understanding in science involves being able to coordinate representational modes and re-represent information appropriately to construct an explanatory narrative, and the generation of new ideas, based on evidence. This involves collecting data and re-representing it in a number of representational passes.
The paper reports on the teacher perceived effectiveness of this explicit representational focus, based on data from; teacher individual interviews, group interviews, reflective journals and video analysis of classroom transactions using Studiocode software.

The environmental conservation behavior status among undergraduate students at Universiti Kebangsaan Malaysia

Thursday 11.15am, Seaspray 7

Arbaat Hassan & Norshariani Abd. Rahman
Universiti Kebangsaan Malaysia

Literature review showed that awareness on environmental issues has increased in society but the level of individual involvement in environmental activities was still "low". This study was to investigate the status of intention and environmental behaviour among undergraduate students in Universiti Kebangsaan Malaysia (UKM). The survey employed a quantitative approach using questionnaires involving 377 respondents (n=377). The two types of variables: independent (gender, disciplines, and years of study) and dependent (intention involving attitudes, personal norms, locus of control, and environmental conservation behaviour) were used. Results from descriptive analysis showed "high" intention but demonstrated "moderate" behaviour towards environmental conservation. The constructs under intention variables were attitude, and personal norms were at "high" level, whereas the locus of control was at a "moderate" level. Overall finding showed that there was a high correlation between intention and behaviour. This suggested that the method of teaching and learning should be more focus to their direct experience and "hands-on" activity in order to improve responsible environmental behaviour.

The application of constructivism approach in the environmental education through fieldwork strategy

Friday 4.00pm, Seaspray 7

Arbaat Hassan & Sharifah Intan Sharina Syed Abdulah
Universiti Kebangsaan Malaysia

The constructivist approach is the teaching and learning approach established through research done by cognitive psychologists. Among the pioneers of this theory were Piaget, Brunner and Brand, Dewey, and Ausubel. Environmental education is an aspect of education consisting of humans, environment, and the interaction between humans and environment components. The constructivism-based approach in this paper suggests fieldwork activities strategy as the most applicable method for environmental education. Fieldwork activities will result in experiential learning through active learning and student-centered strategies. As the outcomes of this strategy, students said to be able to build new knowledge and deeper understanding about the components of environmental education. Later, this result will be their prior knowledge when attending the formal teaching and learning in the classroom. Besides, fieldwork activity provides opportunity to students to develop environmental skills through research activity which will be included in the activity. Overall, the teaching and learning environmental education by implementing the constructivism approach provides an opportunity for students to demonstrate their abilities and to get out of the "dark" box.

The 5 Rs: A Conceptual Framework to Encourage Student-generated Animations (Slowmations) of Science Concepts

Saturday 9.15am, Sun Room

Garry Hoban & Wendy Nielsen
University of Wollongong

A "Slowmation" (abbreviated from "Slow Animation") is a narrated animation created by students (preservice teachers in university or children in school) that is played slowly at 2 photos/second to explain a science concept. The teaching approach or conceptual framework for making a slowmation involves students creating a sequence of five multimodal representations that are interconnected (the 5 Rs): (i) background knowledge; (ii) a storyboard; (iii) making 2D or 3D models; (iv) taking digital still photographs as the models are moved manually; and (v) creating the final animation with a narration. In this study, three preservice primary teachers were allocated a topic with which they were not familiar (life cycle of a lady bird beetle) and asked to create a slowmation over a period of three hours. Data were collected in the form of individual interviews, concept maps and a video recording of the whole group process in which the preservice teachers were encouraged to "think aloud" about their learning. Data showed that creating a connected sequence of five multimodal representations helped the preservice teachers to build understanding about the life cycle of the lady bird. The 5 Rs is a new teaching approach that supports preservice teachers in creating animations of science concepts and helps them to develop understanding. See www.slowmation.com for examples.

Grade 10 Thai students' analogy for explaining rate of reaction

Saturday 8.30am, Seaspray 9

Orawan Hompromma, Paisan Suwannoi, Kongsak Thathong & Chokchai Yuenyong
Khon Kaen University, Thailand

The research aimed to examine students' analogy for explaining rate of reaction during learning about rate of reaction by using analogy approach (Focus, Action, and Reflection (FAR) Guide). The target group consisted 47 grade 10 students' in Paksuai Pittayakom School, Nongkhai province, Thailand, during in the second semester of the 2009 academic year. Research methodology regarded the interpretive paradigm. Students' analogs for explaining 4 concepts about rate of reaction (including concentration, temperature, area, catalyst and inhibitor) was interpreted as protocol through students' tasks, questionnaire about rate of reaction concepts, and interviewing. The findings revealed the interesting students' analogs for explaining 4 concepts. These included driving car back home on the motor way, blowing up balloon by pumping, using pulley as labor-saving equipment, changing from letter to email, changing from riding bicycle to motorcycle, and changing from using stair to elevator. These analogs were clarified as representing of students' constructing meaning about rate of reaction. The paper will discuss implications of these to provide enhancing students generating their scientific concepts based on local setting.

An Investigation of Elementary School Students' Self-expectation, Involvement, and Interests in Learning Science

Thursday 10.30am, Marlin Room

Zuway-R Hong, Huann-shyang Lin, Hsiang-Ting Chen, Hsin-Hui Wang, Me-Sui Zheng & Tien-chi Yu
National Sun Yat-sen University, Taiwan

This cross sectional study investigated primary school students' self-expectation, academic achievement, involvement, and interests in learning science. Ninety-six 4^{th} graders, 111 5^{th} graders, 107 6^{th} graders participated in the study in Southern Taiwan. Students responded to an Elementary School Students Questionnaire (ESSQ). In addition, follow-up in-depth individual interviews with target students, their parents, classmates and teachers were conducted for triangulation and consolidation of the quantitative findings. Factor analysis was used to examine the validity of instrument, MANOVAs and t-tests were conducted to compare the differences of students' learning outcome. It was found that the 5^{th} and 6^{th} graders with high self-expectation had significantly higher scores in the involvement and interests in learning science than the moderate and low in self-expectation students; 4^{th} and 5^{th} graders with high academic achievement had significantly higher scores in the involvement and interests in learning science than moderate and low achievers. Additionally, we found that the 4^{th} grade girls had significantly higher scores in the involvement and interests in learning science than the

boys; the 6th grade girls had significantly higher scores in the involvement than the boys. Implications for teaching practice were discussed and suggestions were provided.

***Planting the Seeds of Science*: Development and evaluation of a new early childhood science resource**

Friday 1.30pm, Seaspray 7

Christine Howitt
Curtin University of Technology

Planting the Seeds of Science is a new early childhood science resource, in the form of a book, which has been developed through collaboration between scientists, engineers, and teacher educators. This resource is intended to be a catalyst for engagement in science teaching and learning for early career educators, and to address the lack of resources currently experienced in early childhood education. *Planting the Seeds of Science* places an emphasis on a flexible and integrated curriculum that encourages children's curiosity and critical thinking. As such, it contains ideas and activities related to a central theme from which the teacher can choose. Five themed modules based on the environment, day and night, forensic science, cleanliness and solar energy are presented in the book. Evaluation of the book by both pre-service and in-service teachers found *Planting the Seeds of Science* to be useful, holistic and flexible. These teachers believed the resource improved their confidence to teach science, gave them inspiring ideas and activities to engage their students, and improved their attitude and interest in teaching science. Various case studies illustrating how the book was used will be presented. Copies of the book will be available for viewing.

Using structural holes and social capital to develop a model of collaboration and creativity between scientists/engineers and teacher educators

Saturday 11am, Seaspray 7

Christine Howitt & Elaine Blake
Curtin University of Technology

This research took a strategic approach to the problem of better preparing pre-service early childhood teachers to teach science through a uniquely cross-discipline and collaborative approach between scientists/engineers, teacher educators and pre-service teachers. The purpose of this innovation was to provide pre-service teachers with the best possible chance of acquiring the requisite science content to merge with their pedagogical skills, and thus increase their confidence to teach science in the early childhood classroom. The collaborative approach involved scientists/engineers and teacher educators together developing new science resources, and implementing them through team-teaching into the pre-service teachers' science workshops. To develop a model of collaboration between different disciplines, the theoretical frameworks and dialectical positions of structural holes and social capital are presented. The place of the social broker is highlighted in this model. Social brokers connect groups with alternative ways of thinking and behaving, translate information across groups, and are pivotal to idea generation. In this model, the social broker must remain with the project for its entirety to ensure the completion of the original goals of the collaboration. Additional essential elements within the model include an immersion period into partner's practice, selection of partners, trust between partners, and flexibility.

An exploratory study of students' inquiry competence and science teachers' inquiry teaching performance

Thursday 1.30pm, Seaspray 9

Ching-Hua Hsieh[1], Hsiao-Lin Tuan[1] & Chi-Chin Chin[2]
[1]National Changhua University of Education, Taiwan
[2]National Taichung University, Taiwan

The purpose of this study is to investigate students' inquiry competence and their perception of teachers' inquiry teaching performance. Using purposive sampling, we selected Group A (5 classes, 259 students) whose science teachers had inquiry teaching experience, and Group B (five classes, 245 students) from the same schools as group A. All of them completed the "Students' Inquiry Competence in Relation to Teacher's Inquiry Teaching Questionnaire" which consists of: students' inquiry competence (SIC), students' understanding of inquiry (SUI), teacher's inquiry teaching competence (TITC) and the teacher's effect of developing students'

inquiry competence (TEDSIC) (Hsieh, Tuan, & Chin, 2010). The entire alpha was 0.953. The results revealed that students from group A scored significantly higher than group B in TITC, and TEDSIC scales ($p < 0.05$). In the A group, males scored significantly higher than females in the SIC scale ($p < 0.05$). There is no significant difference in each scale for gender in B group, males or females between group A and group B. The results support the construct validity of this questionnaire, that students can perceive the difference between science teachers' inquiry teaching competence and how teachers' teaching influence on their inquiry competence.

Utilizing a graphic organizer for promoting pupils' argumentation

Thursday 3.00pm, Seaspray 8

Fu-Pei Hsieh[1] & Sung-Tao Lee[2]
[1]Elementary school teacher, Kaohsiung, Taiwan
[2]Naval Academy, Kaohsiung, Taiwan

The purpose of this study is utilizing a graphic organizer for promoting pupils' argumentation. The method of case study was employed. A total of 8 fifth grade pupils from 2 classes were assigned (*n* =4, 2 high achievers, 2 low achievers) with graphic organizer instruction (GOI), and the others (*n* =4, 2 high achievers, 2 low achievers) received no treatment. The instrument was composed of six open-ended questions based on Toulmin's Argument Pattern（Toulmin, 1958）. Qualitative data were collected and analyzed through qualitative description. The results indicated that students with GOI performed better on recognizing data, claim, warrant, and backing than the others. They can make main claims and justified them by data provided in the text and their claims were consistent with data, warrant, and backing. Additionally, they all thought GOI was an effective method for promoting argumentation. On the other hand, students without GOI made less important claims and supported them only by their own experience and opinion. Finally, the interviews showed that the low achievers benefited more from graphic organizer than the high-achievers and the GOI can facilitate both the comprehension and argumentation ability.

The influence on 6th graders' knowledge and attitude towards environment with out-of-school learning ~ Visiting a thermal power station

Thursday 12.00, Seaspray 7

Jinmeei K. Hsieh
MingDao University, Taiwan

The purpose of this study was to investigate the effectiveness of knowledge and attitudes towards environment of 6th graders in elementary school from out-of-school learning with visiting a thermal power plant in the middle of Taiwan. The quasi-experiment was designed with two classes including 61 students in an experimental group and the other two classes including 60 students in a compared group. All these four classes were conveniently chosen from one elementary school, 10 kilometers away from the thermal power plant. The 2-hour visiting learning for the experimental group was arranged with four phases: (1) introduction about the thermal power plant with video in a TV room; (2) learning with station model; (3) field observation and note-writing; and (4) discussions and questions with guides and teachers. Students in the compared group were taught the same material about thermal power plant with the traditional teaching in school. Students in the two groups were examined with an "Environmental Knowledge Questionnaire" and an "Attitude towards Environment" before and after the unit teaching. The results showed that there was no significant difference about students' environmental knowledge between two groups ($F=0.507$, $p>.05$) through the analysis of ANCOVA. However, there was significantly different about students' attitude towards environment between two groups ($F=5.038$, $p<.05$). Also, the findings included many students' critical questions which were used for suggestions about the future out-of-school instruction.

The case study of the alternative conceptions and mental models of a night school student on two units: "air pressure" and "sea and land breeze"

Friday 2.15pm, Seaspray 7

Chi-Ting Hsu
National Ping Tung Senior Industrial Vocational School, Taiwan.

This study based on Vosniadou's (1994) framework theory was proceeded to investigate a 10th-grade night school student's alternative conceptions, presuppositions and mental models on two units: "air pressure" and "sea and land breeze". A semi-structured questionnaire was used to interview this student. The results of this

study were listed as follows : 1. The subject had many alternative conceptions, including high pressure (H) means higher temperature, high pressure would cause rain, low pressure would not cause rain, During Day the high pressure zone is located on the land and low pressure zone is located on the sea, etc.. 2. The subject had one ontological presupposition and three epistemological presuppositions. 3. The subject had different mental models on the two units. The results supported Vosniadou's (1994) framework theory that the *naïve framework theory* and specific theory constrain the generation of mental model. Also, the presuppositions in the *naïve framework theory* filter the subject's interpretations of the physical world and constrain the mental models of the two units.

An Online Lesson Embedded with Metacognitive Strategies for Students' Conceptual Change and Inquiry Skill Development

Friday 10.30am, Seaspray 9

Ying-Shao Hsu, Wun-Sin Chang, Hsin-Kai Wu & Fu-Kwun Hwang
National Taiwan Normal University

From literature reviews, students' inquiry skills can be promoted not only through multiple practices and explicit instructions but also through cultivation of their metacognition. Therefore, scaffolds for students' metacognition to perform questioning, planning, data collection & analysis, explaining & concluding, and evaluating are necessary when engaging in scientific inquiry activities. The researchers developed a lesson for technology-infused learning in the topic of Seasons. We selected two classes to receive two different designs including metacognitive strategies and no metacognitive strategies. After collecting data to examine students' conceptual understanding and inquiry skills, the results showed that students' conceptual understanding about seasons (z=-3.09, p<0.01) and inquiry skills (F=7.9, p<0.05) had significantly improved. More qualitative data such as interviews and online worksheets will be analyzed for deepen understanding about how students made progress in this technology-infused learning environment.

Teaching Socio-Scientific Issues in Taiwan via Science News Writing, Peer Discussions and Interactive Use of Website

Friday 8.30am, Marlin Room

Chun-Ju Huang
National Chung Cheng University, Taiwan

During our everyday life, there are so many issues related to science. Are our food, water, and air healthy or not? How will the most recent technology development affect human beings now and in the future? …These so-called **socio-scientific issues** arise almost every day. An informed and socially responsible individual must possess a great deal of scientific literacy in order to cope with these changes and their effects. Science news is the most important and convenient materials available. This study plans to improve students' understanding of socio-scientific issues via science news writing, peer discussions and website interaction. All the participants were selected from students enrolled at the university-level within a general education program in Taiwan. This study is divided into three phases. **First**, students need to read science news related to socio-scientific issues and 'guess' the invisible processes behind this news report. **Second**, following group discussions, students are required to write science news reports on their own favourite issues as homework. **Third**, students must upload their final reports to the class website. There, students will find exhibits and interactive functions that permit them to share different topics and perspectives. Both qualitative and quantitative data were collected. Preliminary results have already shown that the science news based teaching can efficiently improve our students' further understanding of socio-scientific issues.

The Role of Representation in Teaching and Learning Ideas about Matter

Thursday 9.15am Seaspray 8

Peter Hubber
Deakin University

The research described in this paper is designed around the notion that learning involves the recognition and development of students' representational resources. This paper describes a classroom sequence in Ideas about Matter that focuses on representations and their negotiation, and reports on the effectiveness of this perspective in guiding teaching, and in providing further insight into student learning. Classroom sequences involving two

experienced teachers (2008, Year 8 students) and an inexperienced teacher (2010, Year 7 students) were videotaped using a combined focus on the teacher and groups of students. Video analysis software was used to code the variety of representations used teachers and students, and sequences of representational negotiation. The paper reports on the effect of this approach on teacher pedagogy and on student learning of Ideas about Matter. The paper will present data from video of classroom activities, students' work samples, student and teacher interviews and pre and post-unit testing, to explore what a representational focus might entail in teaching Ideas about Matter, and the role of representations in learning and reasoning and exploring scientific ideas.

Using CoRes for laying the foundations of future PCK development in pre-service chemistry teacher education

Friday 12.00, Seaspray 8

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

This paper presents findings from action research that seeks to promote chemistry student teachers' awareness of pedagogical content knowledge (PCK), and provide them with a tool for laying the foundations of their own future PCK development. The approach involves the use of Content Representations (CoRes), which were originally developed as part of a strategy for exploring and gaining insights into the PCK of expert science teachers. As the student teachers explored existing CoRes the course lecturer saw potential for more effectively developing their PCK through engaging them in designing their own CoRes for new topics. Student teachers found CoRe design challenging and their lack of classroom experience and experimentation proved to be a limiting factor. However, the contribution such a task could make to their future PCK development remained a distinct possibility in the lecturer's view. In the following year she carefully scaffolded the learning prior to CoRe design such that the student teachers could more readily access relevant knowledge when attempting such a task. Their resultant CoRes and comments indicate that with appropriate and timely scaffolding the process of CoRe construction does have the potential for PCK development for novice teachers.

The nature of students' explanations about homeostasis

Friday 1.30pm, Seaspray 9

Chia-Hui Hung & Chen-Yung Lin
National Taiwan Normal University, Taiwan.

