Deakin University

Waterfront campus

School of Education

ASERA 2009

40th Australasian Science Education Research Association Conference

1st – 4th July 2009
Geelong, Victoria, Australia

Welcome and Introduction

Welcome to Geelong, gateway to the South-Western coast of Victoria. Geelong is a wonderful place for ASERA 2009 and the location of the Deakin University Waterfront Campus is ideal for the many aspects of the conference. Historically, Geelong was the first port in Victoria and all passengers disembarked here before catching a Cobb & Co. coach to Melbourne. The site of the Deakin University Waterfront campus was one of the original woolstores of Lascelles and over the last ten years, Deakin University has been working on the property to restore and revitalise it while retaining its heritage quality. Today Geelong is characterised by vibrant shopping centres, varied dining and expanding environs. Hopefully, you will have the opportunity to explore some of the many tourist sites and relax in the delightful surroundings around the ASERA 2009 Conference site.

The ASERA conference dinner will be held in the Peninsula Room, Sheraton Hotel. The Sheraton overlooks the beautiful Corio Bay foreshore with its piers, restaurants, yacht club and parks. We will be entertained by 'Suitcase Murphy', a highly recommended local musical group who have promised to keep the night moving along in a lively manner.

The official host of ASERA 2009 is the Science Education Group at Deakin University. The Deakin Events Management group, through Cathy Tay, has efficiently managed the website, the finances and provided support in the administrative tasks. The organisation of the conference has been a collaborative effort with contributions from all of the science education team.

The ASERA 2009 program is extensive with 8 concurrent sessions each day and a varied and interesting range of papers. With a third of the delegates travelling in from overseas, we are indeed pleased to welcome many colleagues from the South-East Asian regions.

We would like to thank all the people who have contributed to the organisation of this conference and bid you an enjoyable and stimulating professional experience.

Coral Campbell, Linda Darby & Russell Tytler
(Conference Convenors)

Deakin's Waterfront Campus

General Information

Deakin's Waterfront Campus

The Geelong Waterfront Campus is located on the foreshore of Corio Bay in the central business district of Geelong. Originally built in 1893, the buildings have undergone extensive redesign and refurbishment to create a modern and impressive campus. The Waterfront Campus retains and acknowledges its history as the hub of the Victorian wool industry throughout most of the last century.

Official Welcome Session

Please enjoy drinks and nibbles from 6.00 to 8.00pm in the B Level Gallery after the pre-conference registration on Wednesday 1st July.

Dinner

The 2009 ASERA Conference dinner will be held on Friday, 3 July at the 4.5 star hotel the *Four Points Hotel Sheraton* which is located on the waterfront in Geelong and provides breathtaking views over Corio Bay.

There will be a three-course meal with beverages provided, plus dancing to a live band.

Annual General Meeting

All members are welcome to attend the ASERA Annual General Meeting in D2.194 at 4.25 pm on Friday 3rd July.

Chairing Sessions

Each session consists of a 20-minute paper presentation and 20 minutes for questions. The Chair is expected to introduce the speaker, monitor their time and chair the question session.

Bookshop and Library

The campus also houses a comprehensive bookshop and an impressive library for both academic and community purposes, a special collection of rare and antique books and a display of part of the University's art collection. The Deakin University Library is open to all visitors.

Computers

Computers are available in the Library at Level 3 and at the Waterfront Café at Level 1 for general use. They have been arranged for accessing and sending e-mails only.

Computer Labs Rooms have been booked for delegate use as follows:

- D1.108 Computer Lab, Level 1
  Wednesday 1 July 2009 from 12pm to 8pm
  Thursday 2 July 2009 from 8am to 8pm
- D4.177 & D4.179, Level 4
  Friday 3 July from 8am to 8pm
  Saturday 4 July from 8am to 8pm

Please see Cathy Tay or Jodi Morgan at the Registration Desk to obtain the Password to allow you to gain Internet Access.

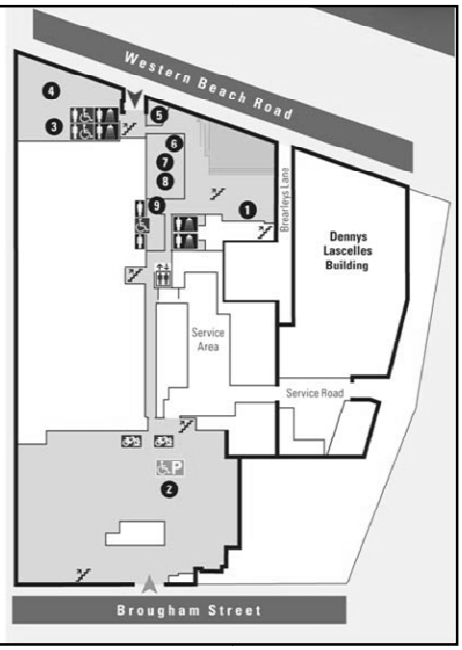
Muslim Prayer Room

The Muslim Prayer Room is situated in Level 1 – Room D1.202.3. Please ask for the Room Access Code at DUSA Reception Desk in Level 1, Room D1.203.03

Waterfront Café

The Waterfront Café is open daily at Level 1: Monday to Thursday from 8.30am to 4.00pm, Friday from 8.15am to 3.00pm.

main entry
vehicle entry
accessible parking
reserved accessible car park
bicycle rack
female accessible toilet
male accessible toilet
unisex accessible toilet
platform lift to level one only
Restricted access by prior arrangement — Contact: Security 222 or 5227 8222
lift
female toilet
male toilet
female shower
male shower
stairs
baby change facilities
public telephone
ATM automatic teller machine
DC Deakin Card reload station



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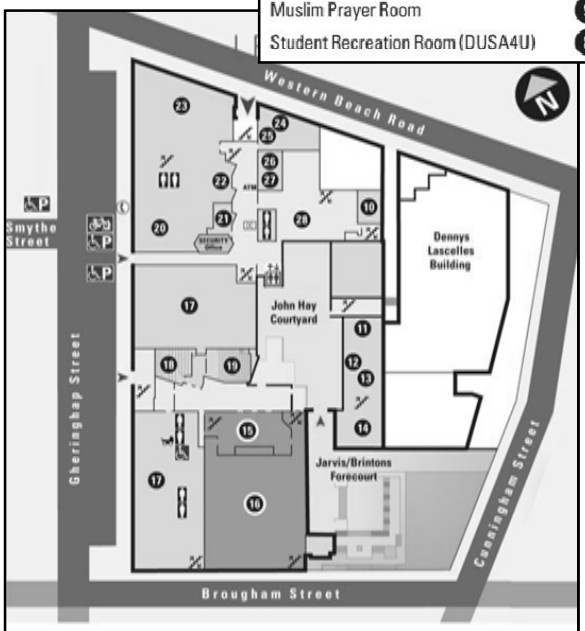
Geelong Waterfront Campus



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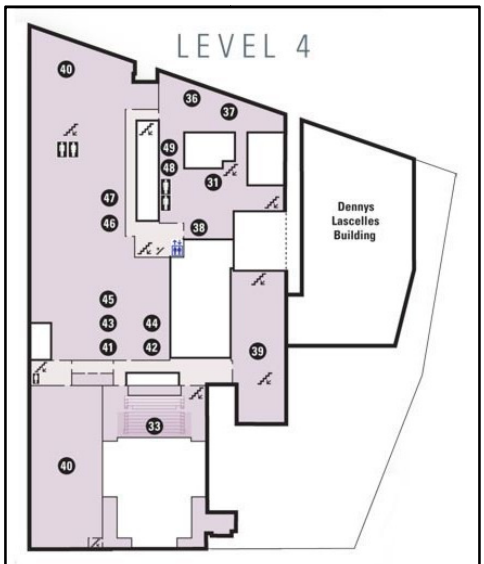

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Thursday 2nd July

8.00am – 5.00pm	Registration desk open
8.45am – 9.00am	Opening and welcome
9.00am – 10.00am	Panel discussion
10.00am – 10.30am	Morning tea
10.30am – 12.40pm	Presentation of papers (three sessions)
12.40pm – 1.30pm	Lunch
1.30pm – 3.40pm	Presentation of papers (three sessions)
3.40pm – 4.00pm	Afternoon tea
4.00pm – 5.25pm	Presentation of papers (two sessions)

Friday 3rd July

8.00am – 5.00pm	Registration desk open
8.30am – 10.40am	Presentation of papers (three sessions)
10.40am – 11.10am	Morning tea
11.10am – 1.20pm	Presentation of papers (three sessions)
1.20pm – 2.10pm	Lunch
1.30pm – 4.20pm	Presentation of papers (three sessions)
4.20pm – 4.45pm	Afternoon tea
4.25pm – 5.30pm	ASERA Annual General Meeting
7.00pm – 11.30pm	Dinner

Saturday 4th July

8.00am – 4.00pm	Registration desk open
8.55am – 10.30am	Presentation of papers (two sessions)
10.30am – 10.50am	Morning tea
10.50am – 12.15pm	Presentation of papers (two sessions)
12.15pm – 1.05pm	Lunch
1.05pm – 4.00pm	Post-conference video workshop

Conference Programme

Wednesday 1st July 2009

Registration and Welcome

4.00pm-8.00pm Registration desk open, B Level Gallery
6.00pm -8.00pm Official welcome reception, B Level Gallery

Morning, Thursday 2nd July 2009

8.45-9.00am Opening and welcome, Percy Baxter Theatre D2.193
9.00am-10.00am Panel discussion, Percy Baxter Theatre D2.193
10.00am-10.30am Morning tea, Costa Hall Foyer

Time	*D2.211*	*D2.212*	*D2.194*	*D4.105*	*D4.107*	*D4.106*	*D4.109*
10.30am-11.10am	**D. Nichols** *Increasing Teachers' Content Knowledge by Developing Partnerships with Scientists* Chair: L. Xu	**J. F. Hung** *The Development and Validation of the Scientific Thinking Disposition Inventory* Chair: G. Hilton	**G. Kidman** *Understanding Conceptual Status: teaching science through "slowmation" animation* Chair: M. C. Hsin	**Z. R. Hong** *Trend Analysis of Primary and Secondary School Students' Self-efficacy and Learning in Science* Chair: W. C. Feng	**K. Y. Yang** *The Effects of Science Problem-based Learning on Science Related Attitudes, Cognitive Strategies ...* Chair: K. Elliott	**B. Jane** *ICTs in Primary Science Education: developing a community of learners to enhance scientific literacy* Chair: M. Hackling	**T. H. Hsiung** *Reflection on the Current Situation of Elementary Science Teacher Education in Taiwan* Chair: J. Robbins
11.15am-11.55am	**S. C. Witt** *Becoming a Teacher: an interpretive inquiry into the construction of pre-service teachers' teaching identity* Chair: W. P. Palmer	**F. P. Hsieh** *An Investigation of Children's Interested Science Topics in Taiwan* Chair: D. Goodrum	**S. Keast** *Slowly Unpacking our Teacher Education Pedagogy: using slowmation to reflect on our practice* Chair: H. Lee	**L. Danaia** *Changes in Students' Perceptions of Junior Secondary Science: an intervention using a remote-controlled telescope* Chair: C. C Chen	**S. Khansophon** *Thai Undergraduate Students' Technological Capability and Attitude toward Science through Teaching and Learning …* Chair: C. Yuenyong	**J. L. Bay** *Scientists in High School Classrooms via Interactive Television* Chair: C. Y. Lin	**Y. C. Li** *The Effect of Mind Mapping on Fifth Graders' Creative Thinking and Achievement* Chair: E. Blake
12.00pm-12.40pm	**D. Tan/D. Treagust** *Kinetics, Stoichiometry and Acid Properties: how do these come together?* Chair: K. Eggington	**D. Palmer** *Constructivist-informed Teaching: the role of motivation* Chair: M. L. Changlai	**G. Hoban** *Seeking a Theoretical Framework for Student-generated Animations ("Slowmations") of Science Concepts* Chair: C. H. Ku	**M. Logan** *Looking at Changes in Students' Attitudes To, and Interest In, Science, From Year Six, Primary School to Year Ten, Secondary School* Chair: L. Ladachart	**L. Darby** *Making Science and Mathematics Relevant: the complexity and subject-specificity of a "relevance imperative"* Chair: W. Nielsen	**L. Chatathicoon** *Developing an Internet-Based Science Instructional Model in the Thai Context* Chair: S. Birdsall	**C. Jakab** *'I Can See Molecules': children's everyday ideas of particles of matter* Chair: C. Howitt
	12.40pm-1.30pm Lunch, Costa Hall Foyer						

Afternoon, Thursday 2nd July 2009

Additional Sessions: Costa Theatre

1.30pm-2.10pm C.C. Lin Student Perception of a Web-based Self-directed Learning Environment in Southern Taiwan Chair: M. Rafter

2.15pm-2.55pm M.S. Hartley Investigating the Effect of Science Clubs on Learners and Teachers at Three Rural Schools in the Western Cape … Chair: R. Tytler

3.00pm-3.40pm H. J. Arzi David P. Ausubel, 1918-2008: reflecting on contributions and unrealized potential of an "old" theory Chair: W. Y. Chan

Time	*D2.211*	*D2.212*	*D2.194*	*D4.105*	*D4.107*	*D4.106*	*D4.109*
1.30pm-2.10pm	**L. Xu** *Teaching and Learning the Particle Model in a Year-seven Science Classroom* Chair: D Nichols	**G. Hilton** *Student Video Production during Science Investigations: …* Chair: J. F. Hung	**M. C. Hsin** *The Investigation of Students' Emotional Engagement in the Inquiry-based Science …* Chair: G. Kidman	**W. C. Feng** *Development of Newton's Laws of Motion: discovery or invention?* Chair: Z. R. Hong	**K. Elliott** *An Investigation of Year 9 students' Engagement or Disengagement …* Chair: K. Y. Yang	**M. W. Hackling** *Laboratory Technicians in Australian Schools: research findings from a national survey* Chair: B. Jane	**J. Robbins** *Children's Scientific and Technological Thinking in Block Play: …* Chair: C. T. Hsiung
2.15pm-2.55pm	**W. P. Palmer** *Robert Williams Wood and the Joy of Physics* Chair: S. Witt	**D. Goodrum** *Evaluating an Innovative Digital Professional Learning Resource* Chair: F. P. Hsieh	**H. Lee** *Indigenous Knowledge and Western Science: a case study of Aboriginal ... Taiwan* Chair: S. Keast	**H. K. Tsai/C. C. Chen** *A Study of the Relationship Between High School Students' Force Diagram …* Chair: L. Danaia	**C. Yuenyong** *Constructing Pedagogical Content Knowledge for Applying Philosophy …* Chair: S. Khansophan	**C. Y. Lin** *Taiwanese Students' Perceived Levels of Understanding and Attitudes Toward …* Chair: J. Bay	**E. Blake** *How Do Children Under 5 Years of Age Develop Scientific Thinking?* Chair: Y. C. Li
3.00pm-3.40pm	**K. Eggington** *Components of Successful Teacher-Scientist Collaborations* Chair: D. Treagust	**M. L. Changlai** *The Effects of Science Problem-based Learning on Attitudes Towards Science …* Chair: D. Palmer	**S. W. Chen/C. H. Ku** *How Do They Think? Exploring Taiwan Aboriginal Students' ...* Chair: G. Hoban	**L. Ladachart** *Physics Teachers' Views of Their Roles Related to Educational Reform …* Chair: M. Logan	**W. S. Nielsen** *Group Work and Metacognition: a case study of Biology students* Chair: L. Darby	**S. Birdsall** *Exploring Students' Attitudes Towards the Use of Animals in Research and Teaching* Chair: L. Chatathicoon	**C. Howitt** *The Collaborative Science Project': planting the seeds of science for early childhood …* Chair: C. Jakab
	3.40pm-4.00pm Afternoon tea, Costa Hall Foyer						
4.00pm-4.40pm	**H. P. Chang/ Y. S. Hsu** *The Study of Learning Outcomes of Innovative Curriculum Materials …* Chair: J. Oversby	**M. W. Hackling** *'Science by Doing' Pilot Program: an innovation in science teacher …* Chair: H. S. Lin	**J. Arnold** *Tension in the Lived Curriculum of One Good Science Teacher* Chair: S. T. Lee	**J. Pranom** *A Case Study of Thai Chemistry Teachers and the Teaching and Learning …* Chair: K. Bingimlas	**C. J. Liu/Y. C. Lin** *Exploring In-service and Novice Elementary Science Teachers' …* Chair: R. Tytler	**J. Ketsing** *Thai Science Teachers' Understanding and Practice of Inquiry-based Instruction* Chair: P. Kurup	**H. P. Chang/C. C. Chen** *Delphi Method Review ：a study of constructing appropriate criterions …* Chair: G. Chittleborough
4.45pm-5.25pm	**Y. S. Hsu** *Implementing Curriculum for Scaffolded Inquiry: examining the effect of scaffolding …* Chair: H. Kanasa	**B. Hanpipat** *Teaching Practices of Thai Geology Teachers in the Upper Secondary School Levels* Chair: Y. W. Lin	**D. Smith** *Citizen Scientist and Scientist Citizen: …* Chair: M. Hanrahan	**A. Hilton** *Enhancing Students' Representational Competence Through Multimodal …* Chair: S. C. Kuo	**R. Cooper** *From Teacher to Teacher Educator: one journey, two people* Chair: P. Hubber	**T. L. Wang** *Association Between Teacher Brain Hemispheric Preference, …* Chair: K. Skamp	**S. T. Lee** *The Investigation of the Progression of Children's Scientific Thinking …* Chair: L. Rennie

Morning, Friday 3rd July 2009

Time	*D2.211*	*D2.212*	*D2.194*	*D4.105*	*D4.107*	*D4.106*	*D4.109*
8.30am-9.10am	**J. Oversby** *History and Philosophy in Science Teaching – an international project* Chair: H. P. Chang	**H. S. Lin** *Using Reflective Practice of Assessment Promote Students' Argumentation and ...* Chair: M. Hackling	**S. T. Lee** *A Comparative Investigation of Students' Reading Comprehension …* Chair: J. Arnold	**K. Bingimlas** *What Science Teachers Do to Develop an Effective … in Saudi Arabia* Chair: J. Pranom	**R. Tytler** *Reasoning Through Representation in Science Classrooms* Chair: Y. C. Lin	**P. Kurup** *Impact of Knowledge Base for Socioscientific Argumentation and Informed Decision …* Chair: J. Ketsing	**C. C. Chen** *A Study of Taiwanese 5th Graders' Changing Understanding of Acids …* Chair: F. Haslam
9.15am-9.55am	**H. Kanasa** *Changes in the Scientific Literacy of Middle Years Students During an Inquiry-Based …* Chair: Y. S. Hsu	**Y. W. Lin** *The Study of Pupils' Discourse Strategies and Roles in Argumentation-Oriented …* Chair: B. Hanpipat	**M. Hanrahan** *Teaching Language and Literacy Skills as they Apply in School Science: …* Chair: D. Smith	**S. C. Kuo** *The Promotion of the Children's Environment Perception and Learning …* Chair: A. Hilton	**P. Hubber** *The Role of Representation in Teaching and Learning Astronomy* Chair: R. Cooper	**K. Skamp** *Beliefs and willingness to act about global warming: …* Chair: T. L. Wang	**L. J. Rennie** *Case Studies from the Scientists in Schools Project* Chair: S. T. Lee
10.00am-10.40am	**R. T. White** *Treasures from the Past* Chair: C. Preston	**S. Dole/G. Hilton** *Initial steps in understanding density: a Year 5 experience* A. Howgrave-Graham	**C. C. Yeh** *The Effects of Science Texts on Students' Reading Comprehension* Chair: P. Fensham	**H. Dhindsa** *Cultural Communication Learning Environment in Science Classes* Chair: L. T. Cheng	**F. Haslam** *Using Representations of the Particulate Nature of Matter ...* Chair: S.S. Lin	**K. Wilson** *Sustainable Science for a Non-Traditional Schooling Context: …* Chair: H. L. Chiu	**G. Venville** *Curriculum Integration: challenging the assumption of school science …* Chair: H. Y. Hsieh
	10.40am11.10am Morning tea, Costa Hall Foyer						
11.10am-11.50am	**C. Preston** *Categorising Children's Responses to Science Diagrams* Chair: C. Malila	**A. Howgrave-Graham** *Transition from Traditional Lecturing to Problem-based and Case-based Learning …* Chair: K. Tobin	**P. J. Fensham** *Assessment of Context-based Science* Chair: R. Tytler	**L. T. Cheng** *Teaching Beliefs of Scientific Creativity and Creative Teaching Practices* Chair: V. Prain	**S. S. Lin** *The Non-science Majors' Critical Thinking in Scientific News about Socioscientific …* Chair: C. C. Chen	**I. J. Chiang/H. L. Chiu** *The Gender Difference in Student-Generated Analogy* Chair: D. Corrigan	**H. Y. Hsieh** *The Effects of a Nature of Science-Explicit Professional Development Program …* Chair: L. Darby
11.55am-12.35pm	**C. K. Chang** *Exploring Students' Views of Nature of Models and Modeling Ability in …* Chair: R. Gounder	**K. Gooding** *The Development of PCK in Early Career Science Teachers* Chair: M. L. Wen	**J. Smith** *Between Literature and Method: looking anew at ways to support …* W. Sumranwanich	**P. Mulhall** *The Views about Physics and Learning and Teaching Physics …* Chair: S. M. Rahman	**D. Lloyd/K. Paige** *Citizen Science: engaging primary teachers with science* Chair: L. Chatathicoon	**L. J. Rennie** *Gender in Science Education: two decades on* Chair: P. Cox	**B. France** *Contextualising NOS and NOT Using a Web-based Resource* Chair: S. C. Kuo
12.40pm-1.20pm	**Y. C. Cheng** *Using Learning Community to Improve Science Teachers' Teaching with Analogies* Chair: P. Leurgam	**W. G. Yang** *The Effects of Text-Reediting and Science Language Teaching on Seventh Graders' …* Chair: J. F. Hung	**K. Doyle** *Science Empowerment Through Science Language Development in Early …* Chair: A. Ohle	**P. Cox** *MSTIE (Multidisiplinary Science Teaching Integrated Experience) a Novel …* Chair: R. M. Roslan	**L. Tomas** *Writing Stories About a Socioscientic Issue: developing students' conceptual ...* Chair: A. Alsulaimani	**J. Crowley** *Persistent Student Difficulties in Understanding the Particulate Nature of …* Chair: R. Fawns	**H. Ma** *Chinese Teachers' Perceptions of the General Role of Culture in the Development of Science* Chair: D. Treagust
	1.20pm-2.10pm Lunch, Costa Hall Foyer						

Afternoon, Friday 3rd July 2009

Time	*D2.211*	*D2.212*	*D2.194*	*D4.105*	*D4.107*	*D4.106*	*D4.109*
2.10pm-2.50pm	**C. Malila** *Grade 11 Student's Scientific Concepts and Decision Making Ability about Acid-Bases …* Chair: R. T. White	**K. Tobin** *Improving the Quality of Teaching and Learning Science in Urban High Schools …* Chair: G. Hilton	**V. Dawson** *A Case Study of the Development of Argumentation Skills by Year 9 Students* Chair: C. C. Yeh	**V. Prain** *Theorizing Effective Formative Assessment of Learning in Junior Secondary Science* Chair: H. Dhindsa	**C. C. Chen** *The Effects of Analogical Animation on the 6th Grade Students' Learning of the Conceptions of Particles* Chair: F. Haslam	**D. Corrigan** *Change in Course, Review of Practice: teacher educators review their teaching* Chair: K. Wislon	**L. Darby** *Mathematics, Science and Technology, and the Establishment of Connection Through Narrative* Chair: G. Venville
2.55pm-3.35pm	**R. Gounder** *Challanges of Linking Theory and Practical Work During Studies of Redox Chemistry* Chair: C. K. Chang	**M. L. Wen** *Development of a Learning Interest of Science Writing Questionnaire* Chair: K. Gooding	**W. Sumranwanich** *The Study of Science Education Undergraduate Students' Understanding about Nature of Science through Inquiry Cycle (5Es)* Chair: J. Smith	**S. M. Rahman** *Current Status of Science Teaching at Junior Secondary Level In Bangladesh -Towards Developing Professional Learning …* Chair: Y. Zeegers	**L. Chatathicoon** *Developing Internet Based Science Instructional Model in the Thai Context* Chair: K. Paige	**P. Cox** *Students - Not in Science lectures, Not Online! Why Is It So?* Chair: L. Rennie	**S. C. Kuo** *The Promotion of the Children's Environment Perception and Learning Motivation in the Social-interaction Classroom* Chair: B. France
3.40pm-4.20pm	**P. Luergam** *Grade 7 Students' Normative Decision Making in Science Learning about Global Warming …* Chair: Y. C. Cheng	**J. F. Hung** *Investigating the Effects of an Innovative Scientific Curriculum- Does the 'Highscope Program' Really Work in Taiwan?* Chair: W. G. Yang	**A. Ohle** *Teachers' Content Knowledge in Physics Related Science Classes in Primary and Secondary Schools* Chair: K. Doyle	**I. Cheong/R. Roslan** *Professional Development to Promote Understang of Science* Chair: M. Rafter	**A. Alsulaimani** *Science Teachers' ICT skills* Chair: L. Tomas	**R. Fawns** *Developing a Classroom Position: how do student teachers know their lesson plan is working?* Chair: J. Crowley	**D. Treagust** *Approaches for Enhancing Chemistry Teaching and Learning by Emphasising the Macro/Submicro/Symbolic …* Chair: H. Ma
	4.25pm-4.45pm Afternoon tea, Costa Hall Foyer						
	4.25pm-5.30pm ASERA Annual General Meeting: Room D2.194						
	7.00pm11.30pm Dinner, Four Points by Sheraton						