Homeostasis is one of most complex and hierarchical topics in biology. As learning such concepts, students need to realize emergent attributes of subjects to generalize their understanding (Chi, 2005). This study was to investigate students' explanations about homeostasis of body temperature. Thirty students from a medical junior college (equal to first year of college) who had exposure of anatomy and physiology were involved in this study. They were asked to take an examination with 5 open questions on homeostasis and interviewed with semi-structured questions to analyze their understanding and ontological attributes. Results: (1) The students in the study easily grasped the elements of homeostasis in questions of phenomenal and mechanical level; (2) The students of higher scores gave more complicated phenomena, direct causality and network causality answers than those of lower scores with statistically significant difference; (3) Twenty out of thirty students demonstrated ontological attributes of direct process, and only 10 students could demonstrated emergent process attributes; (4) ontological attributes held by students had significant relationship with their homeostasis achievement scores, with that lower-scored- students tended to hold direct process causality. Based on the findings above, it is suggested that their misunderstanding are likely the result of their mistaken categorization.

The Development and Validation of Scientific Inquiry Abilities Test

POSTER

Jeng-Fung Hung[1], Fu-Pei Hsieh[2] & Sung-Tao Lee[3]
[1]National Kaohsiung Normal University, Taiwan
[2]Kuang-Hua Primary School, Taiwan,
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In the last few years, several articles have been devoted to the study of scientific inquiry (Fradd & Lee, 1999; Hinrichsen & Jarrett, 1999; Sandoval & Reiser, 2004; Schwarz, 2009; Ruiz-Primo & Furtak, 2007). An

appropriate instrument for educators to measure related constructs is imperative. Based on the related theories, the purpose of this study was to develop a reliable and valid Scientific Inquiry Abilities Test (SIAT) for practical and academic uses. Two hundred and thirty 10^{th}, 11^{th}, and 12^{th} graders in Taiwan participated for item analysis and construct validity test. The results were as follows: (1) The SIAT contains 27 items including 5 testlets; (2) There were low correlations existed between each two Testlets scares ($p<.000$), the values were from .158 to .323; (3) There were moderate correlations existed between all testlets scores and whole test scores ($p<.000$), the values were from .534 to .684; (4) The internal consistency was .629, and the scorer reliability coefficient was .964; (5) High achievement students outperformed their counterparts on SIAT and all testlets with large effect sizes. These results indicated that SIAT has quality reliability and construct validity. Finally, implications for future research and science teaching were discussed.

From Teachers' Questioning to Students Asking Questions: The Case of Learning to Plant Anthuriums in their School

Thursday 2.15pm, Sun Room

Jeng-Fung Hung & I-Che Chung
National Kaohsiung Normal University, Taiwan

The purpose of this study is to promote students to ask questions via teachers' questions and horticulturalists' answers how to plant anthuriums in their school. This study was case-study, and the subjects included two teachers and 10 5^{th} grade students. The study period was divided into three phases: (1) interview professional horticulturalists; (2) practise in the anthurium nurseries in their community; (3) planting anthuriums in their school. Each of these three phases was separated into the primary stage and the secondary stage. During stage 1, students learned how to ask questions by noting down teachers' questions and horticulturalists' answers while teachers questioned horticulturalists about planting anthuriums. During stage 2, students learned to plant anthuriums by asking questions to horticulturalists. The data collection included field observations, teachers' reflection notes, teachers' dialog with students, and interview with professional horticulturalists. The results of this study were: (1) through activities in the three phases, the students' questioning skills were promoted and the frequency of questioning were raised; (2) students learned to ask questions from teachers' questioning, and then they gained knowledge about planting anthuriums.

The relationship between environmental education activities and environmental practices among students: a case study in Kuala Jengal primary school, Terengganu, Malaysia

Friday 4.45pm, Seaspray 7

Mohd Zaid Ismail & Arbaat Hassan
Universiti Kebangaan Malaysia

Goals of environmental education among students can be achieved through activities outside the classroom. Through various activities held continuously, awareness, attitude and environmental practices will be increased. The purpose of the study was to identify the relationship between environmental education activities and environmental practices among students. Samples were 30 students and 2 teachers from Kuala Jengal Primary School, in the state Terengganu, Malaysia. Data were gathered from Nature Club (NC) and Malaysian Nature Society (MNS), interviewing teachers and questionnaires students through Nature Club. The questionnaires contain 10 items regarding to environmental practices among students. Responses were based on a 3-point Likert Scale (1= Never; 2=Sometimes; 3= Always).The data were analyzed using descriptive statistic involving frequency and percentage. The data were also analyzed using inference statistic involving correlation between environmental education activities participated and environmental practices. The data from NC and MNS found that the students were actively involved in all activities and interview showed that high environmental awareness among students. The results from questionnaire showed that environmental practices among students were more than 70% (3= Always). There was strong relationship between activities participated and environmental practices among students where the value of r is 0.607 ($p=0.01$). From these results, the researcher made the conclusion that environmental education in that school is proudly implemented and environmental practices depend on activities participated. Nevertheless, a lot of related activities should be held and all school citizens should be involved.

Children using 'molecules' for thinking

Saturday 11.45am, Seaspray 7

Cheryl Jakab
University of Melbourne

This paper presents results of a research project designed to explore 6 to 11 year old children's meaning making when using molecule artifacts. Data was collected in interviews conducted as genuine dialectic-interactive teaching conversations with this researcher as the expert other. The interview design is based on Vygotsky's two-stage process of double stimulation with the Stage 1, or explicit stage, introducing 'molecule' signs and then a dissolving activity used as the Stage 2, implicit or problem stage. In Stage 1 conversations were conducted around and with available molecular artifacts in the forms of words, images, models and interactive websites. Stage 2 encouraged participants to use the previously offered signs in explanations of the dissolving activity. The provision of the molecular signs prior to exploration of an exemplar physical phenomenon meant that molecular world ideas were available as thinking tools for /in /with the dissolving activity. This research shows primary school children working with the idea of 'molecules and atoms' as a thinking tool in chemistry activities. The results indicate that experiences with atom and molecule terminology and representations can enable young learners to develop more scientifically normative explanations for physical phenomena when particulate nature of matter is made available.

Pre – Service Science Teachers' Understanding of Classroom Research Principles and the Need of Supervision about Classroom Research from Their Cooperating Teachers and University Supervisors

Thursday 9.15am Marlin Room

Ekgapoom Jantarakantee[1], Vantipa Roadrangka[1] & Anthony Clarke[2]
[1]Kasetsart University, Thailand
[2]University of British Columbia, Canada

This research paper explores pre-service science teachers' understanding of classroom research principles, problems in conducting classroom research, and the supervision of classroom research that pre-service science teachers engage in under the supervision of their cooperating teachers and university supervisors. The participants in this study are thirty pre-service science teachers in two universities situated in western Thailand. The research instruments included a questionnaire about classroom research principles and interviews with the pre-service science teachers regarding the problems in conducting classroom research and the supervision of classroom research that pre-service science teachers engage in under the supervision of their cooperating teachers and university supervisors. The data were analyzed using descriptive statistics, and content analysis. The results indicated that most of the pre-service science teachers understood the principles of classroom research. The greatest problem the pre-service science teachers faced in conducting classroom research was generating suitable research question. Pre-service science teachers would like cooperating teachers and university supervisors to give recommendations to them more frequently for promoting pre-service science teachers confidence and efficiency in their chosen classroom research projects. This study has direct implications for the ways in which we introduce and engage pre-service teachers into inquiry oriented practice in their chosen profession.

Students' understanding of the nature of science through classroom arguments about socio-scientific issues and its comparison with debates on the web board

Saturday 11am, Marlin Room

Hunkoog Jho & Jinwoong Song
Seoul National University, Korea

This study implements science teaching based on socio-scientific issues (SSI) in an undergraduate lecture to compare the discourse patterns found in the classroom and on the internet. The students are intended to learn the nature of science through discussions encouraged by a bottom-up dialogue scheme called 'snowballing'. Fifty-four freshmen taking the course have discussed the latest controversial issues such as the 'Toyota recall', global warming and mad-cow disease. Some common discourse patterns in the classroom and on the internet are found and elaborated. Irrespective of the topic, the students invariably rely on intuition and emotion to draw diverse conclusions despite analyzing the same evidence. And while a prevailing attitude is found divisive on the internet, the classroom attitude consistently drifts to the neutral. Whereas the online debating of the topics is

found to decrease in positions, the classroom positions increase in degree and depth. It is conjectured that face-to-face classroom discussion gets 'counter-balanced' but escalates on internet web forums.

Science and design technology: Lessons for rural and regional Australian schools from South East Asia.

Saturday 12.30pm, Star Room

Wendy Jobling
Deakin University

'*Sustainable Solutions for the Local Community*" was the theme of the 2010 regional congress of the Southeast Asian Ministers of Education Organisation (SEAMEO) held at the Regional Centre for Education in Science and Mathematics, Penang Malaysia. Secondary students from member countries presented their solutions to problems they identified within their local communities. As a judge in the *Search for SEAMEO Young Scientists* section of the congress I noted that many projects involved the application of science skills and understandings to design and produce a technological artefact. Students demonstrated a high standard of science knowledge during the presentation of their projects. A motivating factor was their confidence about the difference their projects could make to their local communities. This paper discusses the factors identified in student projects with a design and technology focus that could be applicable to students in rural and regional Australia.

Use of Analogy in the Teaching of Biology Concepts

POSTER

Christiana Jolayemi, Amanda Berry & Deborah Corrigan
Monash University

Research studies have suggested that analogy can be an effective tool in helping students develop an understanding of scientific concepts, especially those that are abstract or difficult to experience directly. Analogies can help students' understanding in many ways for example, by providing a conceptual bridge between already existing and unfamiliar targeted knowledge (Glynn, 1995); and by stimulating students' interests and creative insight (Duit, 1991). However, it is also reported that inappropriate use of analogies can lead students to develop misconceptions (Duit, 1991; Harrison & Treagust, 1994) The central purpose of this study was therefore to investigate the use of analogy in teaching biology concepts and examine what effects it can have on students' understanding of selected concepts. Data was collected through classroom observations, teacher interviews, textbook analyses and textbook author interviews. The research revealed that teachers tended to develop and supply the analogies used in observed lessons with no opportunity for students to construct their own analogies. Analogies presented in textbooks rarely contained a clear statement of limitations. Interviews with textbook authors revealed that experience in high school teaching has influenced textbook authors' use of analogy. Analogy use in biology textbooks was not determined solely by learning considerations.

A research agenda for the development of resources for the 21st century teacher

Thursday 8.30am Seaspray 9

Alister Jones, Bronwen Cowie & Ariana Dougahy
University of Waikato

The *Science Learning Hub* is a website that is being developed by a national team, led by the University of Waikato, to provide readily accessible, up to date and New Zealand oriented resources for teachers of science. The development of Hub materials is grounded in the research work of those involved. The development is complemented by national research programme which has three main foci: an investigation of the ways that teachers access and navigate the Hub materials; teacher use of the SLH as a tool in classroom learning, and the implications and impact of the multimodal nature of the Hub materials. This paper outlines the scope and rationale of this programme as well as emerging research findings.

A secondary analysis study of a survey of Taiwanese students' conceptions of the behavior of gas particles utilizing cognitive map approach

Friday 12.00, Sea Room

Jing-Ping Jong, Mei-Hung Chiu, Chih-Kang Chang & Sheng-An Bai
National Taiwan Normal University, Taiwan

This article describes a secondary analysis of the results of the two-tier diagnostic instruments used to investigate students' performance in achievement tests on the behavior of the gas particles in Taiwan (Chiu, 2007). Unlike other studies only comparing the students' performance, the analytical method of this study adopted a model of cognitive maps (CMs) proposed by Chaib-draa and Desharnais (1998), and Peña, Sossa, and Gutiérrez (2008). The purpose of this study was to explore what CMs were held by secondary school students and how their CMs changed in the representation of qualitatively causal relationships in the different contexts. The results are shown as follows:
1. Five types of CMs in a subset of the two-tier diagnostic instruments were found.
2. In different contexts, the dominant type of CM held by students was not the same.
3. It showed that older students' reasoning was context-dependent and based on their use of inconsistency of scientific CMs in the specific contexts.

Effect of Project– Based Learning on Stress Level

Friday 3.00pm, Sun Room

Nantarat Kaewkrisorn, Tassanee Bunterm, Jintanaporn Wattanathorn & Supaporn Muchimapura
Khon Kaen University, Thailand

Although stress has been recognized as the important factor playing a crucial role in student achievement, less scientific documentation about the effect of teaching models on stress is available. Therefore, the present study is designed to investigate the effect of project-based learning and stress level in Grade 8 students. A total of 51 Grade 8 students in Non-sa-ed Chumsaengvittaya School, Udonthani, Thailand have been recruited to participate in this study. They were randomly divided into 2 separate groups as following: 1) control group that received conventional teaching model; 2) experimental group that received project-based learning teaching model. The intervention has been applied for 7 weeks. All subjects were evaluated achievement via the achievement test, and attitude toward each teaching model via attitude scale. The stress level was evaluated using 2 indices including the self perception stress level and stress hormone or cortisol via the self analysis stress test (Department of Mental Health, Ministry of Health, Thailand) and hormonal assay kit respectively. All assessments were performed before and after the intervention. The data were analyzed using student pair t-test and significance was regarded at p-value less than 0.05. Our results showed that no significant change on the achievement between two groups. Surprisingly, the stress hormone in the students, who obtained project-based teaching model, was significantly decreased while the attitude toward teaching model was increased. However, the self perception of stress level failed to show the significant change. Therefore, the results obtained from this study suggest that project based teaching model appears to be the effective teaching style to reduce stress and enhance the opportunity to learn with happiness.

On the same page: standardised models of global knowledge.

Saturday 12.30pm, Marlin Room

Michael Kateifides
Marrickville Intensive English Centre (former), Sydney

Many in the world eg developing nations, do not have effective access to knowledge. Of those who do eg developed nations, many do not use it effectively. This 'knowledge-disconnect' is growing rapidly, whilst the world experiences an unprecedented 'knowledge-explosion', and global knowledge is increasingly critical to solving global challenges eg Climate Change. Can knowledge be learnt world-wide, with little/no schooling, and be life-lasting, rather than 'learn for exams, then delete'? A solution is to develop standardized models of knowledge so we are all 'on the same page'. These models should be accepted globally and comply with international standards of quality ie ISO 9000. A candidate is the 'Kateifides scale model of the Solar System'. There are several models of the solar system. The Kateifides model incorporates the 'language for learning'(LFL) system, and thus could be learnt by everybody, world-wide, for life. Some LFL components include: 'ying-yang', 'man is the measure of all things', 'scientific method', and 'everyday objects'. The

Kateifides model has been successfully learnt by secondary school students and working adults. The students are migrants to Australia with little/no English. Some come with little/no schooling, and/or with little/no science knowledge.

Using concept mapping to scaffold learning for students who experience learning difficulties in science classes

Thursday 3.00pm, Sun Room

Annette Kazakoff
Queensland University of Technology

While scientific literacy is a goal for most school-science curricula, some students experience difficulty learning concepts in science classes. This paper reports on a study that was conducted with a group of Middle School students who were referred to the school's learning support centre for additional assistance with learning science. The study investigated whether concept mapping could be used to enhance the development of the students' conceptual understanding in science and was conducted using a design-based research methodology. The analysis of student work samples collected during the two-year study identified some of the difficulties and benefits associated with the use of concept mapping with these students. The results of the study support the use of structured pre-writing activities to facilitate the development of conceptual understanding. The implications for classroom teachers are discussed.

Students' Belief about Learning Physics as a Resource of Teaching Physics

Thursday 10.30am, Sea Room

Hong-jeong Kim, Sung-jae Pak & Sung-min Im
Daegu University, Korea

In this study we explored the relationship between students' belief about learning physics and their achievement in study of physics. To investigate students' belief, we used the test form of 'Belief About Learning Physics Survey' (Im, 2001; Im, 2008) which can be analyzed in two dimensions as 'cognitive belief' and 'motivational belief', to pre-service physics teachers before and after physics course for one year. To evaluate students' achievement we adopted both their grades in physics class and the understanding of physics concepts tested by 'Force Concept Inventory' (Hestenes, 1992). The relationship between belief and achievement was statistically analyzed. As a result cognitive belief both before and after the course showed high correlation with their achievements in the grade and the understanding of force concept, while motivational belief after the course only showed correlation with the grade. From this we can infer that students' cognitive belief about learning physics before physics class would be an indicator of successful learning in physics, especially in the understanding of physics concept. However, students' achievement in physics course might affect their cognitive and motivational belief in learning physics. Instructors can investigate and use students' belief about learning physics as a resource as well as an objective in their teaching physics.

Learning Fatigue in a Science Museum and a Science Classroom

Thursday 9.15am, Sun Room

Minchul Kim & Jinwoong Song
Seoul National University, Korea

This paper reports results of a comparison of student fatigue in a science museum and a science classroom. As fatigue interferes with learning and satisfaction, sufficient understanding of its causes allows museum staff and teachers to improve the conditions necessary to maximize outcomes in student learning. The comparison between science museum fatigue and a science classroom fatigue was made in light of three causal attributes: individual, environmental, and socio-cultural (Melton, 1935; Falk et al., 1985; Bitgood, 2002). We surveyed students of elementary, middle, and high schools inquiring the causes of learning fatigue in a science museum and a science classroom. The reported causes differ in two main ways: environmental attributes are more salient in a science museum, whereas individual attributes are more salient in a science classroom. In addition, the major causes depend on school level.

Making Connections Again: A Student's Experiences of Assessment in Context-based and "Traditional" Curriculum Approaches

Friday 2.15pm, Seaspray 9

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

Following on from our study (i.e., King, Bellocchi & Ritchie, 2008) of one student's experiences in both context-based and content-based chemistry programs, we report our analyses of this student's responses to assessment items and tasks across the programs. We describe our unique analytical procedures before contrasting the data. Our findings indicate that when a new curriculum is developed where concepts are separated from their context, unnatural situations arise that require teachers to combine the two in contextualised assessment. We argue that concepts and contexts are better viewed from a dialectical perspective (context|concept) rather than the false binary that polarises these two dimensions of scientific endeavour. Implications for practice, curriculum and assessment development in context-based courses are proposed.

Ways of writing about work and potential energy in textbooks of Taiwanese junior high school

Thursday 9.15am Seaspray 9

Che-Di Lee & Tsung-Hau Jen
National Taiwan Normal University, Taiwan

The purpose of this study is to systematically examine the ways of writing about work, potential energy, and relationship between them in textbooks of Taiwanese junior high school. 230 clauses containing "work" and "potential energy" were retrieved from textbooks printed by four publishers. The expressions at the level of nominal group and clause were analyzed based on systemic functional grammar. The analysis reveals that there are three main problems in the expression system of textbooks. Firstly, it is confusing that the owner of potential energy can be an object exerting a force as well as one acted upon by a force. Secondly, the actor of doing work is ambiguous because sometimes it is an object and at the other times it is a force. Thirdly, students might wrongly think work as energy instead of energy transfer because, in textbooks, work is described as the thing which can be transformed into potential energy or other forms of energy without clear interpretation. A proposed expression system based on the ideas that the owner of potential energy and the actor of doing work should be force and that the potential energy could be defined as unrealized kinetic energy is discussed.

Beyond the behavior of individuals: students' engagement in project-based scientific inquiry

Thursday 2.15pm, Seaspray 9

Jane Jiyoung Lee & Heui-Baik Kim
Seoul National University, Korea

Engagement has been viewed as an important construct to understand students' learning. It should be viewed as interactive processes between students, teachers, and learning environment. The purpose of this study is to examine how students are engaged in science inquiry meaningfully during their project activity and what supports or constrains their meaningful engagement. We report the synthesis of four case studies of eighth grade students. Data for this study included videotape and field notes of classroom practice, students' work samples and reflection notes, and interview data. We categorized students' engagement into cognitive, emotional, and behavioral engagement based on collected data and analyzed the change of students' engagement. Students were more engaged in scientific reasoning and group discussion as they accustomed to the nature of science inquiry. In this process, connection between school science and authentic context provided by teacher supported students' cognitive engagement. They encouraged each other cognitively and emotionally to become more involved in inquiry during project performance. They also become more active in experiment planning and role division. The specific cases will be discussed. This study may provide educational implication to science educators and teachers to help them encouraging students' meaningful engagement in open inquiry context.

The Necessity of a Physics and Mathematics Connected Course for Analyzing Experimental Data

Friday 4.00pm, Marlin Room

Minkyung Lee & Sungmuk Lee
Seoul National University, Korea

Most university students have difficulty in analyzing the error of physics experimental data even if they have already learned mathematical formulas during the secondary or basic university science curriculum. Thus, in this paper, we are finding out the reasons for the difficulties and the educational way to make up for lack of the error analysis ability. Assume the university students already know the basic mathematical formula, they estimate the measurement value thorough the error analysis in the physics experimental class and undergo individual interview for asking the reasons for failure of error analysis. After students get the feedback and proper physics-mathematics connected education, they have a second analysis of the error in a different type of experimental data. From comparing the two written reports, we are going to verify the effectiveness of the physics-mathematics connected education. Even though students just have a few hours of training, their ability of error analysis is improved. These findings suggest that physics-mathematics connected course is necessary in order for improving students' ability to analyze the error of the physics experimental data and recommend this course will be established in the science curriculum.

Primary science teachers' epistemological understandings of school science practices

Friday 10.30am, Seaspray 7

Sun-Kyung Lee[1], Myeong-Kyeong Shin[2] & Gyuho Lee[3]
[1]Seoul National University, Korea
[2]Gyeongin National University of Education, Korea
[3]Seoul National University, Korea

The purpose of this study was to explore science teachers' epistemological understandings of science and science teaching and learning, especially focusing on school science laboratory. Five primary science teachers participated in this study. They had a black-box activity and group discussions on various topics of science, school science, science laboratory, science teaching and learning in the venue of four seminars. Their activity and discussions were videotaped and transcribed. Several epistemological issues were emerged in their activity and discussions. Results involved the teachers' epistemological understandings of four categories: science vs. school science; scientific inquiry vs. school experiments; practical work vs. school science laboratory; and science teaching and learning. Based on the results, discussion and implications about science education and science teacher education were presented.

The Investigation of Students' Reading Strategies in Science Argumentative Text

Friday 3.00pm, Seaspray 9

Sung-Tao Lee[1], Fu-Pei Hsieh[2], Yen-Wen Lin[3] & Pei-Jun Chen[4]
[1]Naval Academy, Kaohsiung, Taiwan
[2]Kuang-Hua Primary School, Kaohsiung, Taiwan
[3]An-Chao Primary School, Kaohsiung, Taiwan
[4]Chung-Sang Primary School, Kaohsiung, Taiwan

The purpose of this study was to explore elementary students' reading strategies in different science argumentative texts. Nine 5th graders from three elementary schools participated in this study. After training in the thinking aloud method for two to three weeks, the protocols of these students' reading strategies were collected and analyzed. The results indicated that students' reading strategies can be divided into five progressive categories with a total of thirteen codes. However, the expected specific strategies needed in reading science argumentative texts did not appear. In addition, it is found that the more advanced reading strategies are easier to be found in high level students' protocols compared to low and medium level students and it is inferred that low and medium reading level students need instructional assistances in learning how to read science argumentative texts. Finally, the analysis also reveals that the two-sided non-refutational text can bring about more cognitive processing in students' reading tasks and this can be seen as a useful feedback when designing science reading materials.

An analysis of the visually impaired students' observation ability in physics experiments using substitute sense for vision

Thursday 12.00, Sea Room

Yunjung Lee, Jin-Su Jeong, Sung Gyu Yun & Sungmin Im
Daegu University, Korea

Observation has been considered as a basic and important inquiry skill for all students including the visually impaired. But as for the visually impaired there are fundamental difficulties in performing visual observation because of their physical condition. Performing observation using substitute senses for vision is an alternative instructional strategy for them in learning science. In this study the visually impaired students' ability for observation was analyzed in several physics experiment tasks with the use of substitute senses for vision, including making sounds, propagation of light, reflection of light. Observation is defined as a process to get objective and accurate information about events or objects, and to describe it using human senses and tools. For evaluating students' ability of observation, we suggested an analyzing framework consisted of five criteria like using senses and tools, diversity, objectivity, correctness, and elaborateness of observation. In addition, sighted students' ability of observation was also investigated for the comparison with the visually impaired. According to the results we could infer that the visually impaired students can also perform observation well if the observational tasks were properly organized to use various senses and tools.

Science education, scientific literacy and the problem of democracy.

Friday 8.30am, Star Room

Ralph Levinson
University of London, UK

Policy statements by governments in industrialized western democracies link justifications for school science education with improved democratic processes. These claims have a long history stretching back from John Dewey to contemporary publications such as AAAS:Project 2061 and Nuffield 2000. Contemporary discourses on science education for democracy predominantly reflect aspects of deliberative democracy in which shared aims are striven for through processes of rational discussion and deliberation, reflecting communicative action theory. There are both epistemological problems with, as well as lack of empirical grounding of, such claims. Substantive science, conceived as both instrumental and reductive, has distinct epistemological and ontological foundations from the scientific issues which comprise socio-political discourse. Furthermore, although social relations between scientific research and public policy-making have been reconfigured since the latter part of the twentieth century as depicted by post-normal, post-academic and mode 2 representations, empirical research through deliberative processes reflect deficit structures in terms of power relations between knowledge producers and consumers. I will present a critique of contemporary representations of the relations between science education and democracy and propose ways forward based on conceptions of scientific citizenship, epistemic communities, guided teaching of political literacy and the overall implications for research.

Traumatized students' motivation, interest and self-confidence of science in Taiwan

Saturday 8.30am, Sun Room

Hui Chen Liang[1], Janice Chialing Liu[2] & Sau Ing Li[3]
[1]National Kaohsiung Normal University, Taiwan
[2]Shu-Te University, Taiwan
[3]National Taitung Junior College, Taiwan

Typhoon Morakot slammed into Taiwan and caused great damage on August 8th, 2009. The disaster not only influenced children's psychology but also their learning motivation. Children's psychological trauma and learning capability became critical in this area. Studies proved that play activity could relive children's aftershock depression; it also can help children to light up the posttraumatic stress and rebuilt their confidence. The purpose of this study was planned to help traumatized children in learning science through play and hands-on activities (PHAs). Activities were designed by professors and practice teachers of science related field. The focus of this research was to understand students' motivation, interests and self-confidence with questionnaire after PHAs. The Cronbach's Alpha value of the questionnaire which was designed based on learning theories and the result was 0.828. Altogether these researchers had carried on the disaster area auxiliary, including 6 school 31 classes, the participant students were 593. Each class had 6 hour PHAs. The preliminary findings of this study showed that (1) 84% students favor in learning science through PHAs; (2) 85.4% of students thought

that learning science with PHAs will enhance their interest; (3) 83.3% students gained self-confidence when they learnt science with PHAs.

Investigating science teachers' PCK and its role in achieving understandable learning for students

Friday 10.30am, Seaspray 8

Liao Liang
The Chinese University of Hong Kong

Teaching for understanding is an important aim in science education. There are three levels of understanding in science learning: limited understanding, relational understanding and transformational understanding. Among them, transformational understanding is the keyword for effective teaching and learning with its definition of "…occurs when scientific knowledge is consistent with the belief of an individuals' life-world" (Tobin, 1999).The aim of the research is to investigate to what extent does science teachers' PCK help to facilitate students' understanding, and what influences teachers in achieving understandable learning? The empirical part of the research is accomplished in China. Classroom observation, semi-structured interview are used as the main methods to obtain data. Results showed that understandable learning is difficult for both teachers and students. Limited understanding is easier to obtain comparing with relational and transformational understanding. As transformational understanding is indispensable for learners to grasp science knowledge and the nature of science, we argue that such inadequacy is crucial in need of attention. The influences for Chinese teachers' PCK are mainly from the outside demands such as examination or curriculum standards. The implications in these influences are discussed and need exploring further.

An exploration of the linguistic nature of the reading difficulties encountered by an Atayal student

Thursday 11.15am, Seaspray 8

Pin-Yin Liao, Wen-Gin Yang, Chia-Cheng Yeh & Po-Sen Huang
National Taiwan Normal University, Taiwan

Multicultural learning experiences are inevitable in general and even more critical for indigenous students in particular in modern Taiwan society. This study, based on the fundamental lexico-grammatical differences between Mandarin Chinese and Atayal, explored the comprehension difficulties of indigenous students in reading Mandarin science text. There were nineteen Atayal 8th grade students participated. Almost all can communicate with their parents and grand-parents in Atayal; meanwhile they read and write in Mandarin in the school setting, however, the average amount of Chinese character recognition is nearly reached the level of 4th grade. The target student was selected purposefully since she is encouraged to speak Atayal by her family and can read as many Mandarin characters as average 8th graders. Her responses reflect the difficulties of special relations among science objects, the meaning potential of noun phrases, and part-whole relation. These difficulties could be interpreted as a result of the mixture of two different incommensurable lexico-grammars. The findings suggest that the science text and the language of science teaching should be a reconciliation of the two languages to facilitate Atayal students learning science.

Using collaborative reflections to support teachers' inquiry-based instruction

Friday 4.45pm, Seaspray 9

Huann-shyang Lin, Zuway-R Hong, Kuay-Keng Yang & Ya-Chun Chen
National Sun Yat-sen University, Taiwan

This study investigated the impact of collaborative reflections on teachers' inquiry-based teaching practices and identified supportive actions and limitations relating to their professional development. Three science teachers in a same elementary school worked as a cooperative and collaborative group. Workshops, reflective journal writings, observations of colleagues' teaching practices, and collaborative discussions were used to help their professional development of inquiry teaching. The pre- and post-treatment classroom observations and comparisons of their teaching reveal that the three teachers are more focused on asking inquiry-oriented questions in the post-treatment teaching. Despite that sample teaching units of inquiry have been demonstrated and explained, developing inquiry-based teaching materials is still a big challenge for the teachers. Peer

support, collaborative discussions, and reflections are identified as critical facilitators for their professional development.

Students' Understandings of Metric Scale and Size of Objects in Higher Education

Friday 8.30am, Seaspray 7

Show-Yu Lin
Aletheia University, Taiwan

Understandings of metric scale and size of objects are increasing its important aspect of science education worldwide, such as GIS, Nanoscience. However, the relevant previous researches are few, especially in higher education and application of Rasch Model. The purpose of this study is to examine the adequate of the instrument -- "concepts of metric scale and size of objects" in Chinese version conducted here; furthermore, to investigate it was a valid and reliable measure for the understandings of metric scale size of objects across science majors and non-science majors, and so on. This paper presented the results from the instrument, interviews and so forth. Data were analyzed using Rasch Model and content analysis. Analyses concerning reliability and validity indicated the instrument might provide an adequate measure of these concepts and showed the accuracy of these concepts with respect to their background of education both from quantitative and qualitative results. The results of this study may provide a valuable contribution to science curriculum design as well as science teaching, especially to fostering students learning of metric scale and size of objects in science education.

Affording Elementary Teachers by a Research-based Nature of Science Teaching Material

Friday 4.00pm, Seaspray 9

Shu-Fen Lin[1], Sang-Chong Lieu[2], Wen-Hua Chang[3], Sufen Chen[4], Mao-Tsai Huang[5] & Wen-Ling Chen[6]
[1]National Chiao Tung University, Taiwan
[2]National Dong Hwa University, Taiwan
[3]National Taiwan Normal University, Taiwan
[4]National Taiwan University of Science and Technology, Taiwan
[5]National Academy of Educational Research, Taiwan
[6]De-Gau Elementary School, Taiwan

This study explored the effects of a research-based teaching material on affording elementary teachers to teach Nature of Science (NOS) and improve their students' understanding of NOS. We unpacked NOS-competence indicators in the National Curriculum Standards, proposed a model of embedding teaching NOS in an inquiry activity, and illustrated NOS-PCK in the teachers' guide to build understanding of NOS and corresponding pedagogy. The design of the teachers' guide was mainly based on the results of a nation-wide survey (the Science Teachers Using Teacher Guides, STUTG) on assistance of teachers' guides for science teachers (Lin, Chang, Cheng, & Hsu, 2008). Night teachers from different geological areas volunteered to adopt the NOS teaching material. Five of them had previously registered in graduate courses or professional development programs about enhancing their understanding of NOS but not the other four teachers. Data sources included student outcomes on NOS and science concepts, and teachers' perceptions of assistance of teachers' guide with the STUTG and focus group interviews. Results indicated that, after implementing the teaching material, all students improved in their understanding of NOS and science concepts. Based on the students' and teachers' data, we summarized some important features for designing educative NOS teaching materials.

Exploring the Argument Skills of Sixth Graders with Different Language Abilities in a Socioscientific Context in Taiwan

Thursday 2.15pm, Seaspray 8

Shu-Sheng Lin
National Chiayi University, Taiwan

Language ability is an important variable influencing students to make arguments. However, it seems that we still do not clearly understand the effect of students' language ability on their argument skills. This study explored the possible relationship between language ability and argument skills, and examined differences in the extent of argument skills among the sixth graders with different language ability in Taiwan. The

standardized test of Chinese Language Ability was adopted to categorize the subjects into three groups—high, middle and low language-ability students who were asked to make arguments, counterarguments, supportive arguments and evidence in a socioscientific context. The results showed that a positive correlation exists between language ability and argument skills ($r = 0.57$, $p<.01$). The students' language ability can explain 31.9 % of the variance of their argument skills. There are statistically significant differences in formulating arguments, counterarguments, and supportive arguments among three groups ($p<.01$), but not in constructing evidence. Only in making supportive arguments, the high language-ability students significantly outperform both of the middle and low language-ability students ($p<.01$).

The Inquiry of the Differences of Pupils' Reading Characteristics in Different argumentation-based texts

Friday 9.15am, Sun Room

Yen-Wen Lin[1] & Sung-Tao Lee[2]
[1]An-Zhao Elementary School, Taiwan
[2]Naval Academy, Kaohsiung, Taiwan

The purpose of this study is to explore the differences of pupils' reading characteristics in three types of argumentation-based texts. Twelve subjects of 5th and 6th graders, three classes and six persons in each grades, participated in this study. In each class, one high and one low achiever in Chinese were selected to take part in the tests of semi-opened questionnaires after reading different texts. After coding and analyzing, we had several findings. First, the sixth graders revealed a better reading rate. Secondly, the sixth-grade high achievers had presented a better text understanding than the fifth-grade high achievers but there were no obvious differences in low achievers between the two grades. Third, in selecting the correct scientist's explanation in different texts, the elder students also showed better results (83.3% in 6th grade vs. 58.3% in 5th grade). However, the coherence of pupils' explanations and the tendency to be distracted by texts showed no obvious differences in different grades. Finally, it was also found that the high achievers had exhibited better reflecting and critical thinking than the low achievers.

Thematic Teaching Based On Ribosomal DNA Can Facilitate An Understanding Of Modern Genetics, Biodiversity And Further Develop Skills In Biomolecular Analysis.

POSTER

Michael Linich
The University of Newcastle

The molecular biology revolution in the last two decades of the 20th century and research on the small sub-unit rRNA gene (16S DNA and 18S DNA) has triggered a major paradigm shift in our understanding of biodiversity where only a tiny percentage of microorganisms, identified by molecular analysis, were found to be cultivable by conventional methods. Genetic information gained from this research also forced a major shift in our understanding of the "Tree of Life". The study of the 16S rRNA gene has the potential to cut to the core of modern biological knowledge. The 16S rRNA gene has the largest freely accessible database and therefore remains the most informative sequence database for phylogenetic analysis. For these reasons, a teaching module based on the molecular genetic analysis of microbial ecosystems, using the 16S rRNA gene, creates opportunities to provide the student and student teacher with a valuable 'history of science' and molecular knowledge base in genetics, biodiversity, phylogeny and develops generic skills in biomolecular analysis. This approach supports the general need to integrate genetics and evolutionary thinking in biology and life science education.

Genetics Education within the Australian National Curriculum

Saturday 11am, Seaspray 9

Michael Linich
The University of Newcastle

Our understanding of genetic causes of disease is rapidly advancing and gene therapy is becoming routinely offered as a form of therapy and or a potential cure. Ethical considerations of such treatments require an informed consent from the patient before therapy takes place. Research in the public understanding of genetics indicates that literacy is poor. Low literacy outcomes in genetics is significant in that they are major contributers to the realisation by international governments that science education must be reformed to cater for the 'Net' generation and a general public who are increasingly consuming genetic services in a rapidly

developing knowledge based economy. Misconceptions at all levels of genetics exist and the goalposts keep changing. These findings beg the question 'Does the K – 12 National Science Curriculum improve or retard the development of literacies in genetics'?