Saturday 4th July 2009

Time	*D2.211*	*D2.212*	*D2.194*	*D2.193*	*D4.107*	*D4.106*	*D4.109*
8.55am-9.35am	**H. E. Fischer** *Video Analysis as a Tool for Understanding Science Instruction* Chair: H. E. Chu	**A. Jones** *Expanding the Context for Student Learning of Science: the conceptual development of the New Zealand science learning ...* Chair: T. H. Jen	**A. Hassan** *Value Practices on Informal Environmental Education Among Adults in Sabah, Malaysia* Chair: E. Settelmaier	**H. S. Dhindsa** *What Intrinsic Factors Teachers Feel Important in Affecting Motivation to Teach Science* Chair: P. C. Kuo	**H. H. Chen** *Effects of an Argumentation-Embedded Inquiry Workshop on Secondary Science Teachers' Understandings …* Chair: L. Boonprasert	**C. T. Hsiung** *Using PODE Strategy to Enhance Children's Understanding of "Dissolving"* Chair: B. Lewthwaite	**M. Rafter** *Building a Picture of Teacher Practice Promoting Student Investigations in the Chemistry Classroom* Chair: J. Tapsai
9.40am-10.30am	**A. Fitzgerald** *Through the Viewfinder: reflecting on the collection and analysis of classroom video data* Chair: W. Jobling	**W. Y. Chan** *Investigating High School Students' Mental Model of Nature of Gas Particles and Ideal Gas Law* Chair: H. L. Chiu	**T. L. Lai** *Enacting Inquiry-Based Curriculum: lessons learned from a professional development program* Chair: H. J. Arzi	**C. Campbell** *Improving secondary school students' engagement in science: case studies of doing authentic science in schools from across South East Asia* Chair: C. Campbell	**E. Settelmaier** *Socially Responsible Science as a Step Towards Scientific Literacy: supporting teachers, challenging students* G. Chittleborough	**B. H. Ku** *The Development of a More Comprehensive Scale of Levels of Openness for Inquiry Activities and Its Application on Teaching Practices* Chair: C. F. Tsaur	**T. Wright** *Exploring the Disciplines – Perspectives from Physics, Biology, History and Music in the Classroom* Chair: A. Nisselle
	10.30am-10.50am Morning tea, Costa Hall Foyer						
10.50am-11.30am		**T. H. Jen** *A Secondary Analysis of Taiwanese 8th Graders' Social Relationships in Science Class and Science Achievement* Chair: H. E. Fischer		**P. C. Kuo** *A Comparative Study of Senior and Junior High School Students' Attitudes toward Science and Views of Nature of Science* Chair: A. Hassan	**L. Boonprasert** *Grade 8 students' Capability of Analytical Thinking and Attitude toward Science through Teaching and Learning about Soil and its' Pollution …* Chair: H. S. Dhindsa	**B. Lewthwaite** *Inuit Students Perceptions of Success and Pedagogical and Interactive Processes Influencing Success* Chair: H. H. Chen	**T. Phanusit/J. Tapsai** *Grade 11 Thai Students' Analytical Thinking Processes about Fluid in Science Projects* Chair: C. T. Hsiung
11.35am-12.15pm		**H. L. Chiu** *The Factors of Junior High School Students in Taiwan Taking Science Classes in Cram Schools* Chair: A. Fitzgerald		**W. Jobling** *Promoting Effective Small School Science: maximising students and teacher learning* Chair: T. L. Tai	**H. E. Chu** *Investigation of Students' Conceptual Understanding of Fundamental Thermodynamics Concepts in Everyday Contexts* Chair: C. Campbell	**C. F. Tsaur** *A Development of Inquiry-type Chemistry Laboratory Curriculum* Chair: B. H. Ku	**A. Nisselle** *"Miss, it's cool but I don't understand it!": the challenges of teaching genetics using new technologies* Chair: T. Wright
	12.15pm-1.05pm Lunch, Costa Hall Foyer						
	1.05pm-4.00pm Post-conference Video workshop: Room D2.194						

Programme Abstracts

3.40pm Friday, 3rd July ***Room: D4.105*** ***Chair: L. Thomas***

Science Teachers' ICT skills

Abdulellah Alsulaimani and **Mary Hanrahan**
RMIT University, Australia

The literature suggests that ICT can improve the quality of science teaching in a variety of ways. This paper is part of a larger study titled, "Integration of ICT into science teaching and determination of the professional development needs of Saudi Science Teachers in relation to ICT skills" which aims to investigate the ICT skills of male and female science teachers and to explore their respective strengths and weaknesses in relation to teaching science. We used a questionnaire to collect data and then used descriptive statistics via SPSS software program to analyse 311 science teachers' responses regarding their ICT skills.

To determine the participants' level of ICT skills, their mean ratings were divided into six levels. The results indicated differences between the male and female teachers, and the majority of the participants reported their ICT skills at the lowest three levels: "satisfactory", "poor", and "very poor ICT skills level".

The findings indicate the need for more professional development for science teachers in KSA. They need more training in integrating ICT, so that both male and female science teachers can increase their ICT skills particularly those at the "poor" and "very poor" ICT skill levels. Only then can we expect successful integration of ICT into science teaching.

4.00pm Thursday, 2nd July ***Room: D2.194*** ***Chair: S. T. Lee***

Tension in the Lived Curriculum of One Good Science Teacher

Jenny Arnold
Graduate School of Education, The University of Melbourne, Australia

This paper explores themes emerging in classroom videotapes of a middle years science classroom from a case study of student identity and agency as performatively constituted in and through science educational practices. Science classrooms in action were video recorded as part of the 'Causal Connections in Science Classrooms' project, each for a complete unit of work. The classroom at the focus of this paper completed a unit on 'The States of Matter'. Positioning theory was used to analyse social acts within whole-class conversations. The degree of personal responsibility taken for speech-action was gauged using language use, gestures and pronominal coding. From this analysis, the relative positioning of actors and concurrent, evolving storylines were tracked through the conversations enabling an understanding of the way in which actions were taken up as relatively determinate social acts leading to displays of personal identity of the focus students and the teacher. Normative storylines emerged in the analysis and one of these is illustrated here, highlighting the teacher's practice of teaching-science-as-usual through normative modes of positioning. Conflicting storylines resulting from the teacher's response to student displays of personal interest and knowledge and related student positioning are discussed in light of contemporary approaches to science curriculum and pedagogy.

3.00pm Thursday, 2nd July ***Room: Costa Theatre*** ***Chair: W.Y. Chan***

David P. Ausubel, 1918-2008: reflecting on contributions and unrealized potential of an "old" theory

Hanna J. Arzi
Independent Researcher, Tel Aviv, Israel

David Ausubel died on 7th July 2008 in a small town in the Hudson Valley, upstate New York. With an MD in psychiatry and a PhD in psychology, Ausubel had research careers in both areas until his early retirement from academic life in 1973, whereafter he focused on psychiatry. Ausubel's cognitive theory of meaningful verbal learning, first presented in a monograph, 1963, had significant impact on science education. In hindsight, with constructivism now taken for granted, it is easy to point to flaws in an early theory. When it was published, however, during the heydays of behaviourism, the theory provided a much needed explanatory and predictive frame for the emerging field of science education, subsequently supporting research on student prior knowledge and concept learning, as well as the development of concept mapping. Beyond acknowledging the historical role and past contributions of Ausubel's theory, I posit that its potential has not yet been fully realized. *Advance organizers* have continued to draw attention, even though this is not at the centre of the theory; whereas there has been limited interest in *long-term* concept learning and retention for which Ausubel delineated a guiding frame, including the processes of *progressive differentiation* and *integrative reconciliation.*

11.15am Thursday, 2nd July ***Room: D4.106*** ***Chair: M. Hackling***

Scientists in High School Classrooms via Interactive Television

Jacquie L. Bay, Deborah M. Sloboda, Jo. K Perry, Peter E. Lobie, Helen A. Mora, Robert Hamilton, and Peter D. Gluckman
University of Auckland, New Zealand

"LENScience Connect" uses Information Communication Technologies to provide effective teaching and learning experiences, connecting schools with scientists. Specifically, this project is designed to provide a mechanism by which students from a range of geographic locations can come together as a learning community for education events supporting the development of subject specific concept understanding while simultaneously increasing student awareness of the work of NZ scientists, and the role of science in society. Following a concept trial in 2007 using simple data conferencing technology, a further concept trial using interactive satellite television or multicast technology was launched in 2008. Evaluation of the learning experience within these trials has demonstrated that the programme concept is well received by both students and teachers; that communication of concepts to the student is most effective when pre-seminar readings are written by teachers in consultation with scientists, and seminar presentation is shared by teacher and scientist; that scientists appreciate the opportunity to communicate in this way with secondary students; that satellite television technology with interactivity via wiki, Skype room and telephone bridge provided effective communication for participant schools from a wide range of geographic locations, independent of the level of broadband capability in the school.

8.30am Friday, 3rd July ***Room: D4.105*** ***Chair: J. Pranom***

What Science Teachers Do to Develop an Effective Learning Teaching Environment in Saudi Arabia

Khalid Bingimlas and Mary Hanrahan
RMIT University, Australia

This paper presents my findings relating to science teachers' perspectives about effective learning for teaching science. National Research Council (2000) in the United States provides a framework, based on research findings, for assisting educators and teachers to understand and establish an effective learning environment in the classroom. The framework presents an effective learning environment as having four essential aspects: it should be student-centred, knowledge-centred, assessment-centred and community-centred. A mixed research methodology that combines both quantitative and qualitative data analyses was utilised in this study. Data collection was conducted through both a questionnaire and semi-structured interviews. According to the analysis based on the interview and questionnaire data, the participant teachers did hold some of the principles of an effective learning environment. However, some principles were not reflected in their beliefs and actions. Although the participant teachers were able to articulate the understanding of some principles of the teaching and learning theories such as collaborative learning, problem solving, summative and formative assessment and students' motivation, there was limited evidence that these beliefs and understandings were converted into the design of the science lesson at a primary school level. Some implications of these findings will be presented.

3.00pm Thursday 2nd July ***Room: D4.106*** ***Chair: L. Chatathicoon***

Exploring Students' Attitudes Towards the Use of Animals in Research and Teaching

Sally Birdsall
The University of Auckland, New Zealand

The use of animals in research and testing is governed by specific legislation in New Zealand and scrutinised far more closely by the public than any other uses of animals. Even though there are calls for greater transparency around the process whereby approval is given for animal use, research has shown that the majority of New Zealanders are neither concerned nor interested in the use of animals in research and testing (Williams, Dacre & Elliott, 2007). The Australian and New Zealand Council for the Care of Animals in Research and Teaching (ANZCCART)'s mission includes fostering "informed and responsible discussion and debate" within the wider community around this issue and accordingly, they have commissioned the development of an education resource designed to assist in the formation of individual opinions and clarification of values about such use of animals.

This presentation will show segments of the DVD that illustrate uses of animals in research through interviews with prominent New Zealand scientists and present samples of the activities being developed around the themes of animal use in research and the nature of science. It will also present an outline of the research planned with secondary students around the use of this resource. Feedback about the research design and the resource will be invited.

2.15pm Thursday 2nd July ***Room: D4.109*** ***Chair: Y. C. Li***

How Do Children Under 5 Years of Age Develop Scientific Thinking?

Elaine Blake and **Christine Howitt**
Curtin University of Technology

Although much has been written about improving primary school science and scientific skills for children, not a lot has been done to seek what science actually looks like for children under 5 years of age. There is a common belief among many adults that science concept learning is something to be addressed in the later years of schooling. Thus early childhood educators tend not to emphasise science teaching and learning. Science, however, is a discipline upon which all curriculum learning can begin as young children are innately curious about their world. As a means of capturing the understanding of science by young children, six children in three very different learning centres have been observed to witness their experiences of scientific discovery. These observations and conversations with the children and their teachers are presented and interpreted as a means of understanding young children's thinking in science. Suggestions on how early childhood educators can enhance science learning in early learning centres are discussed.