Modeling processes of the atomic structure in chemistry textbooks and their implication

Friday 11.15am, Marlin Room

Chun-Keng Liu & Mei-Hung Chiu
National Taiwan Normal University, Taiwan

The importance of textbooks in science education has been acknowledged for their use in transmitting to students how a particular science has developed. In addition, they play an important role as a major source of knowledge in helping teachers to plan their lessons. Despite the pervasiveness of models and modeling in science and that textbooks are full of examples of modeling, textbooks do not explicitly identify these examples as modeling (Well, Hestenes, & Swackhamer, 1995). To understand textbooks, students need the ability to recognize models and modeling. The objective of this study was to review the recent literature on the nature of models and modeling, to evaluate 16 chemistry textbooks in Taiwan, and to show modeling processes in different textbooks. The results show that most textbooks include models of the atom perspective, but not adequately in two aspects: (i) most chemistry textbooks present an inductivist perspective in which experimental details are considered to be paramount, and (ii) contain little model validation, analysis, and evaluation during the modeling processes. In addition, these findings suggest that emphasis is needed for textbooks on providing students with clear descriptions of the models, and presenting explicitly to students the modeling processes of the atomic theory.

Listening to the students' voice in science education: Teaching practices that stimulate interest in, engagement with, motivation towards, and a positive attitude to, science.

Friday 3.00pm, Marlin Room

Marianne R. Logan
Southern Cross University

The science education literature reveals a crisis in school science in Australia, and a number of other countries (Tytler, 2007) relating to a decrease in positive attitude to science as students move from primary school into secondary school (Braund & Driver, 2005) and as they progress through junior secondary school, particularly with the 11-14 age range (Barmby, Kind & Jones, 2008; Bennett & Hogarth, 2009). A longitudinal study was carried out with 14 students looking at changes in these students' attitudes to, and interest in science as they moved from primary school into secondary school and through junior secondary school. The majority of these student participants maintained a positive attitude towards science and interest in the subject. Teaching practices that have been identified by the participants as stimulating interest in, and engagement with science, in year ten, primary school, are the focus of this paper.

Science and Worldviews in the Classroom: Joseph Priestley and Photosynthesis

Thursday 4.00pm, Seaspray 9

Michael R. Matthews
University of New South Wales

This paper elaborates on the life and publications of Joseph Priestley, the eighteenth-century polymath. The paper outlines his particular place in the European Enlightenment; it stresses the importance of philosophy and worldview in his scientific work on pneumatic chemistry, the composition of air, and his discovery of the process of photosynthesis (or the 'restoration of air' as it was called at the time); finally the paper indicates ways in which Priestley's work on photosynthesis can be utilised in the school classroom to advance the understanding of scientific subject matter, to promote an understanding of the nature of scientific procedure and methodology, and finally to evaluate some basic tenets of the European Enlightenment that Priestley so passionately advocated.

Teachers' Professional Learning in a Renewable Energies Unit – Science and Technology Education Leveraging Relevance (STELR) Pilot Project 2009

Friday 2.15pm, Seaspray 8

Terence P McClafferty & Léonie J Rennie
Curtin University of Technology

The introduction of new packages of curriculum materials, or of participating in school-community projects, provides opportunities for teachers' professional learning that are beyond the aims of the curriculum or project. In this presentation, we provide examples of a range of ways teachers have been able to learn professionally from their participation in a new curriculum unit on renewable energies. Science and Technology Education Leveraging Relevance (STELR) is a curriculum project sponsored by the Australian Academy of Technological Sciences and Engineering. STELR is presented as a package of curriculum materials and equipment resources. Our examples come from an evaluation of the STELR pilot program in 2009.

Exploring the influence of an argumentation professional development program on inservice secondary science teachers' views of nature of science

Friday 8.30am, Seaspray 9

Christine V. McDonald[1], Deborah Heck[2], Richard Cooper[1] & Clare Christensen[1]
[1]Griffith University
[2]University of the Sunshine Coast

Emerging research has suggested that engaging learners in argumentation may aid in the development of their NOS views, although this claim lacks empirical support. This study assessed the influence of a professional development program incorporating explicit argumentation instruction on five inservice secondary science teachers' views of NOS. Data sources included open-ended questionnaires and interviews. Data analysis indicated there was no substantial development in participants' views of NOS following participation in an argumentation professional development program. These results indicate that a professional development program emphasising explicit argumentation instruction, without the incorporation of explicit NOS instruction, is not effective in enabling participants' views of NOS to be improved. Implications from this study highlight the importance of including explicit NOS instruction in studies that utilise argumentation as a pedagogical strategy to develop learners' views of NOS.

Pre-service teachers' personal and general science teaching efficacy: A longitudinal case study

Thursday 10.30am, Seaspray 9

David H. McKinnon, Lena Danaia & Melinda Cross
Charles Sturt University

This paper presents results of a longitudinal study of pre-service primary teachers' personal and general science teaching efficacy beliefs in two compulsory science and technology curriculum subjects of a Bachelor of Education (Primary) degree. The Science Teaching Efficacy Belief Instrument (STEBI) is administered to pre-service teachers on multiple occasions to elicit information on their personal and general science teaching efficacy. Data have been collected from five different cohorts over a four-year period (2007-2010). Results for each of the cohorts show highly significant changes in both their personal and general teaching efficacy over the course of the two subjects. In 2010, additional science teaching efficacy data were collected from pre-service teachers throughout the first subject, where a 16-item brief version of the STEBI was administered at weekly intervals during the semester. Results from the multiple administrations of the STEBI show interesting changes in the pre-service teachers' science teacher efficacy that seem to covary with certain activities which occur within the tutorial sessions. This research is part of a longitudinal action-research project into primary school science teacher preparation that has been ongoing since 2005.

Primary teachers and science: Beliefs and influences

Friday 11.15am, Seaspray 7

Merryn McKinnon
The Australian National University

Primary school teachers are expected to teach all subject areas. For some, science poses a particular challenge. Previous studies have found that some teachers lack self-efficacy, confidence and competence in their science teaching abilities (Appleton 2003; Hackling and Prain, 2005). This can manifest in the reduction or minimisation of time spent teaching science in the classroom (Angus, Olney and Ainley, 2007). The aim of this research was to inform the direction of a larger doctoral study by examining factors that may influence a teacher's science teaching self-efficacy, and to assist professional development (PD) practitioners in identifying where to target their efforts. Surveys of teachers participating in science PD workshops revealed that there was no correlation ($\rho(140) = 0.027$, $p > 0.05$) between a teacher's level of teaching expertise and their confidence in their ability to teach science. Teachers with more than 20 years of experience were just as likely to not feel confident teaching science as a beginning teacher. Therefore teaching experience alone is not enough to predict who confident, competent teachers of science are. Other influences, both personal and environmental, need to be examined in order to effectively address this issue.

Professional Development of Primary Science Marginalized Teachers

Friday 12.00, Seaspray 7

T. Subahan Mohd. Meerah
National University of Malaysia

Marginalized Teachers face an uphill task of teaching primary science pupils in marginalized areas. Not only do they have to surmount the problem of motivating and sustaining the interest of the pupils to attend school, but they also face the problems of having inadequate learning resources to teach science comfortably. This is because of geographical location of the school and socioeconomic factors of the children living in the remote areas and the difficulty of getting to school. Most of the teachers are also not fully equipped or prepared to teach these children in such schools. Some of the schools have small intakes (low intake) and some have been classified as under achievement schools because of higher rate of student's failure in the final year of primary school education examination. Thus, there is a dire need to upgrade pedagogical skills of these teachers to teach marginalized students, taking into consideration the environment of the school. Experience has shown the difficulty of changing teachers' teaching methods. Often teachers are not convinced to use child centered learning methods. They are more comfortable using the 'telling method' that is a teacher 'centered method'. Thus, the traditional way of conducting professional development courses for teachers has to be re-looked. This study was conducted to improve teachers' teaching methods through involving teachers in engaging action research, and getting teachers involved in the development of materials, working collaboratively with the science educators who conduct the course. This paper describes the experience and the results of the research involving teachers in pedagogical action research with the researchers. Through workshop and practical exercises, this study has shown that the teachers were more willing to try out new alternative child-centered methods of teaching and learning in their practice. A model for providing professional development of *Primary Science Marginalized School Teachers* is being proposed based on the above research.

Can nonlinear physics engage? Learning and the nature of intuitive knowledge in the study of nonlinear phenomena

POSTER

Arthur E. Michalak & Jinwoong Song
Seoul National University

Teaching experiments of nonlinear phenomena can be a reasonable tool to assist in physics education, supplementing theoretical instruction and classical experiment. For this purpose the concept and governing equation has to be designed to didactic need. The educational potential of nonlinear physics has been give surprisingly little attention, though it is practiced professionally in the proverbial real world. In this paper we propose to look at the nature of intuitive knowledge using, as an example, the Belosov-Zhabotinsky reaction to probe how students approach nonlinear phenomena. Aside from the research implication of this finding, the making of nonlinear science into a good school curriculum is, but itself, an interesting direction to work. We

intend to study how, when, and why nonlinear content can engage students in order to convert the short term excitement into long-term engagement. This study is at the initial stages of development.

Teaching Earth and Environmental Science in Years 11 and 12 in Western Australia

Saturday 11am, Sun Room

Leah Moore[1], Vaille Dawson[1], Katherine Carson[1] & Diane Tompkins[2]
[1]Curtin University of Technology
[2]Earth Science Western Australia

In 2007, a new upper secondary course, Earth and Environmental Science (EES) was introduced in Western Australia. The development and implementation of the course was supported by Earth Science Western Australia (ESWA), a consortium of universities, the CSIRO and other organisations. The role of ESWA is to support the teaching of earth science in schools by developing teaching and learning resources, providing professional development for teachers and to assist with field experiences for students. Since 2008, EES has been offered in 25 schools with 417 students enrolled increasing to 667 in 2010. In 2009 an evaluation of the implementation of EES was conducted. A total of 27 EES teachers from 24 schools were interviewed about their background and professional development in EES, their perceptions of the course and the impact on students' understanding and attitudes towards EES. In addition, 20 Year 12 students from four schools were interviewed and 247 EES students completed a written questionnaire to determine their perceptions the course. Initial findings indicate that: students select EES because of interest and future career choices; students and teachers find the earth science topics difficult; the course has a positive impact on students' attitudes to the environment and awareness of careers in earth science. The findings of this study have implications for the development and implementation of the proposed Earth and Environmental Science course in the National Science Curriculum.

Pre-service primary teachers' handling of data

Saturday 8.30am, Sea Room

MD Shahrin K S Moorthy
Nanyang Technological University, Singapore

With scientific literacy being an important goal of science education, the school science curriculum in Singapore and elsewhere has been revised to provide primary pupils with more opportunities to learn about scientific evidence. Lessons that are aimed towards using evidence often involve data from secondary sources or from the pupils' very own science investigations. The primary pupils are usually taught how to observe trends and patterns in data as well as to analyse data from a collection of repeated measurements [Primary Science Syllabus (MOE, Singapore), 2008]. However, an integral and essential part in teaching the interpretation of data is to develop in these primary pupils the importance of questioning the validity and reliability of their own and others' data. Granted that teachers have such an important task in teaching pupils how to evaluate the data, the development of such knowledge in them will undoubtedly be strongly influenced by their teachers' very own, often implicit, understanding of evidence. The findings that will be reported at this conference form part of a larger study that looks into pre-service primary teachers' understanding of the 'concepts of evidence' (Gott & Roberts, 2008), particularly about the concepts of validity and reliability that they hold. The data for this presentation are derived from interviews conducted with a total of fifty-five pre-service teachers. The presentation will focus mainly on their different conceptions about variation in repeated readings, their ideas concerning the causes of variation and uncertainty as well as how they distinguish patterns in data especially when the data are reported in the table format. Some of the findings imply that pre-service teachers deploy 'point' and 'set' (Buffler et al., 2001; Campbell et al., 2005) reasoning when explaining variations in data. The findings reported here will have strong implications for science teachers' education.

Interrogating the impact of interactive whiteboard technology on science discourse

Symposium, Thursday 10.30am, Star Room

Karen Murcia & Rachel Sheffield
Edith Cowan University

Teachers using effective interactive pedagogy with an interactive whiteboard (IWB) can engage and motivate students' with a range of digital resources that require them to explore science's role in making sense of our world and to construct knowledge of key scientific concepts. Yet the current research described in this paper,

goes beyond describing the interactive pedagogies used by teachers by exploring their impact on the nature and quality of science discourse. The reported studies conceptual framework structured the interrogation of the discourse surrounding four teachers' and their students use of interactive whiteboard (IWB) technology in their primary science classrooms. Comparing video captured lessons, matched in the stage of science enquiry and then, with and without the use of the IWB provided quantifiable evidence of an increase in students' participation in substantive science conversations and exploratory talk. Teachers' were using more open questions, greater wait time and requiring greater participation from students. This research provided evidence of teachers' effective IWB pedagogy impacting on the quality of science discourse and as such it is recommend that the technology be fully exploited in contemporary classrooms for scaffolding deep substantial discourse, which is essential in developing students' scientific literacy.

Exploring Thai primary students' understanding about the world before they come to science classroom

Thursday 1.30pm, Star Room

Kusalin Musikul
Institute for the Promotion of Teaching Science and Technology, Thailand

The purpose of this study was to investigate 1st, 2nd, 4th, and 5th grade students' preconceptions of several topics in science. The selected topics were included in the Thai Science Education Standards. The participants were 1st, 2nd, 4th, and 5th grade students from six primary schools in three provinces in Thailand. The participant students at each grade level were asked to complete the test at the beginning of school year. Regarding the participants' scores, I clustered them into three groups, high (H), medium (M), and low (L). I purposefully selected 12 students per school for an intensive interview in order to examine their understanding in more details. These selected students were 3 representatives from each cluster. The research results revealed that the majority of students from H group were able to scientifically provide explanations of the selected topics. However, the students from M and L groups and also some H group students showed alternative conceptions that differed from scientific explanation. These findings may be significant to researchers and science educators.

A Review of Instruments Assessing the Understanding of the Nature of Science.

Thursday 11.15am, Marlin Room

Jiyeon Na & Jinwoong Song
Seoul National University, Korea

One of the ultimate goals of research concerning NOS is for students to get proper understanding of NOS. The extent what the NOS contents tackled in the studies correspond with those proposed in science education should be investigated. The purpose of this study was to review and compare the instruments used to assess individual understanding of the nature of science (NOS). The assessment tools were selected from 100 articles in representative science education journals published from 1990 to 2009 in relation to the NOS. The most cited ones were categorized according to the features of them such as target population, item type, philosophical perspectives and others. Evaluation domains of the instruments were also compared with the features of the NOS endorsed in the international science education standards documents, such as Benchmarks for Science Literacy (AAAS, 1993), National Science Education Standards (NRC, 1996). The results showed that over half of them focused on the features of scientific knowledge and scientific methods in NOS territory, whereas there were only a few of instruments to ask science ethics, significance of science process and the context. NOS instruments focused on limited aspects of NOS emphasized by the standard documents.

An Analysis of the Sequences of Problem Solving in the Japanese 6th Grade School Science Textbook: In the Content Area of "Substances and Energy"

Friday 8.30am, Sun Room

Hayashi Nakayama[1] & Yuji Saruta[2]
[1]University of Miyazaki, Japan
[2]National Institute of Education and Policy, Japan

According to the Course of Study of Japanese primary school science, to develop pupils' problem-solving abilities is one of the important aim of the subject. To find out in which way Japanese pupils are intended to develop the ability of problem solving, we are trying to analyze the statements of Japanese primary school science textbooks, because the textbooks are regarded as the implemented curriculum. In this time we present

the result of analysis on the case of 6th grade school science textbooks, especially the contents area of "Substances and Energy". Through the analysis we categorized each sentence or group of words on the textbook as "Problem", "Hypotheses or Prediction", "Way to solve", "Fact", "Conclusion". As a result we found out that most of the statements belong to such categories, and there are sequences of problem solving, but sometimes the sequence of problem solving is not complete. Sometimes the facts as the results of the observations or the experiments were not described. Sometimes the conclusions were not written on the textbook. They might not be written intentionally, because such statements might spoil pupils' active problem solving.

ICT : Supporting a whole school change in and across local and remote settings.

Saturday 8.30am, Seaspray 8

Paul Nicholson[1], Filocha Haslam[1] & Peter de Wacht[2]
[1]Deakin University
[2]Bayswater West Primary School

In developing effective whole school professional development programs, Desforges (2001) argues that there is a need for examples of effective practice that embody a standard and stable model of learning, coherent well established findings and vibrant examples of success. Where ICT has a key role to play in professional development programs, it needs a clearly articulated basis that includes considerations as to how its use links to learning and effective change (Nicholson & White, 2002). This paper presents a case study of the application of these principles in supporting whole school change in and across local and remote settings. It describes the use of specific models of use of ICT in underpinning and enhancing interaction and learning, and stands in contrast to the many ICT professional development programs that do not have such a clearly articulated basis.

Thinking Science Australia: Improving teaching and learning through science activities and reasoning

Thursday 1.30pm, Sun Room

Mary Oliver[1], Grady Venville[1] & Philip Adey[2]
[1]University of Western Australia
[2]King's College London, UK

'Thinking skills' is one of the eight general capabilities explicitly included in the content description and achievement standards of the recently released draft Australian Curriculum: Science. Unfortunately, it is often not clear to teachers how they can successfully teach thinking skills to students and make a difference to their achievement. The significance of this research is that it is providing science teachers and students an opportunity to participate in a program of science activities that has the potential to enhance the students' reasoning capacity. The aim of this paper is to outline the 'Thinking Science Australia' project and to examine some of the initial data from this project. Teachers from ten schools in WA were provided with two days professional development on Thinking Science, a program initially developed in the UK. Data collection involved observation of the implementation of the thinking activities in Year 8 and focus group interviews with teachers about how best to adapt the activities to the Australian school environment. A baseline cognitive test was administered to participating students. Findings from the focus group interviews and the classroom observations (including short video clips) will be presented as well as an overview of the baseline test results.

What's hot (or not)? A five-year review of journals in science education

Friday 11.15am, Seaspray 9

Mitch O'Toole & Karina McKoy
University of Newcastle

This review originated in a mid-2009 request from a local school for an update on the current state of science education. That particular group of experienced science teachers felt that their focus on local concerns might disadvantage their students as Australia moved towards another cycle of curricular change. All reviews are selective and this one restricts itself to articles published between the beginning of 2005 and the end of 2009. The journals reviewed for this paper were *International Journal of Science Education*, *Journal of Research in Science Teaching*, *Research in Science Education*, *Science Education*, and *Studies in Science Education*.

Content was reviewed in terms of disciplinary context, educational level, research type and major topic. These categories, and sub-categories within each, emerged as the review iterated. The abstracts of published papers were coded under each of the categories and complete papers were reviewed when the abstract was not clear enough to allow categorisation. Articles were tallied within each category for each journal to produce ranks indicating the relative importance of the category. Broad reviews such as this provide a useful spur to expert reflection while also mapping the field for novices attempting to enter it.

Collaborative learning practices in science classrooms: Possibilities and boundaries using computers and the Internet

Saturday 9.15am, Seaspray 8

Kathrin Otrel-Cass, Bronwen Cowie & Elaine Khoo
University of Waikato

Student investigations in science classrooms involve them building on existing understanding and using problem-solving skills and reasoning. The process of explaining complex problems often involves working with multiple sets of data and sources of information, including online resources and information. Outcomes of such activities can take a written form, frequently prepared on a computer. We claim computers are appealing tools, that readily support social thinking to produce an acceptable answer to student inquiry questions. Talking, thinking and composing using the computer-plus Internet and other resources is an important aspect of collaborative science inquiries. Computers provide a bounded site for this form of social thinking by virtue of their physical dimensions. It is through this process of social thinking that students actively evaluate, challenge and adapt the information they access in light of their investigative experiences. This article presents stories from Teaching and Learning Research Initiative (TLRI) funded research into a primary science classroom investigating changes of state. Information students accessed and processed were shaped by inscription practices they used. These were governed by the task at hand, the affordances of the programme they were using for retrieving and recording information and the person with the mouse. Inscription practices reflected the degree of authority that was attributed to the information under discussion.

Educating for Sustainability as central pedagogical practice for engaging pre-service Primary/Middle Years educators with science

Friday 3.00pm, Seaspray 8

Kathryn Paige & David Lloyd
University of South Australia

Over the past decade science and mathematics curriculum courses in the primary/middle program have been integrated which has allowed us to reinforce pedagogical practices through a sequence of four courses. Connections to practicum placements, authentic assessment and interactive workshops have been the core practices which are central to all courses. Place-based learning, futures thinking, integrated learning and transdisciplinary problem-solving have also informed the teaching and learning. These wide-ranging and complex practices have been the foci to deliver both a rigorous and sound curriculum in science and mathematics with equal attention paid to educating for sustainability. In this presentation we describe a number of examples of how we have tackled this. On going feedback from students on the impact of our approach on their thinking and confidence to teach science with a focus on sustainability provides a reflective perspective and informs future directions.

The story of H. E. Roscoe: friendship, politics, textbooks and research

Thursday 4.45pm, Seaspray 9

Bill Palmer
Curtin University

As a chemist, Henry Enfield Roscoe (1833-1915) is best known as the discoverer of vanadium. Roscoe's early mentor was Thomas Graham. After his first degree, he completed his doctorate under Robert Bunsen at Heidelberg, starting a friendship and research partnership, with spectroscopy as a major area of research, which continued until Bunsen's death. Roscoe became a Professor at Owen's College, Manchester, when only 24 years old, was a popular lecturer sharing the podium with T. H. Huxley and John Tyndall. He was the author of some of the best textbooks of the period frequently co-writing with Schorlemmer nicknamed 'The red chemist'. Roscoe was well-known and popular in the north of England. He was knighted in 1884 for services to technical

education. He represented the constituency of South Manchester as a Liberal Member of Parliament from 1885 to 1895. In 1896, he became Vice-Chancellor of the University of London until 1902. In 1909 he was selected for the Privy Council. This is indeed a remarkable career for a dedicated chemist.

Examining student staff and student visitors in terms of their perceptions of a science festival

Friday 4.45pm, Marlin Room

Eun Ji Park[1], Sun-Kyung Lee[1], Kisang Kim[2] & Chan-Jong Kim[1]
[1]Seoul National University
[2]Korea Foundation for the Advancement of Science & Creativity

"Science festival" is an annual public event featuring a variety of science- and technology-related activities in workshops and live demonstrations of experiments by student staff. This study was to explore the perceptions of the students who participated as the staff of a science festival, and comparison with some other students as visitors. The subjects were 323 student staff who managed laboratory booths and 495 student visitors who attended at the festival for six days. We developed a questionnaire for this study consisted of items modified from one of Lee et al. (2010). We tried to find the differences between the student staff and the student visitors in terms of their perceiving the festival and joining motivation of a future festival. Based on the results, discussion and implications for out-of-school activities were presented.

The Effects of Multiple Factors on Teaching for Conceptual Change in Thai Primary Science

Thursday 2.15pm, Star Room

Pattamaporn Pimthong
Khon Kaen University, Thailand

The purpose of this research is to study the impact of multiple factors (such as motivational belief and student contexts on students' conceptual change), in the development of teaching for conceptual change about material and its properties. The subjects of the study were thirty-two Grade 5 (10-11 year old) students. A 14-hour conceptual change instructional unit was developed, included three teaching strategies proved to be successful for promoting conceptual change namely problem solving, the use of experiments, and analogies. Data were collected through pre and post concept surveys, classroom observations, student works and student interviews. The results showed the influences of instructional activities that challenged and encouraged students' conceptual change about material and its properties and indicated some effects of motivational belief, social, and language factors on students' conceptual change. This study illustrates how a conceptual change approach might be accomplished in specific cultures and contexts.

Views on Science Teaching about Animals based on Science, Technology, Society, and Environment (STSE) Education of Bangkok Elementary Science Teachers

Paper Set, Saturday 8.30am, Star Room

Sasithep Pitiporntapin[1], *Kantimanee* Phanwichien[1], Gaalen Erickson[2] & David Anderson[2]
[1]Kasetsart University, Thailand
[2]University of British Columbia, Canada

STSE education is in line with the goals of Thai Education. This research aimed to study the views of upper elementary science teachers (Grade 4-6) on science teaching about animals based on STSE education in the Bangkok Metropolitan Administration. For collecting data, the researchers distributed open-ended questionnaires to 108 schools. There were 66 elementary science teachers (60%) who sent the questionnaire back to the researchers. The data from respondents used descriptive statistics to identify which categories were most commonly answered. The finding showed that most teachers' views regarding the teaching objectives were in promoting students' science concepts related to animals, rather than in promoting the students' awareness of the interaction among Science, Technology, Society and Environment. Moreover, in terms of pedagogical approaches, most teachers expressed a desire for students to learn by completing worksheets. For application of knowledge in daily life, the activities did not relate much to take action in the community. For evaluation of students' learning, most teachers focused on knowledge more than scientific process skills. From

the results of this study, school administrators and professional developers should promote the upper elementary science teachers' views and practices about animal topics based on STSE education.

Theorising how and why student construction of representations supports learning in science

Friday 1.30pm, Sea Room

Vaughan Prain[1] & Russell Tytler[2]
[1]La Trobe University
[2]Deakin University

Researchers in science education now broadly agree that school students need to learn how to interpret and construct subject-specific representations of science. There is extensive research on student engagement with, and learning from interpreting, expert representations (Ainsworth, 2006, Gilbert, 2005, Robinson, 2000), with strong theoretical justifications for how and why this learning occurs, or is enabled (Ainsworth, 1999; Mayer, 2002; Pavio, 1986). However, research into, and the rationale for, student-constructed representations is less developed, as is the theoretical justification for this practice. Our paper seeks to address this issue. Drawing on key literature in this area, including Cox (1999), diSessa (2004), Greeno and Hall (1997), Kozma and Russell (2005) and others, and through extensive conceptual, semiotic and sociocultural analyses of student representations arising from our research over the last 6 years on teacher-guided, student-generated representations, we propose a theoretical framework that links semiotic, motivational, epistemological and epistemic justifications to explain how and why the processes and outcomes of this representational work enable student learning. We also draw partly on Norman's (1999) refinement of Gibson's (1979) construct of affordances to develop this framework.

Thai Chemistry Teachers' Understanding and Their Teaching for Critical Thinking

Paper Set, Saturday 8.30am, Star Room

Kanlayanee Punbo[1], Samia Khan[2] & Ladda Meesuk[1]
[1]Kasetsart University, Thailand
[2]University of British Columbia, Canada

This study aimed to assess chemistry teachers' understanding of, and teaching for critical thinking which affect students' learning and thinking abilities. Participants included four chemistry teachers, grades 10-12, in Nonthaburi Province, Thailand: two teachers each in two schools. Data collection took place in the first semester of academic year 2009 using semi-structured interviews, classroom observations, teachers' questionnaire, and document analysis. Data were analyzed inductively, and then categorized into themes. The results indicated that the teachers understood critical thinking to some extent: they defined critical thinking as the ability to generate reasons supporting answers, or arguments. The chief strategies employed by the chemistry teachers to promote critical thinking included: asking closed questions and cooperative group work. Although the teachers did experiments with students, the teachers did not use experiments to teach for critical thinking. In addition, the teachers did not employ further teaching critical thinking strategies: encouraging open-ended class discussions, problem-solving, or dealing classrooms with real-world problems. It implies that professional development on designing and implementing learning activities, teaching techniques, instructional media, and assessment related to teaching for critical thinking would be valuable.

Developing secondary science teachers' professional learning communities

Symposium, Thursday 4.00pm, Star Room

S M Hafizur Rahman
Monash University

While the current reform efforts in Bangladesh require a substantive change in how science is taught, an equally substantive change is needed in the culture of professional practice. This paper explores how an intervention guided secondary science teachers to observe, reflect on and critique each others' teaching practice. Teachers used a new constructivist teaching approach (Predict Observe Explain - POE) to explore and engage them in professional learning through development of a professional learning community. One peer pair of participant teachers was formed in each secondary school and data have been collected from seven such schools in

Bangladesh. Analysis of mixed data illustrates how some of the discussions prompted participants to clarify different aspects of their teaching which leads to develop a positive attitude towards discussing their practice with their colleagues. The findings of this study have implications for understanding change in science teachers' culture of professional practice as a member of professional learning community as well as changing traditional teacher development programs.

The development of an ecologically valid science curriculum in the Democratic Republic of São Tomé and Príncipe

Friday 4.45pm, Seaspray 8

Pedro Reis
Polytechnic Institute of Santarém & University of Lisbon, Portugal

The paper describes and discusses the development process of the science curriculum (grades 1 to 4) for the Democratic Republic of São Tomé and Príncipe (2005-2010), supported by the World Bank and the Calouste Gulbenkian Foundation. Through an ethnographic study based on participant observation and interviews to a wide group of citizens from different sectors of society, information was gathered on the knowledge, skills, attitudes and values considered essential for students to function effectively in the local environments they live in. The main purpose was to develop an ecologically valid curriculum. A set of educational materials was developed and tested in a sample of classes. A training and supervision program supported the local implementation of new materials and methodologies. Subsequently, the modified materials were generalized to all the schools. The curriculum intends to promote a science education centered on local needs and daily life problems and is orientated towards collaborative problem solving, decision-making and the promotion of informed and responsible citizens. The curriculum establishes links between students' experiences and school science, helping students to cross the border between the culture of their family/society and the culture of school. Some evaluation data of the process is discussed in the paper.

Collaboration, Communication and Complementarity: Improving Science Education

Thursday 10.30am, Sun Room

Léonie J Rennie[1], Susan M. Stocklmayer[2] & John K. Gilbert[3]
[1]Curtin University of Technology.
[2]The Australian National University
[3]The University of Reading and King's College, London, UK

A recent editorial in *Nature* (Learning in the Wild, 8 April, 2010) pointed out that "much of what people know about science is learned informally. Education policy-makers should take note" (p. 813). At a time when the draft *Australian Curriculum: Science* is open for comment, it is important that we consider the ways in which formal school science education can take advantage of science-based learning opportunities in the world outside of school. Such opportunities include museums, zoos, aquaria and other institutions that include education in their mission; government community resources, such as water and health education programs; and media, including print, television and the Internet. In this paper we distil the factors that make out-of-school learning from these sources appealing and suggest ways that science learning in school, and science learning from out-of-school sources can be brought closer together.

Reproducing Successful Rituals in Bad Times: Exploring Emotional Interactions of a New Science Teacher.

Symposium, Thursday 8.30am, Star Room

Stephen M. Ritchie[1], Kenneth Tobin[2], Peter Hudson[1], Wolff-Michael Roth[3], Jennifer Oakley[1] & Victoria Mergard[1]
[1]Queensland University of Technology
[2]City University of New York, USA
[3]University of Victoria, Canada

Teaching is emotional work. This is especially the case in the first years of teaching when new teachers are particularly vulnerable. By understanding changes in teacher identities and emotions in the early years of

teaching we hope to identify strategies that might ultimately reduce teacher attrition. As part of a larger study of the transition of new teachers to the profession, this paper explores how a science teacher produced and reproduced positive emotional interaction rituals with her students in her first year of teaching. This video ethnography applies conversation and prosodic analyses to support two claims. First, dialogical interactions were positive and satisfying experiences for the teacher, and these were reproduced successfully in different contexts. Our second claim is that both teacher and students used humour to create structures for dialogical interactions. The students also used shared resources to demonstrate canonical understanding of the related topic in these successful interactions. The implications of what we have learned for the professional development of new teachers are discussed in relation to an expanded understanding of teacher emotions.

Rural and Urban Early Childhood Teachers' Knowledge in Technology Education

Thursday 4.45pm, Marlin Room

Jill Robbins
Monash University

The new Early Years Learning Framework for Australia (Department of Education, Employment and Workplace Relations, 2009) highlights the importance of early childhood educators supporting young children's use of a range of technologies, products, processes and systems. However, an earlier pilot project on design and technology in young children's play conducted by Robbins et al (2008) suggested that some early childhood professionals demonstrate limited knowledge of what constitutes technology and technology education. This paper describes a current project that is further examining a wider cohort of early childhood educators' understandings and practice in relation to technology education. It reports on data generated through interviews with 40 participants working in a range of rural and urban early childhood settings within Victoria. Specifically, the study, informed by cultural-historical theory, seeks to examine how early childhood educators define technology, and the extent to which they implement design and technology education in their curriculum. The paper argues that there is a need for greater emphasis to be placed on assisting early childhood professionals to develop their knowledge of technology education if they are to effectively promote young children's learning in this area.

Analysing teacher-student interactions in a year 6 UK science classroom

Thursday 8.30am, Sea Room

Roslinawati Mohd. Roslan
University of Queensland

This study is concerned with analysing the interactions between a teacher and her students in a Year 6 UK science classroom. From the analysis, several patterns emerge using the framework developed by Mortimer & Scott (2003). Three of the framework such as Teaching Purpose, Communicative Approach and Patterns of Interactions are used to analyse the interactions between the teacher and the students in learning the concept 'forces'. From this study, pattern of interaction being one aspect of the framework is extended in terms of using prompts in the science classroom. Following on from this, several suggestions and recommendations are given for implementing professional development activities in Brunei Darussalam.

Year 10 & 11 students' alternative conceptions of alternative energy

Saturday 8.30am, Marlin Room

Hjh Hardimah Hj Mohd Said, I. Poh-Ai Cheong & Marlizayati Hj Johari
Universiti Brunei Darussalam

This study determined alternative conceptions amongst Bruneian Year 10 & 11 students about Alternative Energy. A two-tier questionnaire about Alternative Energy (2tierAEmih) was developed to ensure that reliability, discriminatory, difficulty, readability measures were valid. This instrument was then administered to Year 10 & 11 students (n=495). Several alternative conceptions of Alternative Energy were identified with the use of this questionnaire are discussed in terms of these aspects: sources, conversion of energy, efficiency, greenhouse emission, costs, advantages and disadvantages. Students' own reasons for their first tier responses gave additional insights to the limitations of the students' understanding as well as ideas to improve the

distractors for the instrument designed. The implications for changes in teaching and learning, curriculum and examination are highlighted. These include the need to tackle learning of such areas of study in an interdisciplinary manner so that the issues involved are understood and can be based upon to make decisions on future energy practices and policies.

Promoting scientific literacy through secondary science textbooks

Symposium, Thursday 4.00pm, Star Room

Md. Mahbub Alam Sarkar
Monash University

A number of previous studies reported that in Bangladesh, classroom science teaching is textbook oriented and examination based, where students are assessed by the items taken from the textbooks and tests often demand answers to be copied from the textbooks. Such an approach reinforces the need for students and teachers to rely heavily on the recommended textbooks that may also influence promoting scientific literacy. This paper, therefore, examines the representation of science content in three 'General Science' textbooks used in junior secondary education in Bangladesh in an attempt to find out whether they have the potential to prepare scientifically literate citizens. A framework consists of two types of science content - pure content and content applied in contexts- were used to analyse the textbooks. Results show that the analysed textbooks mostly emphasised pure content; different life contexts were not well-considered in presenting the content, which presents a challenge for preparing a scientifically literate populace in Bangladesh. Therefore, it was argued that textbooks need to place more emphasis on science content that are applied in learners' contexts.