10.50am Saturday 4th July *Room: D4.107* *Chair: H. S. Dhindsa*

Grade 8 students' Capability of Analytical Thinking and Attitude toward Science through Teaching and Learning about Soil and its' Pollution based on Science Technology and Society (STS) approach

Lapisarin Boonprasert and **Chokchai Yuenyong**
Faculty of Education, Khon Kaen University, Thailand

This study reported Grade 8 students' analytical thinking and attitude toward science in teaching and learning about soil and its' pollution through a science technology and society (STS) approach. The participants were 36 Grade 8 students in Naklang, Nongbualumphu, Thailand. The teaching and learning about soil and its' pollution through STS approach was carried out for six weeks. The unit was developed based on the framework of Yuenyong (2006) that consisted of five stages, including (1) identification of social issues, (2) identification of potential solutions, (3) need for knowledge, (4) decision-making, and (5) socialization stage. Students' analytical thinking and attitude toward science was collected during their learning by participant observation, analytical thinking test, students' tasks, and journal writing. The findings revealed that students were capable of analytical thinking. They could give ideas or demonstrate the characteristics of analytical thinking, such as thinking for classifying, compare and contrast, reasoning, interpreting, collecting data and decision making. Students' journal writing reflected that the STS class of soil and its' pollution motivated students. The paper will discuss implications of these findings for science teaching and learning through STS in Thailand.

9.40am Saturday 4th July *Room: D2.193* *Chair: C. Campbell*

Improving Secondary School Students' Engagement in Science: case studies of doing authentic science in schools from across South East Asia

Coral Campbell and **Damian Blake**
Deakin University, Australia

A report to the Australian Government (Tytler, Symington, Smith & Rogrigues,2008) discussing the Australian School Innovation in Science, Technology and Mathematics (ASISTM) Project highlighted many benefits of community based learning. For example, the report highlighted that students found contextual science learning more meaningful and relevant. By linking science to students' lived experiences, students were more motivated and could understand the need for the science in the community. "The use of real world contexts and stories involving science and technology has been a key to engaging both boys and girls" (Fensham, 2006).
This research examines science education initiatives that have been developed by science teachers in ASEAN countries, Australia and New Zealand as a response to school-age students' declining interests in science education across the region. The initiatives under investigation in this project have an emphasis on the use of authentic and community-based projects to engage students in learning science. Using documented information from the Regional Educational Centre for Science and Mathematics Education (RECSAM) such as student questionnaires, student project submissions and taped interview responses from the main stakeholders, researchers will investigate what underpinning principles and strategies contribute to the successful use of authentic and community-based science education initiatives in different contexts across South East Asia. Finally, the researchers would like to discuss the implications of this research for Australian contexts.

9.40am Saturday 4th July *Room: D2.212* *Chair: H. L. Chiu*

Investigating High School Students' Mental Model of Nature of Gas Particles and Ideal Gas Law

Wan-Yueh Chan and **Mei-Hung Chiu**
Graduate Institute of Science Education, National Taiwan Normal University, Taiwan

This research examined the mental models of ideal gas held by the 10th, 11th, and 12th grade students, and found that students' mental models changed after their learning of the related concepts of ideal gases. The types of main mental models were categorized as scientific, scientific-like, pressure-oriented, partial pressure-oriented, and physical phenomenon-oriented models. There were 76.9% of 12th graders and 69.3% of 11th graders who have learned the ideal gas concepts appeared to hold the scientific, scientific-like, pressure-oriented, and partial pressure-oriented mental models. In other words, even though they held different mental models, they still understood the nature of gas particles at least. However, students who have not learned about the ideal gas concepts appeared to represent their thinking by the "Physical phenomenon-oriented" mental model or "No model" without any internal consistency. The results revealed that (1) students could not deal with all the variables about the ideal gas law at once while solving problems; (2) there were 26.9% of 12th graders and 23.1% of 11th graders who have learned ideal gas concepts could merely solve simple variable problems of ideal gas law; and (3) students' daily life experiences often affected their perspective of gas particle behavior.

11.55am Friday, 3rd July *Room: D2.211* *Chair: R. Gounder*

Exploring Students' Views of Nature of Models and Modeling Ability in Taiwan: the correlation between domain-general and domain-specific contexts

Chih-Kang Chang and **Mei-Hung Chiu**
Graduate Institute of Science Education, National Taiwan Normal University, Taiwan

In science education, "views of nature of models and modeling ability (VNMMA)" is an important discipline for developing scientific theories by scientists as well as for learning scientific concepts by learners. As proposed by Chiu (2008), VNMMA consists of three perspectives, namely, an ontological view, an epistemological view, and a methodological view. This study used the VNMMA instrument of three perspectives to investigate how Taiwanese high school students' views are in response to 4-point Likert scale items related to domain-general and domain-specific contexts. The results revealed that (1) Taiwanese high school students had high scores on VNMMA in these two types of contexts. (2) There was no significant correlation of the students' performance between domain-general and domain-specific contexts. (3) Between these two types of contexts, the junior-high school students had positive correlation, but senior-high school students did not.. As for educational implications, not only did we find students developed good VNMMA, but we also found that students had lower performance on the methodological view than others about scientific models. Therefore, science teachers should take development of this ability into serious consideration in school teaching.

4.00pm Thursday, 2nd July *Room: D2.211* *Chair: J. Oversby*

The Study of Learning Outcomes of Innovative Curriculum Materials to Promote Students' Competency, Confidence, and Cooperation

Huey-Por Chang and **Chin-Chang Chen**
Department of Physics, National Changhua University of Education
Gwo-Jen Guo
Department of Guidance and Counseling, National Changhua University of Education
Wen-Hua Chang and **Ying-Shao Hsu**
Graduate Institute of Science Education, National Taiwan Normal University

The goal of this study was to evaluate the learning effects of two new curricula created to help promote students' 3C literacy defined as inquiry competence, cooperation competence and self-confidence. The samples were two classes in central Taiwan. One in elementary school was administered a new biology curriculum, and another in senior high school was administered a new earth science curriculum. In addition to 3C literacy and domain content, each curriculum had different objectives. The study served as external evaluation to learn if new curriculum could promote students' 3C literacy. A 3C literacy Battery-Competence self reported scale and an open-ended situated questionnaire were administered to students. The data of the prior and post competence, the open-ended questionnaire, and the interview were collected from the experimental group. Data from the control group were also collected to compare with those of experimental group. The result showed that students had a positive attitude toward new curriculum. The data of the open-ended questionnaire revealed that students in the experimental group gained higher competence than those in the control group. However, self-report scale data didn't show a significant difference between the two groups, but the data from experimental group were better than those from control group.

4.00pm Thursday, 2nd July *Room: D4.109* *Chair: G. Chittleborough*

Delphi Method Review：a study of constructing appropriate criterions on competence in learning science scale for primary and middle school students

Huey-Por Chang and **Chin-Chang Chen**
Department of Physics, National Changhua University of Education
Gwo-Jen Guo
Department of Guidance and Counselling, National Changhua University of Education
I-Chen Chien and **Chi-He, Su**
Graduate Institute of Guidance and Counselling, National Changhua University of Education

In order to trigger an effective improvement in Taiwanese students' competence, a 3C Curriculum Block Integrated Plan was drawn to develop new science curricula from different aspects. It was designed in hopes of effectively enhancing students' 3C literacy including three scales such as Competence in Learning Science, Cooperation in Learning Science, and Self-confidence in Learning Science. This study is namely aimed to construct the appropriate criterions of "Competence in Learning Science scale" for primary and middle school students. There are measuring tools developed through Delphi method to assess the effectiveness of the 3C curriculum in improving students' 3C literacy. Five science education experts participated in the two-round Delphi study with the response rates of 80% and 100%, respectively. The finding showed that the experts believed "Competence in Learning Science scale" should contain "Competence in Communication" and "Competence in Scientific Inquiry". In the Competence in Communication, seven indices such as expression, listening, negotiation, asking, assessment, answering, and none-verbal messages should be comprised. In addition, five indices such as questioning, data collecting, science attitude, analyze alternative explanation, and analyze alternative explanations should be also included in Competence in Scientific Inquiry.

3.00pm Thursday, 2nd July ***Room: D2.212*** ***Chair: D. Palmer***

The Effects of Science Problem-based Learning on Attitudes towards Science and Science Learning Achievement for Elementary Students

Miao-Li Changlai
General Education Center, China University of Technology
Kun-Yuan Yang
Graduate School of Education and Center for Teacher Education, Chung Yuan Christian University

The purposes of this study were to develop and implement the science problem-based learning model for elementary students in Taiwan and to explore the effects of science problem-based learning on fifth graders' attitudes towards science and science learning achievement. Thirty-two students of the experimental group by problem-based learning and thirty-one students of the control group by conventional teaching participated in the study for twelve weeks. Attitudes Toward Science Scale (ATSS) and Science Achievement Test (SAT) were given to the subjects as pre-test and post-test to examine the effects between the two groups. The results of the study showed that students' post-test scores of ATSS, Attitudes toward Learning Science, Attitudes toward Participating in Science Activities and Inquiry, Attitudes toward Scientists and Career Related to Science, and SAT were significantly better than their pre-test scores through science PBL. The effects of ATSS, three subscales and SAT between PBL and conventional teaching were not significantly different. But the effect of Attitudes toward Learning Science by PBL was significantly better than that by conventional teaching.

2.55pm Friday 3rd July ***Room: D4.107*** ***Chair: K. Paige***

Developing Internet-Based Science Instructional Model in the Thai Context

Leang Chatathicoon and **Sudthiporn Chatathicoon**
Faculty of Education , Khon Kaen University, Thailand

The study aimed to develop an internet based science instructional model in the Thai context. The participating teachers were science teachers who teach in Muang, Khon Kaen, Thailand, in the 2006 academic year. The research method included (1) studying the current states and conditions of internet based science instruction, (2) developing a model of the internet based science instruction, and (3) evaluating teaching and learning through use of the model of the internet based science instruction. The results were as follows:

1. The current states and conditions of internet based science instruction were moderation of readiness for internet infrastructure, curriculum administration, personnel resources, and internet use in school.
2. Internet based science instructional model consists of 5 stages including analyzing, planning, practicing, elaboration, evaluation stage.
3. Evaluation for teaching and learning through using the model of the internet based science instruction showed that all stages have high level of need for the model. The learning outcomes revealed that learning achievement was significantly (0.05 higher) post rather than pre-intervention.

8.30am Friday, 3rd July ***Room: D4.109*** ***Chair: F. Haslam***

A Study of Taiwanese 5th Graders' Changing Understanding of Acids and Bases

Ching-Chi Chen and **Chi-Ling Wu**
Department of Natural Science Education, National Taipei University of Education

The purpose of this study was to investigate the changes in elementary students' understanding of acids and bases. A pre-post test design was used to investigate the changes. The participants included 139 fifth-grade elementary school students in Taiwan. There were three data sources: a paper and pencil test, a structured interview, and a concept mapping activity. The paper and pencil test and student concept maps were scored and rated with researcher-developed rubric and qualitative methods including triangulation as well as coding were used to analyze the interview data. Results could support the following research claims: (a) prior to any instruction, students had only a vague knowledge of the vocabulary of acid, base and neutral aqueous solution and little or no understanding of the concepts; (b) following the instruction, most (62.59%) students could distinguish acids from bases in aqueous solution using an acid and base indicator and showed evidence of newly constructed conceptual frameworks of the acid base concepts. Specifically, students' post-instruction concept maps contained many new conceptual terms and more complex branching. These results suggest that 5th grade students are capable of developing a basic understanding of acids and bases when challenged to organize and discuss their changing conceptual frameworks.

2.10pm Friday 3rd July ***Room: D4.107*** ***Chair: F. Haslam***

The Effects of Analogical Animation on the 6th Grade Students' Learning of the Conceptions of Particles

Chun-Cheng Chen , Houn-Lin Chiu and **Chia-Ju Liu**
Graduate Institute of Science Education, National Kaohsiung Normal University, Taiwan

An analogical animation about solutions was developed and used in teaching the process of dissolution in 6th grade in this research. The purpose of this research is to investigate the effects of the analogical animation on the construction of the conception of particles and the transformation of knowledge.

The findings are that the explanations of the phenomenon of dissolution by macro perspective and the misconceptions held by students are similar to previous research. The misconceptions come from life experience and the lack of the concept of particles in microscopical level.

The students in the animation group performed better than traditional analogical teaching group. The students could transfer the concept of a particle to the composition of substances and the concept of acid-base neutralization.