Nature of science portrayed in the science textbooks: The case of Bangladesh

Saturday 11.45am, Marlin Room

Md. Mahbub Alam Sarkar
Monash University

This study analysed the representation of nature of science (NOS) in the General Science textbooks used in Bangladeshi junior secondary education in an attempt to find out how they have represented the contemporary NOS. Lederman's (2004) set of NOS was adopted as contemporary NOS in the conceptual framework of this research. Consequently, analyses focused on the tentative, empirical, subjective, inferential, and creative NOS, in addition to the nature of scientific laws and theories and the social and cultural embeddedness of science. By adopting a scoring rubric (Abd-El-Khalick, Waters, & Le, 2008) the textbooks were scored on each of the target NOS aspects on a scale ranging from -3 to +3, which reflected the accuracy (informed representation), completeness (consistent) and manner (explicit versus implicit representation) in which these aspects were addressed. Results showed that the textbooks scored poorly in their representations of the target NOS aspects. Moreover, some NOS aspects, for example, the creative NOS, the social and cultural embeddedness of science, and the nature of scientific laws and theories were totally absent in all of the textbooks. This provides scope for a better representation of contemporary NOS in the science textbooks.

A Critical Stand of My Own: Responsible Environmental Science Education and Quality Thinking

Friday 10.30am, Marlin Room

Carol E Scarff
University of British Columbia, Canada

This paper examines some of the issues and problems in science, environment and sustainability education, examining the potential for embedded critical thinking in the curriculum. Unpacking useful conceptualizations of the nature of the concept and its applicability to quality thinking and drawing on the works of such authors and researchers as Case & Daniels (2009), Hunter (2009), Mogensen (1997) Siegel (2009) & Wals & Jickling (2002), four perspectives of critical thinking are developed: epistemological, transformative, dialectical and holistic. The purpose here is to support the notion that critical thought as described and presented in this paper is not limited to a higher order, analytical process, suitable for a select few intellectuals out of touch with the familiar. The concept as situated and portrayed in this paper is particularly suited to teaching and learning environmental and sustainability concepts, values and action. Finally, an argument is put forward that positions

quality thinking as central to the development of responsible science education and students' learning to be critically reflective pro-environmental citizens. The recent oppositional activism in the form of the Auckland Protest March provides the context for the complementarity of critical thinking and responsible environmental behavior.

Analysing science classroom language at a grammatical level: What this approach tells us about the language demands in learning science

Symposium, Friday 1.30pm, Star Room

Lay Hoon Seah & Christina Hart
University of Melbourne

The appropriation of the language of school science is a widely acknowledged goal of science education. This study investigates the language demands on students in learning science by adopting an analytical frame that targets science classroom language at a grammatical level. Research on science classroom language has focused mainly on the features of language at the macro-level in terms of its content, structure, interactional patterns and discursive strategies. This study specifically addresses the gaps in the literature by examining science classroom language at a grammatical level, that is, in terms of the linguistic resources employed. Students' written assignments and lesson transcripts generated from a sequence of lessons on the topic of "States of Matter" were the focus of analysis. Grammatical analysis was conducted using the Systemic Functional Linguistics framework. Our analysis revealed features of language use that appear to be significant for realising scientific meanings. We highlight some implications relating to students learning the language of school science and some specific issues of pedagogy.

Explore the EEG activity of problem solving

POSTER

Hsiao-Ching She[1], Tzyy-Ping Jung[2] & Wen-Chi Chou[1]
[1]National Chiao Tung University, Taiwan
[2]University of California, USA.

The purpose of this study was to explore the electroencephalo-graphic (EEG) activity during the physics problem solving. There were thirty seven undergraduate students involved in this study who were majored in science and engineering. All of the students were asked to solve an ill-structured problem which was an optic maze that was under a computer simulation condition. Students were instructed to generate as many solutions as possible and also encouraged to seek the least number of mirrors and lens combinations. All of the experiment period were accompanied by EEG data recorded, and then to analysis the EEG power activity of different frequency across solutions. The results indicated the numbers of lens that students used significantly decreased from first solution to the third solution. The EEG power show significant increased from solution 1 to solution 2 across all frequency. and significant increased between S1 and S3 in theta and lower alpha band. Furthermore, the lens numbers generated by POS was significant lower than their non-POS condition, however, the EEG power of POS was significant greater than non-POS across frequency. It implicates that students devote greater brain activity while they are generating their personal optimal solution.

Promoting scientific values through secondary science teaching

Symposium, Thursday 4.00pm, Star Room

Mohammad Nure Alam Siddique
Monash University

In line with recent global trends, the science curriculum in Bangladesh sets a goal of promoting selected values through teaching science. This paper presents partial findings from a study which explores how teachers construct meanings of those values and how these values can be promoted in science classrooms. Data for this qualitative study were collected from classroom observation, post-lesson interviews with teachers and Focus Group Discussion with students. Analysis of data indicates that teachers have varied understandings of curricular goals and unclear understandings of scientific values. However, they consider developing scientific values in students' mind as an important goal of science teaching. Data also indicate that teachers struggle to promote intended values effectively and students could not perceive whether any values have been promoted in their science classes. These findings may serve as a guide for policy makers, curriculum developers, teacher

trainers and teachers in developing science curricula, preparing teachers and implementing the curricula to promote scientific values in secondary schools in Bangladesh.

Using children's drawings to determine conceptual understanding of ecology

Thursday 4.45pm, Seaspray 7

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 has hypothesized that Kindergarten children have a level of ecoliteracy higher than currently acknowledged by the NSW Early Stage 1 curriculum. To test my hypothesis I have designed a teaching intervention which focuses on ecological concepts, and will be applied to students in the classroom. Their ecoliteracy will be tested as part of a pre- and post-testing protocol. I have developed a coding matrix to analyse the data collected from children's drawings and follow-up interviews. The combination of drawings and interviews is known to be effective and reliable in assessing young people's understanding of science (see Shepardson, 2002; Strommen 1995). My initial results show that within the cohort there is broad variation in level of knowledge and understanding of ecological concepts. However the majority of students can articulate an understanding of ecology, and the next phase will determine how an intervention changes their level of ecoliteracy.

Gender and Science, individuals and essentialism: avoiding dichotomies.

Friday 9.15am, Sea Room

Dorothy V. Smith
La Trobe University

The past several years have seen a renewal of interest in the possibility of intrinsic cognitive sex differences between girls and boys. New methods of investigating brain function purport to show significant differences in the brains of men and women. Although much of the reasoning that goes into such reports is deeply flawed, the reported differences have been taken up the media and by proponents of single-sex education for girls and boys, who link possible differences in brains to inevitable differences in cognition and learning styles. In this presentation I examine some of the recent claims that have been made about what science can tell us about the differences between girls and boys as learners. I argue that these claims largely frame each learner as an individual and leave unexamined the place of community in supporting learning. As a result, essentialist explanations for commonality become easier to accept; such explanations also leave the idea of science as a social institution largely unexamined. I re-visit an analysis of the hazards of dichotomous thinking about gender and science, first made in the 1980s and '90s, to assess its potential for a way forward today.

The ghosts of science past and the Frankenstein effect: Influences on pre-service teachers efforts to teach primary science.

Saturday 10.00am, Sea Room

Julian Smith
University of Tasmania

This paper, a preview of an unfinished PhD thesis, concerns the teaching experiences of one cohort of primary pre-service teachers at a two day Science fair held at UTAS. The paper provides an overview of the research design, the method of analysis using grounded theory and a discourse analysis, and the preliminary findings of the pre-service teacher's post science fair teaching, written reflections (n=45). The method of analysis resulted in the construction of five, thematically distinct, discourses. The preliminary research findings draw attention to the importance of the influences of past experiences in science on the desire of beginning teachers to become efficacious primary science teachers. The research, which corroborates current publications, is presented as the discourse of *the ghosts of science past.* The data also provides additional layers of interpretation, one of which is constructed as *the Frankenstein effect*. This novel construct provides evidence of attempts by pre-service teachers to make connections between theoretical, practical and pedagogical aspects of cognitive and affective teaching intentions, practices and outcomes. The discourse, *the Frankenstein effect* in its metaphorical attempt

to [re]attach disconnected heads to decapitated bodies has implications for educators and researchers interested in supporting beginning teachers to teach primary science.

Enhancing classroom discourse: Teaching primary science with puppets

Symposium, Thursday 10.30am, Star Room

Pru Smith & Mark Hackling
Edith Cowan University

Students must actively construct understandings through making sense of experiences using their prior knowledge and through conversation with others (Driver et al., 1994). However, classroom talk tends to be dominated by teachers (Alexander, 2006). Teachers control discourse by using a predominance of closed questions and a question-answer recitation script, which limits the exploration of students' ideas (Nystrand et al., 1997). Consequently, appropriate forms of discourse are needed to fully explore and work on students' ideas (Hackling, Smith & Murcia, 2010). Previous research has indicated that puppets can be used as a pedagogical tool to effectively engage students in classroom discourse (Simons et al., 2008). This paper reports on a professional learning intervention designed to support teachers to enhance the effectiveness of talk in their science lessons. Eleven teachers participated in workshops in which they developed understandings about quality talk, the classroom culture needed to support whole-class talk, and the skills of using puppets to engage students in discourse. Analysis of video recordings of science lessons using NVivo8 focussed on the impact of the intervention on student engagement, the amount of substantive talk, teacher questioning and discourse moves, as well as changes in classroom climate. Highlights from these preliminary analyses will be reported.

Value Judgment of Grade 10 Thai Students' Normative Decision Making during Learning about Newton's Law of Motion through the Science Technology and Society (STS) Approach

Saturday 9.15am, Marlin Room

Thidarat Soyjak & Chokchai Yuenyong
Khon Kaen University, Thailand

The research aimed to study value judgments of students' normative decision making in learning about Newton's law of motion through science, technology, and society (STS) approach. The STS Newton's law of motion activities was designed to bring the physics concept relating to societal and technological local issues, and raise the decision-making based on the Thai value of the Philosophy of Sufficiency Economy (PSE). The PSE is beyond value which the King of Thailand Bhumibol Adulyadej gives to Thai population. The PSE includes three elements: moderation, reasonableness, and self-immunity and requires two conditions for the philosophy to work are knowledge and virtues. The participants were 42 Grade 10 students in Saimoon, Yasothon, Thailand. Learning about Newton's law of motion with considering PSE would support students to value their normative decision making under the relationship science, technology, and society of Thai contexts. Students' normative decision making was collected from students' tasks, journal writing, interview, and participant observation. The findings revealed that value judgment of students' normative decision making supported students to learn science through ethic consideration and decision making with the relationship between science, technology and society. The paper will discuss implications of these for habits of mind to provide scientific literate person base on Thai values.

Inquiry-Based Activism in Science Teacher Education: Commitment Building through Co-constructed Activist Culture

POSTER

Erin Sperling & J. Lawrence Bencze
University of Toronto, Canada

There are many challenging issues associated with fields of science and technology that affect humans, other species and environments. Of most concern, arguably, is Climate Change, but there are multiple issues, such as access to fresh water, food quality, and waste management. Many of these problems may be related to individuals' tendencies towards repeating cycles of consumption of goods and services, and socio-cultural focus on profit-generation over well being. In the study reported here, we support developments in addressing such challenges through educational engagements that encourage activism; for example, by encouraging student-

teachers to consider complex socioscientific issues, take positions about them, and develop and defend plans of action to address them. We provide outcomes—based on constant comparative analyses of qualitative data—that student-teachers' tendencies towards promotion of socio-political activism may be enhanced through repeating and partly-scaffolded activist conferences, based around group-selected focus issues. Through the use of meta-analysis tools, conferencing and regrouping, the student-teachers found ways to support their actions in their border crossing, and to refute or reintegrate pertinent suggestions from beyond their group. These events appeared to promote more focused dialectic interactions between specific engagements with activism and their justification, and general activist frameworks.

A Teacher Professional Development Program to remediate misconceptions in Physics

Thursday 11.15am, Sea Room

R. Subramaniam
Nanyang Technological University, Singapore

In promoting learning outcomes in Physics, the need to address the misconceptions of students is especially imperative. Strongly entrenched misconceptions, if not remediated, can affect the promotion of conceptual understanding in a topic. This study reports on a unique professional development program conducted by the National Institute of Education in Singapore for teachers and shows how over 40 misconceptions in Mechanics can be remediated using a mix of demonstrations, textual scaffolds and guided explanations. Feedback from the program over the past five years indicate positive support for the approach used to address misconceptions. Details of the program, examples of how a number of misconceptions are remediated and feedback from the teachers (in the form of a psychometrically robust evaluation instrument) who attended this program are discussed. Some implications for teaching and learning are also discussed.

Linguistic Analysis on Japanese Science Textbooks

Thursday 4.00pm, Sun Room

Manabu Sumida[1], Hayashi Nakayama[2] & Joel Bernal Faustino[1]
[1]Ehime University, Japan
[2]Miyazaki University, Japan

The purpose of this study is to investigate the linguistic characteristics of questions that Japanese science textbooks contained. This study extracted the text included in all information formats as text data and used this as the primary source data. All the 818 questions in the third grade to sixth grade textbooks were analyzed and it was found that: (1) there were evident biases in the question appearance patterns in particular grade levels and content areas. The number of questions increases dramatically from 130 in the third grade to 241 in the fourth grade. There are far fewer questions in the area of "Earth and Space" than in the areas of "Living Things and the Environment" and "Matters and Energy"; (2) out of 818 questions in the third grade to sixth grade textbooks only 15 (2%) were interrogative *why* questions; (3) yes/no and noun-seeking questions appeared in high rate, 76% (164/216) in the sixth grade science textbooks were of these questions. In Japan, although there are many hands-on and integrated science activities included in elementary school science classes still meaningful questions are tend to be limited.

Thai elementary teachers' understanding of and teaching about the nature of science

Paper Set, Saturday 8.30am, Star Room

Puangphaka Suttakun[1], Jolie Mayer-Smith[2] & Boongeua Vajarasathira[1]
[1]Kasetsart University, Thailand
[2]University of British Columbia, Canada

Teachers' understanding and teaching about the nature of science influences students' learning of science practices and processes. Conceptions of the nature of science should be explicitly taught by integrating them into the curriculum taught in science classes. This case study aimed to explore four Thai elementary science teachers' understanding of the nature of science and their teaching practices. Three of the teachers had degrees in science teaching and more than 15 years of science teaching experience. Data were collected through a questionnaire, classroom observations, individual semi-structured interviews, and teaching documents. The data

was transcribed and analyzed using content analysis to find out teachers' understanding of the nature of science. The teachers' practices were analyzed using the constant comparative method. The results revealed that the teachers had limited conceptions of the nature of science in 3 aspects: scientific inquiry, the nature of scientific knowledge, and the relationships between science and society. The teachers usually taught science by lecturing and demonstrating and rarely explicitly taught the conceptions of the nature of science. These findings suggest that teacher professional development related to the nature of science is needed to support teachers' understanding of and teaching about the nature of science.

Chinese and Australian Year 3 Children's Conceptual Understanding of Science

Saturday 10.00am, Sun Room

Ying Tao
The University of Western Australia

The purpose of this study was to compare Chinese and Australian Year 3 children's conceptual understanding of science. Participants were Year 3 children from a public school, a private school, and a rural school in Hunan Province, China (n=135) and Western Australia (n=120). The students' understanding was assessed by a science quiz, developed from the past TIMSS science released items for lower primary. In-depth interviews were carried out to further explore children's conceptual understanding of living things, the Earth, and floating and sinking. Science teachers and school principals were interviewed, classroom observations completed and documents collected to ascertain different approaches to primary science curricula in the two countries. The results revealed that Year 3 children in both countries had similar conceptual understanding of life science, earth science and physical science. Chinese Year 3 children showed relative strength in classification of living things, and Australian Year 3 children demonstrated better understanding of floating and sinking. Children in both countries were weaker in applying and reasoning with complex concepts in the domain of earth science due to limited instruction. Classroom observations showed that Year 3 teachers in both countries tended to integrate science with literacy and numeracy.

The Development of Integrated Instruction for Natural Resources Conservation Using Forest in Khok Phu Taka as the Learning Resource for Schools in Phu Wiang Areas

Thursday 9.15am Seaspray 7

Kongsak Thathong
Khon Kaen University, Thailand

The aim of this research was to construct and use integrated instruction plans on the conservation of natural resources using Khok Phutaka Forest as the learning resource. The ideas of student-centered learning and cross-curriculum teaching were integrated into the construction of the desired teaching plan while the doctrine of action research (Kemmis & McTaggart, 1992) was also adopted. The research instruments include integrated instruction plans, questionnaires, focus group record forms, a tape recorder and a camera. Qualitative information was analyzed by content analysis and then reported in narrative form while quantitative data was analyzed using mean and standard deviation. The findings of the research can be summarized by the following points: 1) the basic information on Phutaka area reveals that Khok Phutaka Forest, which was once a thriving habitat for many valuable plants and animals, while continuing to the community's major food source, has suffered from extensive damage; 2) The construction of the integrated instruction plans produced (2.1) 4 study guides (small books) and one study guide which combines the trees in 4 zones into one big book; (2.2) a schematic chart of cross-curriculum teaching of 8 strands in normal curriculum using the trees in Khok Phutaka Forest as a core of integration; (2.3) The integration instruction plans of 8 strands; and (2.4) the results of field experiment of Science and Art education strands showed that the students saw the learning activity as a whole to be of good level ($\overline{X}$ = 4.42, SD=0.70) while the teachers similarly rated the whole experience as being of good level ($\overline{X}$ = 4.49, SD=0.54). The students also liked and enjoyed the activity.

The Effects of Information preference and Scientific Epistemological Beliefs on a Socio-scientific Dilemma

POSTER

Hsin-Chung Ting
Chia Nan University of Pharmacy & Science, Taiwan

This study aims to explore how senior high school students apply their cognitive orientation toward scientific or social information, designated as information preference of informal reasoning, and scientific epistemological beliefs on the science-related controversial issues. A questionnaire was designed by containing a text created based on the influence of global warming and its mechanism included authentic scientific data and social news, and a information preference survey test that presented with a socio-scientific issue concerning the developing petrochemical industry in Taiwan, and also including open-ended questions to confirm students' decision-making about the petrochemical industry developing. The other "situated scientific epistemological belief questionnaire" was designed to investigate their viewpoints of the nature of science about global warming. The samples consisted of 335 eleventh-grade students from six senior high schools in Kaohsiung City, Yunlin County, Taichung city, and Keelung city. Findings revealed that most students pay attention to "Substitutive Energy & Ecological Environmental Protection" of scientific dimension, and they make less care for "Experts' Opinions & Political Party Attitude" of social dimension. There are significant differences among students with different decision-making about the petrochemical industry developing on the information preference. The human population acceptors that support petrochemical industry developing prefer the social information preference concerning "Job opportunity & Economic Development". However, there are no significant differences between human population acceptors with different decision-making about the petrochemical industry developing on the viewpoints of the nature of science.

The hydrogen-fuel concept immerged in chemistry curriculum based-on-inquiry for senior high students in middle Taiwan high school

Thursday 3.00pm, Seaspray 7

Hung-Yi Ting, Cheng-Fong Chiang & Jinmeei Kuo Hsieh
MingDao University, Taiwan

The purpose was to develop the chemistry curriculum merged with the hydrogen-fuel concept for senior high students and explore its effectiveness. The chemistry curriculum with hydrogen-fuel concept was valididated through expert science education researchers and was taught experimentally for 40 senior high students during one semester in middle Taiwan high school. Two units, hydrogen production & storage and hydrogen-fuel cell, were included in this concept learning and arranged for one hour every week. Five phases for the instructional approach, reading information about hydrogen-fuel concept, elicit the questions themes, solving the problems and visiting the related companies and scholars, and presenting the performance, were designed based on inquiry learning. The curriculum in this study was developed through two years from the views of expert science education researchers and the students' performance. Data from the students' performance and pre- and post-test about scientific literacy for content-dependent and content-independent revealed that the chemistry curriculum with the hydrogen-fuel concept is appropriate.

Emotional climate, laughter and the quality of enacted science education

Symposium, Thursday 8.30am, Star Room

Kenneth Tobin[1], Stephen M. Ritchie[2], Peter Hudson[2] & Victoria Mergard[2]
[1]City University of New York, USA
[2]Queensland University of Technology

This research, which employs sociocultural theory as a framework, involves grade 7 students from Brisbane engaged in physical and life science (e.g., properties of water; cell structure). A dialectical relationship between agency and passivity assumes that participants appropriate structures to meet their goals as their practices are structured by a dynamic structural flux, including others' practices. Research methods include critical ethnography and microanalyses using discourse, conversation, and prosody analyses to study micro enactment of emotions and occurrences of laughter in relation to what happened before the occurrence of laughter, co-occurrent practices, and what happened after the laughter occurred. Based on assessments at three-minute intervals we create maps of the emotional climate in each lesson. Within a context of dialectical relationships

between individuals and collective we study power, identity, and quality of learning environments and prevailing emotional climates. Data include ethnography and prosodic features of laughter (e.g., energy, frequency and intensity versus time graphs; and at a given time power versus frequency graphs). Through analyses of who laughs, when and why we examine the roles of laughter in maintaining positive and negative emotional climates. Implications are considered for teachers and students collaborating to produce success in science education.

The Work of Art: The Work of Science

Saturday 12.30pm, Seaspray 7

Maurizio Toscano
The University of Melbourne

We may safely assume that our capacity to adumbrate the nature of science education would greatly benefit from the occasional excursion of the researcher's gaze away from the familiar shoreline of science-in-the-classroom or science-in-the-circus. With this assumption firmly in place, this paper takes up the cause of attending to a more intimate and, perhaps, more phenomenologically immediate space in which science learning and teaching takes place. The space of which I speak is that of the discursive and practice space opened up by the interaction between the scientific specialist and the artistic practitioner: that is to say, the work of art. I take the writings of both I. A. Richards and Ludwig Wittgenstein as the launching place for my analysis of this space. The former permits us to view this interaction as something other than extraordinary by foregrounding the ubiquity of metaphor use in language. The latter, in sympathy with the first, offers us the philosophical tools needed to examine this metaphoric ordinariness: language games, family resemblances and forms of life to note a few. And the bank on which the analysis shall land? That will be the familiar shore alluded to earlier in the abstract.

Why does research in schools not change the practice of science teachers?

Saturday 10.00am, Marlin Room

David Treagust, Julianne Crowley & Mauro Mocerino
Curtin University of Technology

During the past three years the three of us have been conducting research in local schools supported by an Australian Research Council grant. As part of the planning for this grant we worked with science staff in two schools to find out what aspects of teaching and student learning they would like to improve. We conducted short workshops in each school to demonstrate the kinds of small changes they could make to their teaching with a likely greater success in student learning. Subsequently, the research was designed to enhance secondary students' metacognitive capabilities for explaining scientific concepts. The plan was to accomplish this by involving teachers in a teaching/learning intervention that incorporated explanations using multiple representations and the levels of interpretation of the science concepts to be learned. Teachers were also to teach students metacognitive strategies which were assessed by pencil and paper instrument and small group interviews. Despite agreement by the teachers to participate and with much support from each Head of Department and School Principal, any changes in teaching style were not sustained from one class to another or even from one lesson to another by most of the teachers. Despite a willingness to participate, the task of putting ideas into practice, even with the one of us (JC) freely available to help with materials support, analyzing tests and providing next day feedback, seemed to be too difficult.

Toughness, Caring, and Smoothness: Gender culture and scientist identities in three women-led laboratories in Taiwan

Friday 11.15am, Star Room

Li-Ling Tsai
National Kaohsiung Normal University, Taiwan

How do women scientists as the gender minority in science and engineering demonstrate leadership and recruit good students? How do their students take them as role models and mingle between femininity and masculinity in the labs while forming future scientist identities? This research adopts the identity study approach to understand the gender cultures in the science related environments for women professionals and their students in Taiwan. Three science laboratories led by women professors were included in this research from October,

2007 to October, 2008. This research investigates the gendered expectations carried during student recruitment, along the lab-training processes, among professor-student interactions and peer interactions, and in the division of laboratory labors. The gender cultures in these three labs can be marked as "toughness," "caring," and "smoothness." "Toughness" was developed by a junior professor and seemed to be a gender minority's protest against the male-dominated department. "Caring" was established by a senior professor as a safe gesture to steer through the masculinities in the department and make her laboratory impressive. "Smoothness" was shown by a renowned female scientist as her strategy to straddle between the roles of "the wife" and "the chair" in the group meetings co-chairing with her husband. Students in these three labs show different kinds of scientist identities in the various leadership and gender cultures.

Can learning feminism help to retain women students to stay in science careers?

Friday 8.30am, Sea Room

Li-Ling Tsai & Pei-Ying Lin
National Kaohsiung Normal University, Taiwan

Feminist science educators have long ago pointed out many gender issues in science learning, and various strategies have been implemented in earlier learning stages. However, less attention is paid to college and graduate stages where women students continue to confront self-suspicions whether they are the right gender to study science. This research adopts an interventionist approach to ask whether teaching feminism can help to empower women students pursing their rights in studying science therefore retaining in a science career. A "model" student and nine others have participated in this study. In-depth interviews and program interventions are used as the main data collection methods during August, 2009 to May, 2010. The model student has shown a successful retention case as her choosing to stay in science major after learning feminism; while the other nine are experiencing similar stimulations and are now pondering on their career choices. Preliminary findings show that, even in the 21st century, women who choose science majors still experience along their learning paths various discouragement stressing science is not for women and a lack of role-modeling with clear feminist messages is serious; yet after some intervention, feminism can help to retain women's interests and sense of rights in science.

The student as scientist: Schools developing a culture of open investigation

Saturday 11am, Star Room

Russell Tytler[1] & Linda Darby[2]
[1]Deakin University
[2]RMIT University

There has been longstanding interest in developing science investigative capability in school students, associated with advocacy of inquiry approaches (Schwab 1962, Goodrum, Hackling & Rennie 2001), with the increased prominence of 'working scientifically' dimensions of science curricula (e.g. ACARA 2009), and concern that students understand the nature of evidence in science (Tytler, Duggan & Gott 2001). Questions have been raised, however, about the dominant 'variable control' characterisation of open investigative work (Watson, Goldsworthy, & Wood-Robinson 1999) and there is evidence that some open investigations can represent a naïve epistemology based on simplistic versions of scientific method (Windschitl 2003). In practical terms, teachers can find open investigative work challenging and few schools are seriously involved in this activity. This paper draws on a study of a major science awards program to explore the ways in which open investigative work is developed and supported in schools. The research used interviews with teachers and students and state organisers to develop a picture of what happens on the ground in running such activities, and will draw on selected case studies to trace the history and nature of the development of a culture of investigation in schools. The paper will explore the extent to which student investigative activity reflects authentic science practice, and the epistemological positions implied by the activities of teachers and students involved in a school investigative culture.

Science careers outreach: One size doesn't fit all

Friday 12.00, Star Room

Grady Venville[1], Sophia Bickford[1], Mary Oliver[1], Nancy Longnecker[1] & Léonie Rennie[2]
[1]University of Western Australia
[2]Curtin University of Technology

The aim of this research was to explore the impact of a science careers outreach program on high school students' attitudes toward science, their science career aspirations and their views about the relationship between science and their everyday life. The research design was a case study of one science careers outreach program delivered in four high schools. Mixed methods of data collection were employed including pre/post survey with forced response items and open items for students (*n*=529), observation of the show and an open survey and phone interviews with participating teachers (*n*=4). Findings from the forced response items on the survey showed that significantly more students agreed after the outreach that everybody should study science up to Year 12 and that the things they do in science are useful in everyday life. However, the outreach had little impact on students' attitudes toward a science career. Findings from the open-ended items on the survey demonstrated that science careers outreach needs to be carefully aligned to participants' year (age) group, their post-school destinations and the expectations of the teachers.

Effects of a representation-intensive approach to learning science on students' performance in assessment

Thursday 8.30am Seaspray 8

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. These challenges include integrating verbal, visual and mathematical modes in science discourse to make strong conceptual links between representations and classroom experiences. Our paper reports on a project that aimed to identify practical and theoretical issues entailed in a representation-intensive approach to students' conceptual learning in science. We focus here on three case studies of middle school science topics. Analysed examination scripts indicate that this approach resulted in students integrating a range of representations in their responses to exams, writing longer and more comprehensive explanations, and scoring higher results than is normally the case.

The green-energy curriculum with project-based instruction connecting high school and university educations

Thursday 2.15pm, Seaspray 7

Albert T. Wang[1], Jinmeei K. Hsieh[2] & Yichung Chen[1]
[1]MingDao High School, Taiwan
[2]MingDao University, Taiwan

The purpose of this study was to develop a green-energy curriculum for promoting students' scientific literacy, attitudes toward energy-science and connecting their high school and university educations. This curriculum was supported by National Science Council in Taiwan and had been developed for three years because of the public policy of energy-saving and carbon-reduction. There were 250 students of 10^{th} -11^{th} graders in 6 classes and 9 teachers voluntarily participated in this study. Subjects of this curriculum included physics, chemistry, and biology, and the topics contained solo energy, wind energy, biomass energy and energy efficiency. The curriculum with project-based instruction and group-cooperation learning was implemented two hours per week during one year. The topics in the curriculum were partly immerged in the regular science curriculum and partly arranged in the weekend. Questionnaires about students' scientific knowledge and attitudes toward energy-science, students' learning portfolio, students' performance exhibitions, the interviews for the graduates having participated in the project and teachers' reflections were designed for the tools in order to evaluate the curriculum before, during and post developing. The results of the green-energy curriculum developed were based for the suggestions: the applicable practice in the science classrooms of high schools, the effectiveness for connecting high school and university educations.

Influence of metacognitive skillfulness on thinking problems of molecular geometry and polarity

Thursday 12.00, Sun Room

Chia-Yu Wang
National Chiao Tung University, Taiwan

We applied a mixed-method research design to investigate metacognitive skillfulness possessed and used by undergraduate students to solve problems involving molecular geometry and polarity. Three constructs of metacognition were assessed including: self-reported metacognitive knowledge, knowledge-monitoring ability, and task-relevant metacognitive skills. We were interested in exploring the influence of these constructs on chemistry understanding. Thirty-one university students who had taken a general chemistry course participated in this study. Given chemical formulas, participants were to determine their geometric shape and whether they were polar or non-polar molecules. Interview protocols were transcribed and analyzed on spontaneous use of metacognitive skills and scores of chemistry understanding. A knowledge-monitoring assessment and an inventory of metacognitive self-regulation were then given. Findings of correlation analyses indicated that scores of self-reported metacognitive knowledge, knowledge-monitoring ability, and performed metacognitive skills are congruent. We then divided the participants into high, moderate, and low groups based on their scores of chemistry understanding. The MANOVA analysis results indicated that high-scorers self-reported more metacognitive knowledge and possessed better knowledge-monitoring ability. Additionally, high-scorers performed better "task-analysis" and "monitoring" skills than their counterparts when solving problems in the interview. Discussion and implications of the findings will be provided in the full paper.

School administrators' perceptions of beginning secondary science and mathematics teachers.

Friday 12.00, Sun Room

James J Watters
Queensland University of Technology

Attrition rates for beginning teachers are alarmingly high with estimates of up to 40% of new teachers leaving the profession in first three years. This figure is especially concerning for those teachers who come to the profession as mature aged students often with a substantial background in science. At a time of shortages of science teachers, such attrition is unacceptable. As part of a longitudinal study of the experiences of beginning teachers in mathematics and science, this paper reports the perceptions of senior administrators (Principals, Deputy Principals and Heads of Department) on the issues related to the preparation of new teachers and their induction into teaching. The study specifically examined a number of issues including: areas of strength and weakness of beginning teachers, relative importance of specific skills and knowledge, level of support provided during induction and preferred modes of teacher education provided by Universities. Invitations were extended to all State and Non-State School principals in Queensland to respond to an online survey. Analysis of the 79 valid responses (~30% response rate) revealed a diverse range of opinions across sectors, regions and administrative roles. Of particular interest is the value attributed to content knowledge, nature of preservice preparation and the factors impacting attraction and retention of quality teachers. This study contributes to a deeper understanding of the needs of schools in a time of rapid curriculum reform in Australia.

A preliminary eye-movement study of science education graduate students' reading behavior

Thursday 4.45pm, Sun Room

Meichun Lydia Wen
National Changhua University of Education, Taiwan

Being a science educator in a graduate institute, it is important, for the author, to improve the learning of graduate students. However, there is a lack of study in the field of post-graduate science education. Previous research shows the significance of reading ability to learning and conceptual understanding, and students' reading behavior can be linked to their cognitive processes. The emphasis of this study is to examine graduate students' reading behaviour while learning science education-related materials by analyzing eye movement patterns. Sixteen master and doctorate students were involved in the study to read passages, figures and tables from research articles using the Mangold Vision eye tracking device, and its sampling rate was 52 per second. The participants were interviewed before and after the reading. The hypothesis was that novice (first-year master degree) students read all information while the more experienced students read only important

information or concepts. The results support the hypothesis, and there were some factors contributing to participants' individual differences, such as reading preferences, familiarity with English language, and time constraint. This preliminary study suggests that science education professors should teach graduate students how to identify key concepts when they first learn to read science education texts or materials.

Facilitate Students' Competencies in Identifying Scientific Issues through Vertically Scaffolding Web-based Instruction

POSTER

Hsiao-Lan Weng, Hsiao-Ching She, Li-Yu Huang & Sheng-Chang Chen
National Chiao-Tung University, Taiwan

This study was to explore the impact of vertical scaffolding web-based learning on students' concept construction, scientific reasoning and competencies in identifying scientific issues. A total of sixty-eight 7th graders recruited from two average-achievement classes of a middle school in Taiwan participated in this study. They all received vertical scaffolding identifying scientific issues via web-based learning for three units. The content dependent conception Test (CDCT), and content dependent PISA Test (CDPISA) were administered to all students before, directly after and after the eighth week of learning. The scores differences across pre-, post- and retention- of CDCT and CDPISA were analyzed with repeated measures of ANOVA. The results indicated that students' scientific conceptions and identifying scientific issues ability all improved from pre-, post- to retention- of CDCT and CDPISA. Specifically, the retention-CDPISA was statistically significant greater than their pre-scores. The retention-CDCT was statistically significant greater than their post- and pre-scores, and post-CDCT was statistically significant greater than their pre-scores.

Student perceptions of what helps them learn science.

Friday 10.30am, Star Room

Bruce White
University of South Australia

The importance of teachers to student learning and the qualities of effective teachers is an area of ongoing research (Darling-Hammond, 2007). As part of this, students' perception of what teachers do (Wang, Haertel, & Walberg, 1993) and what students themselves do (Lawson, Askell-Williams, 2002) that that helps them learn is of interest. This presentation looks at the students perceptions in general but also specifically in relation to the teaching and learning of science. Data was collected from students at two South Australian schools via a survey where they were and asked to respond to questions relating to what teachers did that helped them learn and what they did as students that helped them learn science. The survey was done online and it was administered to the majority of students in years 8-12. The results of the survey will be presented and will highlight areas that students think are most import and in some cases how often they were experienced by the students.

Exploring Changing Attitudes and Achievement In Science Through The Integration Of A Novel Multimedia Resource

Saturday 10.00am, Seaspray 8

David Winter, Chris Astall & Lindsey Conner
University of Canterbury

The effects of incorporating a novel on-line multimedia resource, The Science Learning Hub, (www.sciencelearn.org.nz) into a junior secondary science physics unit were investigated. This multimedia resource collates context based materials that are closely aligned to the New Zealand science curriculum and focus on the latest research in New Zealand science and technology. Two classes taught by the same teacher participated in the study. Both classes covered the same core content, however the unit of work for one class was enriched with teacher-selected material from the multimedia resource. The attitude of both groups of learners to science was explored using a standard instrument that collects both descriptive and explanatory data and also by focus group interview. Learner achievement for both classes was determined using a written test both prior to and after the intervention. Results are presented and discussed in terms of the potential for this type of resource, that features scientists and their work, to promote learner interest in science and enhance understanding of science concepts.

Embedding PCK in Science Curriculum Using Content Representations.