8.55am Saturday 4th July ***Room: D4.107*** ***Chair: L. Boonprasert***

Effects of an Argumentation-Embedded Inquiry Workshop on Secondary Science Teachers' Understandings of Scientific Argumentation and Argumentation Instruction

H. H. Chen and **W. H. Chang**
Department of Life Science, National Taiwan Normal University
M. L. L, H. C. She and **C. Y. Wang**
Institute of Education, National Chiao Tung University

This study aimed to promote in-service secondary science teachers' understandings of scientific argumentation and argumentation instruction through a two-and-one-half day workshop in which the learning of argumentation and argumentation instruction is embedded in inquiry-oriented activities. Seventeen science teachers with 1-15 years of teaching experiences volunteered to participate. Four validated questionnaires were applied to explore the teachers' beliefs in constructivist teaching orientation, understandings of argumentation and argumentation instruction, as well as their concerns of argumentation instruction before and after the workshop. The workshop was video-taped with five camcorders recording the instructors and each group of teachers. A Wilcoxon signed rank test in non-parametric statistics method on the questionnaires indicated a significant increase of understandings of argumentation ($p < .05$) and argumentation instruction ($p < .05$) for all teachers. Cross compared with videotapes, we found that teachers who interacted with others frequently and built complete Toulmin's Argumentation Pattern in activities got better understandings of argument elements and science concepts. Teachers with high concern about argumentation instruction orientation were better in identifying key features in argumentation instruction after the workshop. The teachers, particularly novice teachers, viewed practicing argumentation instruction as challenging while considering changing current classroom context.

3.00pm Thursday 2nd July ***Room: 2.194*** ***Chair: G. Hoban***

How Do They Think? Exploring Taiwan Aboriginal Students' Self-Efficacy and Attributions in Science Learning

Shih-Wen Chen
Chung-Zhen Primary School, Hualien, Taiwan
Chih-Hsiung Ku
Dong-Hwa University, Hualien, Taiwan

Aboriginal students' science learning is the prevailing research issue in Taiwan. However, a lack cognition and understanding of population for aboriginal culture results in the stereotype that the appropriate domains for aboriginal students to learn are only athletics and art rather than science. This social discrimination might affect their self-efficacy and attributions in science learning. Therefore, this study investigated the aboriginal students' self-efficacy and attributions in science learning which based on Bandura's self-efficacy and Weiner's attribution theory to explore how aboriginal students treated their science achievements. Eighty-three 6th grade aboriginal students were answered the questionnaires of SESL and ASL which developed for inspecting their self-efficacy and attributions respectively. Moreover, 92 sixth general students were also participated in this study as the comparison group. The results revealed the self-efficacy of aboriginal students was not significantly lower than that of general students. However, the aboriginal students regarded "*luck*" as the successful achievement attribution and "*less ability*" for the failure, which differed from the situation that the general students claimed their "*competence*" for the success and "*subject difficulty*" or "*less effort*" for the failure. Finally, this study provided some implications for rethinking aboriginal students' self-efficacy and attributions and improving their science learning.

11.10am Friday, 3rd July ***Room: D4.105*** ***Chair: V. Prain***

Teaching Beliefs of Scientific Creativity and Creative Teaching Practices

Li-Ting Cheng and **Jeng-Fung Hung**
Graduate Institute of Science Education, National Kaohsiung Normal University, Taiwan
Shiang-Yao Liu
Graduate Institute of Environmental Education, National Kaohsiung Normal University, Taiwan

The purpose of this study was to examine science teachers' beliefs on teaching about scientific creativity and their teaching orientations. Both quantitative and qualitative data were collected to explore the relationship between teaching belief and teaching practice. A questionnaire was administered to 346 in-service elementary and secondary science teachers for assessing their science teaching efficacy belief, expectancy of scientific creativity teaching outcome, and perceptions of creative science teaching practice. In addition, teacher's preferences of teacher-centered and learner-centered approaches to teaching scientific creativity were investigated. Results of this research showed a medium level of consistence between teachers' beliefs and their creative teaching practices. In-depth interviews were conducted with 18 teachers who had designed exemplary creative teaching activities to further explore their perspectives on creative science teaching and ideas of "scientific creativity". The interviewed teachers expressed high level of self efficacy on their science teaching. Almost all teachers believed that creative science teaching can induce students' creativity; however, none of them include creative ability into their instructional goal or assessment. This study suggests that more focus should be laid on teachers' evaluation on students' performance of scientific creativity.

12.40am Friday, 3rd July ***Room: D2.211*** ***Chair: P. Leurgam***

Using Learning Community to Improve Science Teachers' Teaching with Analogies

Ying-Chuan Cheng, Houn-Lin Chiu and **Chia-Ju Liu**
Graduate Institute of Science Education, National Kaohsiung Normal University, Taiwan

Analogies are very useful for promoting students' construction of knowledge. This research aims to investigate how science teachers in junior high school use analogy in their teaching through classroom observation and learning community discussion. Another goal of this research is to improve the teachers' using of analogy in their teaching by teachers' sharing professional knowledge and the ways they adopt to apply analogy teaching in the classroom. The learning community was composed of three physics teachers, three chemistry teachers and a Chinese-literature teacher. Six discussion sections were held. During these sections, the teachers shared their experiences of applying analogy teaching. Moreover, the in-classroom observations were conducted on three teachers and then these three teachers share their reflection on their teaching with their peers. The ways of the teachers using analogies in their teaching and the improving of their teaching with analogies will be discussed.

3.40pm Friday 3rd July ***Room: D4.105*** ***Chair: M. Rafter***

Professional Development to Promote Understanding of Science

Irene Poh-Ai Cheong, Hjh Sallimah Hj Mohd Salleh, Roslinawati Muhd Roslan and **Iohermen Kyeleve**
Universiti Brunei Darussalam, Brunei

With the newer educational demands, assessment of students' attainment are to be made more valid, particularly through continuous school-based assessment with intervention strategies used to promote better understanding in students. A professional development (PD) programme was piloted with one secondary school to: (1) diagnose students' science achievement through valid and reliable assessment; (2) promote and practice teaching and learning strategies that are appropriate in order to promote better understanding of science for all students; (3) peer coach the head of science department to guide science teachers in promoting understanding of science concepts with their students. Data from the PD of four teachers with the head of science department were collected from lesson plans, lesson observed as well as videotaped lessons and meetings. Analyses of the qualitative data involved identifying patterns of teaching and learning elements and comparing lessons before and after one peer coaching cycle with each teacher aside from other related factors. Quantitative data were statistically analysed for students' achievements before and after the lessons. Results of the pilot study provided lessons learnt for further refinement of the model for the professional development of the science teachers and peer coaching of head of science department used.

11.10am Friday, 3rd July ***Room: D4.106*** ***Chair: D. Corrigan***

The Gender Difference in Student-Generated Analogy

I- Ju Chiang, Houn-Lin Chiu, and **Chia-Ju Liu**
Graduate Institute of Science Education, National Kaohsiung Normal University, Taiwan

The purpose of this study was to investigate the gender's difference on students learning science concepts through self-generated analogies. One hundred and twenty-two 7th grade students (N=122, boys=60, girls=62) participated in this study. The achievement test of Photosynthesis concept and the questionnaire about the process of self-generated analogies were developed in this study. The results showed that the types of self-generated analogies were different in different gender. For the analogical reasoning, the boys preferred to use procedural retrieval and the girls preferred to use declarative retrieval. Besides, the boys tended to search for the analogies with daily life experience, but girls search the analogies from the background knowledge. At last, boys would compare the characteristics of analogies with target concepts, but girls always mentioned the analogies that teachers taught previously. Based on the interview, the boys like to create new analogies and the girls tend to produce the analogies from their learning experience.

11.35am Saturday 4th July *Room: D2.212* *Chair: A. Fitzgerald*

The Factors of Junior High School Students in Taiwan Taking Science Classes in Cram Schools

Houn-Lin Chiu, Chia-Ju Liu, Hsin-Yi Chiu and **Chin-Fei Huang**
Graduate Institute of Science Education, National Kaohsiung Normal University, Taiwan

This research was to explore the reasons which cause high school students attending cram schools to take science classes in Taiwan. The participants are eighty-one eighth and ninth grade students. The instrument in this study was the questionnaire of learning attitude toward science curriculum. There are four items in this questionnaire which includes "the attitudes toward science curriculum", "the attitudes toward science teachers", "the motivations of learning science" and "the strategies using in learning science". The in-depth interview was conducted following the questionnaire. It's found that the students' attitude toward science teachers between cram school and normal school had significant differences. The interview showed that students believed their science content knowledge learned from cram schools is more useful in examinations. However, students cared about the grades in schools more than in cram schools. The most important thing is that many students considered that cram schools could help them learn science concepts more efficiently.

11.35am Saturday 4th July *Room: D4.107* *Chair: C. Campbell*

Investigation of Students' Conceptual Understanding of Fundamental Thermodynamics Concepts in Everyday Contexts

Hye-Eun Chu
Nanyang Technological University, Singapore
David F Treagust and A.L. Chandrasegaran
Curtin University of Technology, Australia

Students' conceptual understanding of fundamental thermodynamics concepts about heat, temperature, heat transfer, and heat conduction was investigated using 19 multiple-choice items that required free-response justifications for students' choice of responses. The multiple-choice items were developed based on a previously-developed questionnaire and from students' alternative conceptions derived from the research literature. The items were administered to140 Year 12 Korean students who had completed studying heat and temperature concepts. Five students from five classes were interviewed in order to obtain additional information about their conceptual understanding and to explore the reasons why students could not apply the scientific concepts in everyday life contexts. Analysis of students' responses revealed that 30-60% of students had difficulties in applying thermal concepts in everyday contexts. In addition, 20-25% of students had difficulties in understanding the differences between heat and temperature concepts while 40% of students could not apply the thermal equilibrium concepts when explaining everyday phenomena.

4.45pm Thursday 2nd July *Room: 4.107* *Chair: P. Hubber*

From Teacher to Teacher Educator: one journey, two people

Rebecca Cooper and **Stephen Keast**
Centre for Science, Maths and Technology Education, Monash University, Victoria, Australia

This paper considers the learning that takes place as one of us makes the transition from teacher to teacher educator. Often highly accomplished, experienced teachers who make this transition are expected to do so with little explanation. Ideas surrounding the different role of a teacher educator compared to teacher, the pedagogy of teacher education or any formal preparation to teach in the teacher education course need explanation if this process is to be as smooth as possible. The paper will explore a co-teaching experience between an experienced teacher educator and a person new to the role where they were able to plan the lessons together, view each others teaching, maintain a journal and also discuss the shared experience in between lessons. The discussions in particular raised questions for the experienced teacher educator that caused them to question their practice and helped them to gain a clearer understanding of the depth of knowledge they held about teacher education. For the new teacher educator, it was an opportunity to be guided into a new but related profession, to consider what it means to be a teacher educator and to think about the difference between teaching and teacher education.

2.10pm Friday 3rd July ***Room: D4.106*** ***Chair: K. Wilson***

Change in Course, Review of Practice: teacher educators review their teaching

Deborah Corrigan, Rebecca Cooper and **Stephen Keast**
Centre for Science, Maths and Technology Education, Monash University, Victoria, Australia

The structure of the Science Education course was changed at Monash University in 2008. The Science Education team at Monash took this opportunity to research their practice and the pedagogical purposes that underpinned that practice. They adopted a collaborative approach to a new Science Education unit, by planning together, observers visiting sessions, and interviewing preservice teachers and lecturers to gain their feedback on the unit. The lecturers wanted to investigate ways they use frames to explain their understanding of teaching and how these frames can act as guides for preservice teachers to better understand and develop their pedagogy. In completing this research the lecturers have come to understand the differences between each others' pedagogical purposes for their teaching. The program allowed the students to benefit from the teaching orientations of each lecturer in order to reach a common goal for this course that has been outlined based on the frames utilised. This paper will explore how the changes made have impacted on the preservice teachers in the course and how it has helped the lecturers to better understand the way they function as a team.

12.40pm Friday, 3rd July ***Room: D4.105*** ***Chair: R. M. Roslan***

MSTIE (Multidisiplinary Science Teaching Integrated Experience) a Novel Approach Linking Science Units and the Practicum

Peter Cox and **Premnadh Kurup**
La Trobe University, Victoria, Australia

There is growing international recognition of the value of students experiencing a connected curriculum. Our paper reports on a project that sought to address this possibility for preservice primary students as well as their students on practicum. The MSTIE project is embedded within the third-year science curriculum subject and entailed teams of two students developing an integrated unit of work based on the 5E model. This unit was then team-taught by the students during their practicum. The integrated unit was modelled on the VELS curriculum and integrated subjects such as Mathematics, English, Technology, ICT, SOSE. The assessment of the MSTIE project had three key parts; developing an integrated science unit, teaching the unit, and reflecting on the unit. Further, the project provided a real world context with multiple levels of on-going feedback. This feedback occurred from the classroom teacher and university staff during the writing of the unit, feedback from primary students and teachers during the practicum, feedback from peers during forum presentations, and finally from the university lecturers from their assessment of the assignment. This project has enhanced students' confidence, competence and skills in teaching science and has become a "capstone" experience in their Bachelor of Education course.