Friday 2.15pm, Sea Room

Jim Woolnough & C L Moore
University of Canberra

There is an implicit assumption that Pedagogical Content Knowledge (PCK) involves Content Knowledge as well as Pedagogical Knowledge and, more specifically, there is reasonable consensus that it involves some integration of good content knowledge, good knowledge of pedagogy, as well as experience in teaching specific topics. Content Representations (CoRes) were developed to provide a map of PCK of expert and excellent teachers. More recently they have been used successfully to support the development of PCK in pre-service teachers. In this paper we explore the use of CoRes in the development of science curriculum to allow the representation of some aspects of PCK within a curriculum document. We will explore theoretical reasons why some elements of PCK should be included in curriculum documents and an example of how CoRes can be used to achieve this. In this case a CoRe is developed by identifying the 'big ideas' associated with teaching Earth and Environmental Science and then probing these ideas in different ways so that specific information that impacts on the manner in which the content might be taught can be made explicit. Through this process, the CoRe becomes a generalisable form of the teachers' pedagogical content knowledge.

Analysis on TIMSS 2003 Test Items for Grade 4 Science and Elementary Science Curriculum in Taiwan

Saturday 9.15am, Seaspray 7

Hsiu Lien Wu[1] & Mei-Yu Chang[2]
[1]Chung Hua University, Taiwan
[2]National Hsinchu University of Education, Taiwan

According to the results of the questionnaire conducted by the International Association for the Evaluation of Educational Achievement (IEA for short), the percentage of test items in the curriculum for each TIMSS participating country showed a significant difference. This study investigated the coverage situation for the test items of TIMSS2003 on Taiwan science curriculum. The methods used in this study were mainly qualitative. The participants of this study were 8 senior science teachers. Data collections were based on the analysis of documentation, questionnaires, interview, and focus group discussion etc. The results are as follows: (1) The percentage is 72% of TIMSS 2003 Science test items to Taiwan's 1993 Standard Natural Science Curriculum Outline; and 73.8% of them to the Natural Science and Life Technology domains in the 9 year Curriculum Outline. (2) The TIMSS 2003 Science test items are covered about 34.5% for the scope of Grade 1 to 4 of 1993 Standard Curriculum, and covered about 32.1% for the scope of Grade 1 to 4 of 9 year Curriculum Outline.(3) The contents of test items in TIMSS 2003 Grade 4 Science are mainly appeared on the Grade 5 to 6 levels in Taiwan. Such situation is more critical in the domain of Life Science.

"Like the table is made of wood, so the particle is wood" Border crossing in a Grade 7 science classroom

Symposium, Friday 1.30pm, Star Room

Lihua Xu
University of Melbourne

This study investigated the issue of "border crossing" in school science through an empirical investigation of a Grade 7 classroom in Melbourne. Data analysed in this paper include video records of a lesson sequence on the topic of States of Matter and accounts generated from video-stimulated post-lesson interviews. Examples from this 7th grade science classroom will be employed to illustrate the challenges that the students faced in becoming legitimate participants in this classroom in relation to these three aspects of science learning: ways of talking, ways of seeing, and ways of thinking. Firstly, I demonstrate how the undifferentiated employment of everyday and scientific meanings of the same words in the classroom could render considerable conceptual difficulties in student understanding. Secondly, I discuss the difficulties confronted by the students when trying to embrace a scientific way of seeing material objects presented in the classroom. Finally, I provide examples to illustrate the tension between the privileged way of reasoning (inductive and deductive reasoning) and student everyday reasoning (analogical reasoning). Based on these examples, I suggest that the differences in these three aspects of science learning should be made explicit to the students in order to facilitate their enculturation into school science.

The Effect on Enhancing Student's Inquiry Abilities via Step-by-Step Open-ended Inquiry Teaching Design

Thursday 3.00pm, Seaspray 9

Chung-Ming Yang & Iris Tai-Chu Haung
National Kaohsiung Normal University, Taiwan

Since 1999, the Ministry of Education has been engaging in new curriculum standards in Taiwan. The new standards emphasized that all of the students in grades 1-9 were supposed to develop their inquiry and research abilities. In practice, science teachers were faced with the pressure of high school examinations and the limitation of instructional time. Therefore, in the process of science education reform, secondary school teachers had difficulty working on their inquiry teaching. This study used Hazel's proposals of levels-of-inquiry. The method was to carry out the current eighth-grade experiments through the step-by-step teaching material modification (from levels-of-inquiry 0 to 2b) and to combine the experimental teaching with 5E learning cycle. The study showed that academic achievement in the experimental group, based on the same instructional time, was not worse than that in the control group. In the process skills of performance, no significant difference was found on the total scores of the basic science process skills between the two groups, but a significant difference was found on 'predicting dimension'. There was a significant difference on the total scores of the integrated science process skills between the two groups. Significant differences were found on 'interpreting data' as well as 'experiment designing' dimensions. The study indicated that it could enhance students' inquiry ability through step-by-step open inquiry levels to change the existing curriculum, which served as a reference of educational reform.

Is Interactive Whiteboard Effective for Junior High School Students with Different Cognitive Styles in Learning Biology?

Friday 12.00, Seaspray 9

Kai-Ti Yang[1], Tzu-Hua Wang[2] & Mei-Hung Chiu[1]
[1]National Taiwan Normal University
[2]National HsinChu University of Education, Taiwan

With the rapid development of information and communication technology (ICT), integrating the Interactive Whiteboard (IWB) into traditional classroom teaching has become an important research issue in recent years. This study aims to compare the effectiveness of IWB-integrated instruction with that of traditional ICT instruction, and to investigate learning effectiveness of students with different cognitive styles in these two learning environments. The IWB adopted in this study is SmartBoard™. SmartBoard™ is used in the 'Cell Division' course for junior high school seventh graders. This study adopted a quasi-experimental design. One hundred and eleven junior high school seventh graders participated in this study. This research adopted the instrument named 'Hidden Figures Test (HFT)' to categorize students' cognitive styles. The research process is as follows: first, all students were divided into two groups, the experimental group and the control group. Students in the experimental group received IWB-integrated instruction, while students in the control group received traditional ICT instruction. After one-week instruction (five classes), the study finds that students receiving IWB-integrated instruction have significantly better learning effectiveness than those receiving traditional ICT instruction. In addition, the result indicates that IWB has significantly better effectiveness in assisting field dependent (FD) students to learn.

The relationship between Taiwanese university students' cognitive structures and their informal reasoning regarding the use of genetically modified foods

Saturday 8.30am, Seaspray 7

Shih-Ming Yang & Ying-Tien Wu
National Taichung University, Taiwan

This study aimed to investigate the relationship between university students' cognitive structures and informal reasoning regarding the use of genetically modified foods (GMFs). The participants were 42 non-science major students taking a "Science, Technology, and Society" course in a university in Taiwan. After a two-hour learning activities regarding GMFs, the data about the students' cognitive structures were collected with tape-

recorded interviews, and the interview narratives were transcribed into the format of "flow map". The students' informal reasoning on the use of GMFs was assessed with an open-ended questionnaire, and their responses on this questionnaire were analyzed with an integrated framework developed in the previous study. It was revealed that the students' supportive argument construction was significantly correlated with the "extent" of their cognitive structures ($p<0.05$). Moreover, it was found that the students, having more extended as well as more integrated cognitive structures, were more oriented to propose more rebuttals, which was viewed as an important indicator for their reasoning quality ($p<0.05$). More importantly, the students' rebuttal construction was also significantly correlated with the "flexibility" of their cognitive structures ($p<0.05$), suggesting that students' metacognitive ability might play an important role in achieving higher-level reasoning quality regarding a socio-scientific issue.

The development of a conceptual change based website to enhance science/math teachers' inquiry teaching competence

Saturday 11.45am, Sea Room

Chung-Chieh Yu[1], Hsiao-Lin Tuan[1], Chi-Chin Chin[2], Pi-Yun Cheng[1] & Chih-Chung Lai[1]
[1]National Changhua University of Education, Taiwan
[2]National Taichung University of Education, Taiwan

The purpose of this study is to build up a website which concentrated on conceptual change and social constructivist learning to enhance science/math teachers in developing their inquiry teaching competence. There are several features embedded in this website: collecting teachers' perception of inquiry teaching, providing various teaching video clips in reality to exemplary inquiry teaching, exemplars of inquiry lesson plans, and teachers' reflection on each video vignette. Thirty four science/math teachers in junior or senior high schools participated in our pilot study and agreed with our web's design ($M=3.37$, $S.D.=0.86$). Next, thirty in-service science/math teachers used the web to learn inquiry teaching. By the end of the course, they turned in their written feedback about this web. The Mentoring Assisted Inquiry Teaching [MAIT] questionnaire result in relation to their perception of the web shows that most participants felt satisfied about the operation, content, interaction and accessibility of the website ($M=3.65$, $S.D.=0.82$). These thirty teachers' perceptions of the website are as follows: it can facilitate teachers to understand the meaning of inquiry; it provides the manifest knowledge in designing inquiry instruction; it provides various inquiry-teaching cases for referring; it facilitates teachers' reflection; and it can enhance the teachers' confidence in conducting inquiry instruction.

Local Learning Enrichment Network (LLEN) in Khon Kaen Province: Two Years of Developing Science Teacher Network

Friday 9.15am, Marlin Room

Chokchai Yuenyong & Pennee Narot
Khon Kaen University, Thailand

Local Learning Enrichment Network (LLEN) is three year national project of the Thailand Research Funding (TRF). The LLEN aimed to push educational management for improving students' learning quality based on local concerns through collaboration between schools and local universities in each part of Thailand. Khon Kaen University (KKU) is one of nine universities that participated in the TRF LLEN project. The KKU LLEN research project aimed to improve students' learning quality in science, mathematics, and Thai. This paper reports two years of developing a science teacher network for improving students' science learning quality. Participants were science teachers from 50 schools in Khon Kaen province, Thailand. The science teacher network was developed through participatory action research (PAR). The activities of PAR were set concerning with school-based approach. First year participation among teachers, educational personnel, and educational administrators from Khon Kaen educational area 1 - 5, and educational provincial and district organization constructed a knowledge base for improving science learning quality. This included strength and constraints of learning management, outstanding science teachers, and leading schools in each area of Khon Kaen. The science teacher network, then, was initially formed based on first year results. The second year activities was the process of each node of science teacher network driving for improving quality of science learning. The paper will clarify the pathway of developing a science teacher network regarding the Thai sociocultural setting.

Thai Science Cooperating Teachers' Views about Science Teaching and Learning and Their Teaching Practices Resulting from a Professional Development Program

Saturday 11am, Sea Room

Naruemon Yutakom
Kasetsart University, Thailand

Cooperating teachers' views about teaching and learning and their teaching practices play a major role on success in their teaching of prospective teachers. This study, which is a part of a larger project on enhancing supervision practices, reports on data from a one-year professional development program in 2008. The subjects were 12 elementary and secondary teachers from 4 'professional development schools' associated with a university in Bangkok. The data was collected via interviews, classroom observations, questionnaires, and document analysis of lesson plans. The data were analyzed using content analysis. The findings revealed that over the time of the project most teachers' views about student learning, objectives in teaching, teaching methods, content that should be taught, assessment procedures moved closer to the Thai reform initiatives. Some of the teachers' views concerning the nature of science were limited, especially in terms of the nature of scientific knowledge and experiments. These views affected how they taught science. Their teaching practices improved both in lesson planning and their actual teaching to some extent. The results identified issues and needs for improving science professional development programs both for pre-service and in-service teacher education.

'Operation Magpie': are we engaging teachers with science, and students with their environment?

Thursday 3.00pm, Marlin Room

Yvonne Zeegers, Kathy Paige & David Lloyd
University of South Australia

Citizen Science involves scientists in engaging the public to collect scientific data within a cooperative framework. The project to be reported on here, known as "Operation Magpie", began with a collaboration of science educators, environmental scientists and the local ABC radio station. It focused on encouraging primary teachers to teach science by involving their students in a 'Citizen Science' project. After initial workshops with 75 teachers, the science educators met regularly with twelve primary teachers who each volunteered to plan and teach a unit of work on birds. The unit included student collection of data about magpies in their immediate environment. Meeting in focus groups over a three month period, the teachers shared their pedagogical strategies with the researchers and with each other. In addition, surveys were sent to non focus group teachers who had attended one of the initial workshops but did not want further involvement with the research. Key findings of the study include the importance of teachers being able to access on-going support during the science unit; the consequent capacity building of teachers and their students in collecting and using scientific data and, the innovative ways that teachers approached the unit. One unexpected finding was that teachers tended to identify student learning in terms of English rather than in science. This has implications for assessment and reporting in the new Australian Curriculum.

A study of Chinese secondary physics teachers' beliefs and their instructional practices regarding inquiry-based teaching

Thursday 12.00, Marlin Room

Zheng Zhu
The University of Queensland

Teachers' beliefs are generally reported to link to teachers' instructional practices. The author's study was intended to explore Chinese secondary physics teachers' beliefs, and how their beliefs influence their classroom practices regarding implementing inquiry-based teaching (IBT) in the context of the current Chinese curriculum reform. A mixed-method approach was employed. Ninety teachers were involved in this study. A range of beliefs teachers held about teaching and learning seemed to influence teachers' instructional decisions, however, one major theme was prominent. Teachers' perceptions of effective teaching seemed to dominate teachers' reactions to and implementation of IBT in high school physics classrooms. However, these beliefs and their influences on teachers' instructional practices should be understood in the context of the unique situation that Chinese secondary physics teachers encountered: they were teaching a reformed, inquiry-based curriculum while lacking an appropriate and complete assessment system, they were pressed for time, and they were under

high pressure to prepare students for the College Entrance Examination (CEE). Furthermore, the scaffolding and professional development system seemed to be far from being enough to help teachers confidently apply an inquiry-based teaching approach in their classrooms.

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PROGRAM CHANGES

D Winter, C Astall & L Conner *Exploring Changing Attitudes and Achievement In Science Through The Integration Of A Novel Multimedia Resource*
THIS SESSION HAS BEEN MOVED from Saturday 10am in Seaspray 8 to Friday 1.30pm in the Marlin Room.

J-R Choi, S-K Lee & C-J Kim *A Case Study on Articulation of Science Teachers' Tacit Knowledge While Repeating to Teach the Same Contents in Different Classes*
Thurs 4.45 Seaspray 8 THIS SESSION IS CANCELLED

C Boylan & P Stephens *Selection of senior secondary science subjects by preservice primary teacher education students*
THIS SESSION WILL BE on Thursday at 4pm in the Sea Room (PTO abstract)

C Preston *Primary Children's interpretation of food chain / web diagrams* [below]
THIS SESSION WILL BE on Thursday at 10.30am in Seaspray 8

Primary children's interpretation of food chain / web diagrams

Christine Preston,
University of Sydney Thursday 10.30am, Seaspray 8

Science diagrams are used widely in primary schools for instruction and assessment despite the absence of substantive research into their effectiveness as aids for conceptual development or indicators of scientific literacy. The paper will outline and discuss one section of a larger study designed to explore how primary children interpret scientific diagrams. The study aimed to investigate children's reading of diagrams and the meanings they construct from them. Semi-structured interviews with Year 3 and Year 5 children from one primary school were used to elicit preconceptions about feeding relationships between familiar organisms and to record their interpretation of a related set of diagrams. Follow up interviews determined any changes in children's conceptual schema and in their interpretation of the diagrams over time. The results reveal insight into the way primary children approach the reading of food chain / web diagrams and have implications for the use of science diagrams in teaching, learning and assessment.

Selection of senior secondary science subjects by pre-service primary teacher education students

Thursday 4pm, Sea Room

Colin Boylan and Penny Stephens
Charles Sturt University

The design of science curriculum subjects in the primary pre-service teacher education course includes consideration about pedagogy, content and pedagogical content knowledge. In this paper, the tertiary entry-level science background of first year primary students is examined through exploring both their participation rates in science subjects in Years 11 and 12 and the reasons why / why not the students selected to study senior science. The current research examined the reported level of usage by first year primary teacher education students when they studied science in their senior high school years (Years 11 and 12). The research questions were: 1) To what degree have primary teacher education students engaged with senior science studies as part of their senior secondary education; and, 2) What reasons were provided by these students to justify why they did or did not choose a senior science subject. All primary students at Charles Sturt University, Wagga Wagga campus, study the first of two science curriculum subjects in the first semester of first year. Longitudinal data were collected from five sequential intake cohorts, 2006 to 2010 inclusively (n= 428). A self report questionnaire developed by the authors was used to generate the data that informs the focus of this paper. Data analyses were conducted using SPSS Version 16. Major findings revealed that a) approximately 80% of students were females, a result similar to most NSW universities, and b) between 38% and 56% of each intake cohort had not studied a science subject in Years 11 and 12. For those students who had studied a science subject, Biology was the most frequently selected subject. For those students who *continued* studying science in Years 11/12, the four main reasons for their decision, in rank order, were: 1) *An interest in science*; 2) *Perceived relevance to career pathway; 3*) *Positive prior science learning experience*, and, 4) *Improve University admission chances*. Collectively these responses indicated that many students had selected a science course in Years 11/12 based on a personal interest in science phenomena and the relevance of science to their chosen career pathway after completing high school. Reasons why students had *not selected* a science course in their Year 11/12 study program identified five emergent themes, in rank order: 1) *Lack of interest in science*; 2) *Other subjects preferred*; 3) *Lack of science subject confidence*; 4) *Not related to career path*way; and, 5) *Subject availability*. Collectively these responses suggest that for those students who dropped science many of these students did not have an interest in science and chose to study subjects in other areas that they believed were more interesting and relevant. Audience participation in sharing observations for the science background of primary pre-service students enrolled at other tertiary institutions and the implications from these findings for both tertiary subject design will be facilitated during the presentation.

LAST MINUTE CHANGES

THE FOLLOWING SESSIONS HAVE BEEN CANCELLED:

Nicholson, Haslam & de Wacht *ICT: Supporting a whole school change in and across local and remote settings.* Saturday 8.30 Seaspray 8

Almeida *Environmental education in a climate of reform: Understanding teacher educators' experiences*. Thursday 8.30am, Seaspray 7

THE FOLLOWING SESSION HAS BEEN MOVED

Bingimlas & Hanrahan A framework for ICT supported learning and teaching environments for primary science in Saudi Arabia. WAS Thursday 1.30 Sea Room NOW MOVED TO Saturday11.45 Seaspray 9