2.55pm Friday 3rd July ***Room: D4.106*** ***Chair: L. Rennie***

Students - Not in Science lectures, Not Online! Why Is It So?

Peter Cox and **Premnadh Kurup**
La Trobe University, Victoria, Australia

We noticed a steep decline in lecture attendance after implementing Lectopia (an on-line audio and visual recording of lectures) in *Integrated Science Learning* - a third year BEd unit. This unit provided all aspects of the lecture on-line via LMS (Learning Management System) including Lectopia recordings. We became concerned when we discovered that the Lectopia usage statistics did not match with the declining lecture attendance. Hence it was decided to survey the cohort of students to ascertain how they obtained the material covered in lectures. Over the last three years we have made our lectures more interactive and engaging. We also have a continuum in the unit from what is covered in the lecture to the practical sessions and on-line activities. Despite interactive and engaging lectures and the availability of these on-line, it was found that there was a failure from the majority of students to use either of these alternatives. The majority of students were found to opt for the easiest option (downloading notes) and this is a serious concern. The results and implications from the survey will be shared and discussed in an interactive presentation.

12.40pm Friday, 3rd July *Room: D4.106* *Chair: R. Fawns*

Persistent Student Difficulties in Understanding the Particulate Nature of Matter: is it inevitable that the findings of research do not impinge on practice?

Julianne Crowley, David F. Treagust and **A.L. Chandrasegaren**
Science and Mathematics Education Centre, Curtin University of Technology, Australia
Mauro Mocerino
Department of Applied Chemistry, Curtin University of Technology, Australia

In chemistry, the idea that matter is composed of small, discrete, invisible particles is a fundamental concept. However, students traditionally find the particulate nature of matter very difficult to visualise and mentally manipulate. Consequently, there is a wide gap between what scientific understanding is expected/desired and what learners do understand about this concept.

The results of a two-tier diagnostic multiple-choice instrument designed to evaluate understanding of particle theory of matter demonstrated the persistence of many alternative conceptions across year levels. The instrument was administered to four groups of students enrolled in Year 9 and Year 11 chemistry, a university bridging chemistry course and a preservice science teachers course. A similar pattern of understanding across all groups was evident. One conclusion is that despite these alternate conceptions being well-documented and teaching techniques being available to challenge students' thinking, they continue to be evident in a new generation of students, some of whom will be teachers of a new generation of science students. This raises the critical question: Is it inevitable that the findings of research in chemistry education fail to impact on practice?

The research is part of a larger project funded by an ARC grant. The aims of the project are to improve the quality of student and teacher scientific explanations by working with teachers to increase their students' metacognitive capabilities and awareness of student explanatory frameworks.

11.15am Thursday, 2nd July *Room: D4.105* *Chair: C. C. Chen*

Changes in Students' Perceptions of Junior Secondary Science: an intervention using a remote-controlled telescope

Lena Danaia and **David H. McKinnon**
Charles Sturt University, Queensland, Australia

This paper investigates changes in students' perceptions of junior secondary science after their involvement in an educational programme using a remote-controlled telescope over the Internet. The 2016 participants were drawn from junior secondary science classes in four Australian jurisdictions. Questionnaire data were collected on two occasions to elicit information about the science students experienced in junior secondary school both before and during the programme. Interviews were also held with a sample of participants to gain further insight into their experiences in science. Pre-occasion results show that many students seemed to be disengaged by the teacher-directed pedagogies employed. Many perceived there to be a high incidence of copying notes, few opportunities to investigate interesting topics and indicated that they were rarely excited about the science they were doing. Comparisons of the pre- and post-occasion responses showed that there were highly significant increases in the incidence of using technology, fewer teacher-directed experiments and marked changes in the teachers' role. Interview data highlighted commonalities across groups yet portrayed distinct features unique to each school that were associated with the implementation of the programme. The way science is implemented by teachers is crucial to the success of students' experiences in the subject at school.

2.10pm Friday 3rd July *Room: D4.109* *Chair: G. Venville*

Mathematics, Science and Technology, and the Establishment of Connection Through Narrative

Linda Darby
RMIT University, Australia
Rob Davis
University of Ballarat, Australia

Science, mathematics and technology education are experiencing difficulties in their implementation in schools around Australia, and internationally. This is evidenced by falling enrolments in post-compulsory science and mathematics, and student disenchantment with curricula that they often consider to be irrelevant. In addition, technology education has important issues relating to subject identification and meaning that are hampering its effective implementation. This paper involves a synthesis of findings from previous research that demonstrates a convergence of proposed models of practice emphasizing the role of narrative in learning in science and mathematics education (first author) and technology education (second author). While the research programs and development of findings were carried out independently, this paper proposes a synthesis of ideas that were central to the three discipline areas. Common to both of these research programs is the sense of connection that was essential to students' (and teachers') understanding in science, mathematics and technology education. Narrative establishes and maintains this connectedness in all of the subject areas: mathematics and science emphasise reconnection; in technology, maintenance of connection is emphasised. These findings suggest a revised approach to teaching and learning in these KLAs that embraces more humanising curricula and pedagogy in order to address student disengagement.

12 Noon Thursday, 2nd July *Room: D4.107* *Chair: W. Nielsen*

Making Science and Mathematics Relevant: the complexity and subject-specificity of a "relevance imperative"

Linda Darby
RMIT University, Australia

In recent years, there has been a push to reframe curriculum and pedagogy in order to make school more meaningful and relevant to students' lives and perceived needs. This "relevance imperative" is prevalent in contemporary rhetoric surrounding quality education, and particularly in relation to the junior secondary years where student disengagement is escalating. This paper explores how teachers translate this imperative into their teaching of mathematics and science. Interview data and critical incidents from classroom practice are used to explore how six teachers attempted to make the subject matter meaningful for their students. Four "Categories of Meaning-Making" emerged, highlighting key differences in how the nature of the science and mathematics content matter constrained and enabled linkages between content and students' lifeworlds. The teachers' views are then contexualised within the aims and goals for science education in current curriculum documents and in the broader science and mathematics education literature. While the teachers' perceptions and desires demonstrated a commitment to humanising the subject at some level, this analysis has shown that expecting teachers to make the curriculum relevant is not unproblematic because the meaning of relevance is complex, subject-specific, and dependent on the teacher understanding the human dimensions of learning, using, and identifying with, the subject.

2.10pm Friday 3rd July *Room: D2.194* *Chair: C. C. Yeh*

A Case Study of the Development of Argumentation Skills by Year 9 Students

Vaille Dawson
Curtin University of Technology, Western Australia
Grady Venville
University of Western Australia

The ability to justify and defend a decision using a rational, scientific and well constructed argument is an important aspect of scientific literacy. Students need to develop the skills to participate in reasoned debate and to make informed personal choices about socioscientific issues. At ASERA in 2008, we presented a case study of a teacher who, after a brief professional learning session, taught argumentation skills to his year 10 students as part of a 10 week genetics unit. It was found that his students performed significantly better on a test of genetics knowledge and argumentation about a socioscientific issue than a comparison group that was not taught argumentation. The same research design was implemented with a second teacher and her class of year 9 students. Despite some differences between the teachers (e.g., experience) and students (e.g., ability) in the two cases, her students also demonstrated a significantly greater improvement in argumentation skills when compared to a comparison group. There was no difference in the degree of improvement in genetics knowledge. It was found that explicit modelling of argumentation skills, the use of writing frames, and encouragement of expression of ideas contributed to the improvement in students' argumentation skills.

8.55am Saturday 4th July *Room: D2.193* *Chair: E. P. C. Kuo*

What Intrinsic Factors Teachers Feel Important in Affecting Motivation to Teach Science

Harkirat S. Dhindsa and **Mahani-Abdul-Rashid**
Universiti Brunei Darusslam, Brunei

The study aimed to investigate the intrinsic factors science teachers perceive important for motivating them to teach and how their perceptions are affected by their gender, marital status, nationality (Bruneian/expatriates), grade level taught, teaching experiences and geographical location of work place. The sample for the study consisted of 351 (109 male and 242 female) science teachers. Five percent of sample teachers were interviewed. A new instrument consisting of 27 items covering three scales (enjoyment, satisfaction and self-actualization) was developed. The factor analysis, discriminant validity, alpha reliability and eta^2 analysis supported that the 24 item intrinsic motivation instrument was valid and reliable. All the teachers considered the intrinsic variables to be "important" and "very important". They perceived enjoyment as the most important factor affecting their motivation to teach science. During interview the majority of teachers ranked enjoyment as one of the three most important factors influencing motivation to teach. The female teachers regarded enjoyment and satisfaction factors as more important factors affecting motivation to teach science than the male teachers. The teachers teaching only at one level (lower or upper secondary) perceived enjoyment variables as more important than those teachers who teach at both lower and upper secondary levels. The teachers' perceptions of importance the intrinsic variables were not affected by marital status, nationality, grade levels taught and geographical location of their workplace. Implications and suggestions are also discussed.

10.00am Friday, 3rd July ***Room: D4.105*** ***Chair: L. T. Cheng***

Cultural Communication Learning Environment in Science Classes

Harkirat S. Dhindsa and **Salwana-Abdul-Latif**
University Brunei Darussalam, Brunei

Communication is a cultural dimension and classroom communication often involves interactions of students and teachers from dissimilar cultures, which influence classroom learning because of their dissimilar cultural communication styles. It is therefore important to study the elements of cultural communication that influence the classroom verbal and nonverbal interactions. The purpose of this study was to develop and validate an instrument to assess students' classroom communication learning environment. The instrument developed consisted of 8 scales: *Body Gestures, Communication Rate*, *Communication Loudness, Eye Contact, English Usage, Verbal Support, Intra-gender Communication* and *Inter-gender Communication*. The instrument was administered to 1723 upper secondary Biology students in Brunei government schools. The alpha reliability (0.58-0.91) and discrimination validity (0.08-0.13) coefficients for these scales were within acceptable range. The statistically significant Eta^2 coefficients data suggested that the instrument was able to differentiate between participating Biology classes. The students perceived to receive low level verbal support and sometimes higher teacher communication rate in their classes. Dialects other than English (the medium of instruction) have been used in Biology classes to some extent. There is a strong tendency for intra-gender than inter-gender communications in classes which could limit the effectiveness of teaching and learning in constructivist classes.

10.00am Friday, 3rd July ***Room: D2.212*** ***Chair: A. Howgrave-Graham***

Initial steps in understanding density: a Year 5 experience

Shelley Dole, Tony Wright and **Geoff Hilton**
The University of Queensland, Australia
Doug Clarke
Australian Catholic University, Australia

In the primary classroom, students often are provided with opportunities to investigate sinking and floating. Such activities provide hands-on experiences where students can wonder, question, and conjecture about properties of objects. This is also a way for laying the foundation for building students' understanding of the concept of density. The literature repeatedly states that promoting students' understanding of density has a long and problematic history (Hitt, 2005; Libarkin, Crockett & Sadler, 2003; Maclin, Grosslight & Davis, 1997). This is acknowledged partly because understanding density requires a measure of proportional reasoning (e.g., Singer, Kohn & Resnick, 1997). Further, as highlighted by Nunes, Desli and Bell (2003), density is an intensive quantity that involves "one extensive quantity that is directly proportional to the intensive quantity and a second one that is inversely proportional to it" (p. 662). Essentially, density is the relationship between an object's mass and volume. In this study, a unit of work on density was trialled in a Year 5 classroom. It took students from exploring sinking and floating to predicting whether objects would sink or float by analysing mass and volume. This experience enabled students to sensibly use language associated with density. Their naïve conceptions of sinking/floating in relation to considering only mass were challenged.

12.40pm Friday, 3rd July ***Room: D2.194*** ***Chair: A. Ohle***

Science Empowerment Through Science Language Development in Early Childhood

Katherine Doyle
Queensland University of Technology, Australia

Science language acquisition is an integral tool for empowering modern-world citizens. Research indicates that development of science language skills enables critical thinking skills and the ability to represent ideas. This proposition invited further case-study investigation into early science language development. Young children's oral and representation language exhibited during the exploration of scientific phenomena was analysed using Halliday's functional grammar framework. Results revealed a childhood view of science as a process which requires their active involvement. Students' language indicated that teacher modelling of specific science language features positively impacted on children's capabilities with science language. These results imply key responsibilities for science pedagogy.

3.00pm Thursday, 2nd July ***Room: D2.211*** ***Chair: D. Treagust***

Components of Successful Teacher-Scientist Collaborations

Kalani Eggington and **Dr Tony Wright**
University of Queensland, Australia

This study investigates teacher-scientist collaborations as a model of professional development for science teachers based upon the premise that working with scientists offers teachers an opportunity to learn more about current science practices. Through the collaborative experience, teachers gain content knowledge, an understanding of real-world science application, as well as receiving the benefits of professional relationships with scientists. This present study examines components of teacher-scientist collaborations. Semi-structured interviews were conducted with teachers and scientists who had previously worked together. Participants were selected from seven different teacher-scientist programs so that a range of circumstances could be considered. The findings identify characteristics of teachers and scientists that contribute to a productive working relationship. These characteristics include respect for each others' expertise, clear expectations of the collaboration, and a mutual desire for real-world scientific applications to be incorporated into classroom practice. Findings also identify settings that foster a greater learning experience for teachers. For example, settings where teachers are able to have hands-on experiences with relative and current scientific practices increase teachers' understanding of the nature of science. The study contributes to the understanding and promotion of teacher-scientist collaborations as a valuable professional learning model by providing information that can help maximize the experience for participants.

1.30pm Thursday 2nd July ***Room: D4.107*** ***Chair: K. Y. Yang***

An Investigation of Year 9 students' Engagement or Disengagement with Science as a Subject

Katrina Elliott
Flinders Centre for Science Education, Flinders University, South Australia

The purpose of this qualitative study was to examine the engagement of Year 9 students with science learning. Thirty-five Year 9 science students from five secondary schools participated in focus group discussions. The research unearthed a number of reasons students give as to whether they have engaged with science as a subject or not. The findings involved contemporary issues such as celebrity status, instant gratification and the use of technology in science pedagogy.

3.40pm Friday 3rd July ***Room: D4.106*** ***Chair: J. Crowley***

Developing a Classroom Position: how do student teachers know their lesson plan is working?

Rod Fawns, Christine Redman and Susan Rodrigues
University of Melbourne and University of Dundee

A lesson plan serves several purposes for student teachers and their university tutors. It is often used as a framework to help student teachers to enter and take charge of a classroom. It is used by tutors as a mechanism from which to gauge the development of student teacher practice. It could also provide a window into what we will call the student's "position" or stance and what Foucault called "attitude" because the structure of a lesson plan may convey to us as tutors the various facets of planning needed by us and valued by the student teacher when preparing to teach. We are aware these facets are often not interchangeable. Hence for example, in a standard science lesson plan we might be looking for the aims and intentions of the lesson, the learning outcomes, the resources required for the lesson, the nature of activity, the timing, sequence and transitions for the activity, the assessment strategies to be used during the lesson, any health and safety issues to address, behaviour management strategies to consider. This technical orientation to planning suggests we are committed to a theory of planned reasoned action or planned behaviour. This probably provides some insight into the practical epistemology (Shulman, 1986) or the student's pedagogical content knowledge. But in discussing a lesson plan, with a student we are likely to be reflecting on their ontology, a reasoned list of the knowledge, relations, processes, skills and so on presupposed in the intentional action of teaching. This paper asks what we might be discussing in reflections on a student's "ontology"?

1.30pm Thursday 2nd July ***Room: D4.105*** ***Chair: Z. R. Hong***

Development of Newton's Laws of Motion: discovery or invention?

Wheijen Chang Feng
Chia University, Taiwan
Beverley Bell and **Alister Jones**
The University of Waikato, New Zealand

A review of the history of Newton's Laws of Motion illustrates the socialized nature and ongoing modification of science knowledge, reflecting the notions of sociocultural views, as well as cognitive and rational endeavors to achieve logical consistency and conceptual coherence, in congruence with the notions of constructivist views. Three stages of the historical development are discussed, i.e., prior to the *Principia*, the 3rd (last) edition of the *Principia*, and the modern view developed during the 18th - 19th centuries. Historical modifications of the four key terms are elaborated, i.e., Newton's 1st Law (NFL), inertia, force, and Newton's 2nd Law (NSL). Throughout their historical development, the meanings and functions of each term were found to vary dramatically, gradually extending their abstractness and complexity, and shifting away from intuition and daily life conventions. Besides, owing to the initiation of novel tools, such as the inertial reference frame, the role of each term and the relations amongst them, e.g., causality between inertia and NFL, have been radically altered. The historical review of Newton's Laws implies that providing sophisticated instruction on the definitions of the key terms/tools, including their ontological assumptions and epistemological underpinnings, is essential to inform students about the counterintuitive and complicated meanings/regulations. Meanwhile, providing ample contextualized problems for students to practice can facilitate them to become acquainted with the functions, usages, and relations amongst the key terms/tools. However, in order to achieve better clarification, precision, and coherence in students' own understanding, the demand of individual cognition is not overlooked. Therefore, integration of lecturing, thinking, and practicing are desired in physics classes, and comprehensive lecturing needs to be provided first, to equip learners with sufficient tools for undertaking effective thinking and practicing.

11.10am Friday, 3rd July ***Room: D2.194*** ***Chair: R. Tytler***

Assessment of Context-based Science

Peter J. Fensham
Queensland University of Technology, Australia

As interest in context-based teaching of science grows, the assessment of its learning needs to change from traditional forms to ones that exploit the potential of this approach.
and are authentic to its intentions. Without explicit attention in this assessment to the science knowledge that is expected, context-based teaching can easily degenerate into quite superficial descriptive learning or narrowly specific learning. The PISA 2006 Science study was an attempt to develop an assessment instrument for well defined cognitive and affective science learnings. Some of the potential in context-based assessment has been demonstrated in the reports of this study. Secondary analyses of its data, using the achievement test's S&T contexts as the unit of analysis, extends this potential, as well as identifying some shortcomings in the PISA test design. These findings are timely as the national curriculum for science in Australia moves into its more detailed phase of development.

8.55am Saturday 4th July ***Room: D2.211*** ***Chair: H. E. Chu***

Video Analysis as a Tool for Understanding Science Instruction

Hans E. Fischer
University Duisburg-Essen, Germany

Recent findings of research on science instruction have revealed complex and nontrivial relations between school conditions and learning outcomes. To clarify these relations, theoretical models as well as appropriate research designs and methodologies are needed to investigate teaching and learning. This allows trailing effects down to the instruction level and sheds light on the gap between teachers' demands and students' efforts and therefore allows for prediction of the effects of interventions to overcome this gap. To accomplish these tasks, variables of teaching and learning sciences have to be investigated using low- and high-inferent video analysis. Therefore, controlling features of students' and teachers' behaviours in the science classroom as cause-effect relations is necessary to draw conclusions for good quality instruction and for identifying empirically grounded elements of teacher education. Many research instruments, such as tests, questionnaires and interviews, are needed to investigate variables on the different levels, and principles of qualitative and quantitative methodologies must be integrated in a mixed-methods approach. This way, features of students' and teachers' behaviours in the science classroom can be related to outcome criteria as cause-effect relations necessary for drawing conclusions to improve the quality of instruction.

9.40am Saturday 4th July ***Room: D2.211*** ***Chair: W. Jobling***

Through the Viewfinder: reflecting on the collection and analysis of classroom video data

Angela Fitzgerald and **Mark Hackling**
Edith Cowan University
Vaille Dawson
Curtin University of Technology

The collection and use of video data is an important innovation in classroom research. However, researchers experience uncertainty about incorporating video into their research as it can present a potential 'minefield' of operational, technical and ethical issues that require consideration and negotiation. With increased emphasis on the use of digital technologies in all areas of education, the timing is right to engage in more in-depth discussions about the use of video data in educational research.

In contributing to this discussion, this paper unpacks several issues connected to the use of video technology as a tool for data collection and analysis. In addressing barriers faced by education researchers, this paper focuses on ways of maintaining authenticity, minimising subjectivity and grappling with ethical issues within video research. In terms of the advantages for researchers, this paper highlights the suitability of video technology for classroom-based research as it provides a permanent and detailed record, which can be analysed at many levels.

These issues are contextualised and interpreted within the experiences of a doctoral study, which used video as the main source for documenting and examining the practices of two effective primary teachers in the area of science.

11.55am Friday, 3rd July ***Room: D4.109*** ***Chair: S. C.Kuo***

Contextualising NOS and NOT Using a Web-based Resource

Bev France and **Rena Heap**
The University of Auckland, New Zealand

Developing Nature of Science (NOS) and Nature of Technology (NOT) understandings for students and teachers is complex and challenging. This research drew data about developing contextual NOS and NOT understandings from a cohort of 52 students enrolled as undergraduates in a B.Ed degree. The primary resource used to develop NOS and NOT understandings in this course was a web-based site You, Me and UV. This resource has been developed for teachers, and showcases current New Zealand science research and researchers. Within this course it was considered that a measure of NOS and NOT understanding could the ability of the student teachers enrolled in the course to augment their explanations of NOS and NOT using examples from this context.
Pre and post open-ended questionnaires identified their developing views. Further data was obtained using students' assignments in which their use of examples when planning an integrated unit was analysed. The data showed that these students' views of NOS and NOT ranged from an applied science view to those that reflected a more contemporary understanding of NOS and NOT. In addition some models of integration in their planning were more successful to show NOS and NOT characteristics.

11.55am Friday, 3rd July ***Room: D2.212*** ***Chair: M. L. Wen***

The Development of PCK in Early Career Science Teachers

Kiera Gooding
Kambrya Secondary College
Claire Stanner
The King David School
Penelope Dumsday
Camberwell Girls Grammar School

How early career teachers (ECTs) develop pedagogical content knowledge (PCK) has been the focus of much research in recent times. This paper will provide a unique opportunity to use some research to frame some very practical experiences of ECTs in tracking their own development of PCK. The frame used builds on Shulman's original definition of PCK and in light of more recent work the frame was elaborated upon to gauge the developing PCK of ECTs. Multiple methods for capturing the reflections of ECTs will be presented in this paper. These include case study methodology to capture how one of these ECTs understands teaching differently after two years in the science classroom. Reflective journaling is used to capture an ECT's involvement in regular meetings with a group of teachers and academics at Monash University articulating teachers' pedagogical purposes. The reflective journal focuses on developing a language to talk about teaching with the group and provides insights into how this teacher's PCK developed over time. Data analysed using the frame gives insights into beginning teacher's developing understanding and articulation of their PCK.

2.15pm Thursday, 2nd July ***Room: D2.212*** ***Chair: F. P. Hsieh***

Evaluating an Innovative Digital Professional Learning Resource

Denis Goodrum
Project Director, *Science by Doing*, Australian Academy of Science
Amelia Druhan
Education specialist, *Science by Doing*, Australian Academy of Science

The shaping paper for the national science curriculum encourages an inquiry-based approach to teaching. *Science by Doing* has developed an innovative digital resource on inquiry-based teaching. The resource details the teaching skills required in the different stages of an activity lesson. Within the resource there is a DVD that provides a model for inquiry-based teaching and a CD-ROM that provides the opportunity for a teacher to practise the teaching skills with a virtual class and use different inquiry strategies. There is a supporting booklet that answers many of the questions that teachers have raised about inquiry teaching.

How effective is this resource in assisting teachers improve their inquiry-based teaching skills? The presentation will outline the trialing of the resource with a large group of teachers across Australia. The purpose of the trial was to determine its effectiveness and value.

2.55pm Friday, 3rd July ***Room: D2.211*** ***Chair: C. K. Chang***

Challanges of Linking Theory and Practical Work During Studies of Redox Chemistry

Roshni Gounder
Otahuhu College, Auckland, New Zealand
Bev France and **Mavis Haigh**
The University of Auckland, New Zealand

Three levels of representation – macroscopic, microscopic and symbolic – are commonly used in chemistry education to enrich students' understandings of chemical phenomena and this research highlights the difficulties experienced by Year 12 chemistry students in moving between macroscopic, microscopic and symbolic levels in order to understand redox chemical concepts.. The research design included an intensive analysis of students' work and their thinking about a chemistry experiment traditionally used during instruction about redox chemical reactions. The results showed that the students lacked the skills required to make accurate observations during the practical work or to link the observed phenomena with redox concepts. They had inadequate prior knowledge of redox chemical concepts and held a variety of alternative conceptions. These students were unable to make appropriate connections between the macroscopic, microscopic and symbolic worlds of chemical explanations. It is proposed that these difficulties could be overcome if the students are explicitly made aware of the relevant knowledge linked to the practical task prior to their engaging in the task.

1.30pm Thursday 2nd July ***Room: 4.106*** ***Chair: B. Jane***

Laboratory Technicians in Australian Schools: research findings from a national survey

Mark W Hackling
Edith Cowan University, Australia

Concern about the status of school science technicians was the stimulus for a research project that was funded by the Australian Government DEEWR and conducted by researchers at ECU in collaboration with ASTA and Science Education Technicians Australia.

Australian schools that enrolled secondary students were surveyed to investigate whether they employed science laboratory technicians and the qualifications, experience, ongoing training and support provided for their technicians. The number of hours worked by technicians and the number of hours of secondary science taught at the schools was also investigated so that the level of servicing of the science program could be determined. The median service factor for the sample of Australian schools with technicians was lower than for all school types surveyed in a large UK study (The Royal Society & ASE, 2001). Fifty-seven per cent of schools with technicians in the study sample had levels of servicing less than the lowest standard set by the UK Association for Science Education. The data also revealed that significant numbers of technicians need further support and training to perform laboratory tasks and address safety matters confidently and competently. The findings have implications for the implementation of a more inquiry oriented national science curriculum.

4.00pm Thursday 2nd July ***Room: 2.212*** ***Chair: H. S. Lin***

Science by Doing Pilot Program: an innovation in science teacher professional learning

Mark W Hackling
Edith Cowan University, Australia
Richard John
Griffith University, Australia

The *Science by Doing* Pilot Program was an initiative of the Australian Academy of Science funded by the Australian Government DEEWR. The pilot program addressed the concerns raised by Goodrum, Hackling and Rennie (2001) and Tytler (2007) about the lack of engagement of secondary students with science and the need to make science more inquiry-oriented and relevant to students.

The project combined an initial teacher professional learning workshop in Canberra, curriculum resources accessible in digital form, professional learning resources and the support of small professional learning communities.

Teachers made large and significant gains in confidence with aspects of science teaching, implementing more student-directed forms of practical work and with teaching inquiry and investigation skills. Teachers reported that their teaching was more inquiry-oriented than before the trial. Students reported that they had a more inquiry-oriented experience of science and made greater use of digital learning resources and learning technologies than in the typical curriculum. The students had more positive affective responses to *Science by Doing* than to the curriculum evaluated by the review of science education in Australian schools by Goodrum et al. (2001) and many students believed that *Science by Doing* had been better than previous science they had studied.

4.45pm Thursday 2nd July ***Room: 2.212*** ***Chair: Y. W Lin***

Teaching Practices of Thai Geology Teachers in the Upper Secondary School Levels

Benjawan Hanpipat and **Vantipa Roadrangka**
Faculty of Education, Kasetsart University, Bangkok, Thailand

As geology contents interconnect with the concepts of physics, chemistry, and biology, which encompass the science discipline, teaching and learning geology should include as many concepts as possible. National Science Curriculum Standards of Thailand place a heavy emphasis on geology as a new subject and on the student-oriented paradigm. Teachers play an essential role in reaching the expectations of the standards. The previous study examined geology teachers' teaching practices in the upper secondary levels in public schools in Bangkok Educational Service Area, Office 2. Generally, 17 out of 35 geology teachers provided information via questionnaires. Specifically, 3 teachers participated in an in-depth investigation of their teaching practices including planning, teaching methods, teaching resources, and problems impeding their practices. Classroom observations, interviews, and teachers' documents were utilized as qualitative means. Teachers employed a variety of teaching methods including lectures, hands-on experiments, model construction, and worksheets. Students seldom had a chance to take field trips. None of the participants seemed to interconnect geology with other science subjects. Possibly they do not have an adequate knowledge of the subjects since these subjects are out of the fields of their expertise. They do not recognize the interrelationship of geology concepts with other scientific knowledge.

9.15am Friday, 3rd July *Room: D2.194* *Chair: D. Smith*

Teaching Language and Literacy Skills as they apply in School Science: exemplary practice in a secondary school

Mary Hanrahan
RMIT University, Australia

Fundamental literacy is now recognised as having a crucial role in learning science (Yore, Bisanz & Hand, 2003). This challenges the notion of placing empirical activities at the heart of school science (Osborne, 2002). What are the implications of this for teachers in terms of how to go about teaching the language and literacies necessary for school science, especially for students who have low literacy skills. This paper provides and exemplar from an experienced science teacher who had also had training in literacy teaching. It explores the literacy-teaching practices of a teacher of "learning support" students during a double-period earth science class. While the focus was on the science content, many reading and writing skills were taught either as part of the lesson plan or incidentally, thus ensuring that all students could participate more fully. Literacy-teaching strategies ranged from basic reading and note-taking skills to the use of nominalization and the passive voice. Implications for science teaching and teacher professional development are discussed.

2.15pm Thursday, 2nd July *Room: Costa Theatre* *Chair: R. Tytler*

Investigating the Effect of Science Clubs on Learners and Teachers at Three Rural Schools in the Western Cape, South Africa

M.S. Hartley
Cape Peninsula University of Technology, South Africa

This paper reports on the role that science clubs played at three schools in the rural part of the Western Cape Province in South Africa. The Centre for Mathematics, Science and Technology Education at the Cape Peninsula University of Technology implemented this project in collaboration with the education department curriculum advisory service. The objectives were to (1) improve teachers' skills in conducting practical and experimental work, (2) build of science clubs at rural schools and (3) increase learner participation and achievement in physical science. Three of the 20 schools involved in the project were selected by the education department officials as case studies to assess the impact of the project on the learners and teachers at these schools. After 4 years of implementation it was found that the numbers of learners taking physical science as a subject increased significantly especially at two of the schools. After tracking learners that took part in the first science club initiative four years previously, the majority of learners reported that they chose science and engineering as study field at tertiary level mainly as a result of their participation in the activities of science clubs at their school.

10.00am Friday, 3rd July *Room: D4.107* *Chair: S. S. Lin*

Using Representations of the Particulate Nature of Matter to Understand Evaporation at a Grade 5/6 Level

Filocha Haslam, Russell Tytler and **Peter Hubber**
Deakin University, Australia

The research presented in this paper is designed around the idea that understanding of the Particulate Theory of Matter at Grade 5/6 level is both possible and generative for understanding phenomena, when an explicit representational approach to reasoning is used. In particular, we argue that the difficulties in understanding the concept of evaporation, well documented in the literature, are representational in nature. The paper describes and analyses a Grade 5/6 classroom sequence on 'water' taught by a team of two teachers, who focused on representation and negotiation of various modes of representation to enable students to better understand the process of evaporation in terms of particle ideas. The paper reports on the effectiveness of this explicit representational focus based on data from: pre and post tests, samples of students' work journals, student and teacher interviews and video analysis of classroom transactions using Studiocode software.

8.55am Saturday 4th July *Room: D2.194* *Chair: E. Settelmaier*

Value Practices on Informal Environmental Education Among Adults in Sabah, Malaysia

Arba'at Hassan
Universiti Kebangsaan Malaysia, Bangi, Malaysia

Malaysian Government outlined environmental education as Green Strategy in promoting Vision 2020. Informal education aims to compliment primary-, secondary-, and alternative secondary education. The environmental education programme flexibility provides environmental knowledge with many activities. The adult education activity is increasingly promoted by various sectors. This paper presents value practices on informal environmental education among adults in Sabah, Malaysia. Methodologies used were review literatures on informal environmental education. Primary data were gathered from the Environment Protection Department and the secondary were compilations of case studies by the Science and Technology Unit. The results showed that activities were practiced through campaigns (awareness and participations) by the non-government organizations mainly meant for adults. The interview of implementers found that nearly 92% campaigns were effective, 75% were efficient, 33% had impact to society, 100% were relevant, and 50% had sustainability to stakeholders. Value practices on informal environmental education among adults organized by the Environment Protection Department showed that most implemented activities for adults from 1999-2008 were environmental talks, exhibitions, seminars, workshops, conventions, and outdoor activities. All activities were implemented 30 times for adults and others were 42 times. All activities had increased public awareness on environmental protection among target groups.

4.45pm Thursday 2nd July *Room: 4.105* *Chair: S. C. Kuo*

Enhancing Students' Representational Competence through Multimodal Text Production in Investigative Environments in High School Chemistry

Annette Hilton
School of Education, The University of Queensland, Australia

This study investigated the effect on students' representational competence of producing multimodal texts to report on chemistry laboratory inquiries. It is widely recognised that students experience difficulties in connecting macroscopic data to molecular-level explanation and in visualising molecular processes. To overcome these challenges, students need to develop representational competence. Two chemistry classes participated in the study, which employed mixed methods within a modified crossover design. Pretest-posttest data were collected to examine students' representational competence related to particular aspects of two investigative inquiries on which students reported. Students' texts were examined to identify the ways that students used and integrated multiple representations to explain data. Pretest-posttest comparisons showed that using multimodal text to report on laboratory inquiry is an effective means by which to develop and improve students' representational competence. Students' texts revealed that

- students were able to select, modify, or produce appropriate representations to support written explanations of macroscopic data on a molecular level,
- the nature of data influenced the types of representations used, and
- text type influenced the ways that students used and integrated representations.

These findings build on other research in this area by focussing on writing multimodal texts as a means of developing students' representational competence.

1.30pm Thursday, 2nd July ***Room: D2.212*** ***Chair: J. F. Hung***

Student Video Production during Science Investigations: enhancing learning through the collaborative process

Geoff Hilton
School of Education, The University of Queensland, Australia

Production of in-class digital videos is now a possibility for many science students. A study into the learning benefits of this technology was conducted. This paper reports that digital video production is a collaborative process that leads to enhanced science learning. Two Year 7 classes (n=21, n=22) worked in mixed ability and gender groups to complete a science investigation. One class reported their findings using a written text (poster) and the other produced digital videos. Two groups from each class were video tracked throughout their investigations and later were interviewed. Pretests, posttests, delayed posttests, and repeated question instruments were administered. Results of these quantitative instruments revealed learning gains were greater for the video producers than those making posters. Video and interview transcript analysis indicated that using video technology afforded greater opportunities to collaborate while engaged in the target scientific concepts than did the production of the written text. This study acknowledges collaborative behaviours as one of the learning-enhancing features of digital video production in science. Knowledge of these learning benefits will assist teachers in the confident incorporation of this technology into their science classrooms.

12 Noon Thursday, 2nd July ***Room: D2.194*** ***Chair: C. H. Ku***

Seeking a Theoretical Framework for Student-generated Animations ("Slowmations") of Science Concepts

Garry Hoban, David McDonald and **Brian Ferry**
University of Wollongong, New South Wales, Australia

A new and simplified form of stop-motion animation, "Slow Motion Animation" (abbreviated to "Slowmation") has been developed which encourages preservice teachers to create their own animations of science concepts (Hoban, 2005). Research has shown that designing and creating an animation of a concept is a new way for preservice teachers to develop science content knowledge (Hoban, 2007). Furthermore, these animations can be shared via email or can be uploaded to internet sites such as TeacherTube or YouTube (Hoban, McDonald and Ferry, 2009). Because student-generated animations are a relatively new procedure in science education, various theoretical frameworks are being explored as a lens to analyse the learning involved. This presentation will discuss the value of various theoretical frameworks — distributed cognition (Salomon, 1993), constructionism (Papert, 1991) and distributed constructionism (Resnick, 1996) — for studying students' learning processes when they create and share animations.

10.30am Thursday, 2nd July ***Room: D4.105*** ***Chair: W. C. Feng***

Trend Analysis of Primary and Secondary School Students' Self-efficacy and Learning in Science

Zuway-R Hong and **Huann-shyang Lin**
National Sun Yat-Sen University, Kaohsiung, Taiwan

This study investigated the trend of elementary, junior high, and senior high school students' development of self-efficacy in learning science in Taiwan. In addition, the comparisons of students' self-efficacy were made among students who played different roles in their science classrooms. Eight hundreds and seventy-eight senior high school students', 577 vocational high school students', 499 junior high school students, and 922 elementary completed School Student Questionnaire (SSQ) in 2008. The analyses of variance were used to compare the similarity and differences among students with different grade levels and roles. The initial findings of the questionnaire survey are as follows:

1. The students' mean scores of self-efficacy were significantly related to grade levels; the elementary school students' self-efficacy was significantly higher than their counterparts of junior high, senior high and vocational high school.
2. The high academic achievers in science played more frequently as **leader** roles than those moderate or low science achievers.
3. Girls presented more frequently as the roles of **executer** and **recorder** than boys in senior high and vocational high schools.
4. The gender difference of self-efficacy is not significant at the elementary school level.
5. Research recommendations and educational implications are discussed.

3.00pm Thursday, 2nd July ***Room: D4.109*** ***Chair: C. Jakab***

The Collaborative Science Project: planting the seeds of science for early childhood pre-service teachers, an initial evaluation

Christine Howitt, Elaine Blake, Yvonne Carnellor, Sandra Frid, Simon Lewis, Mauro Mocerino, Lesley Parker, Len Sparrow, Jo Ward and **Mario Zadnik**
Curtin University of Technology, Western Australia
Martina Calais
Murdoch University, Western Australia

The Collaborative Science Project takes 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 project aimed to develop, implement and evaluate various science modules for pre-service teachers. These resources were developed 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. This paper presents an overview of the project and report results to date. Five modules or work were developed based upon the environment, astronomy, forensic science, cleanliness and solar energy. With assistance from the scientists/engineers, parts of these modules were implemented into the pre-service teachers' Science Education unit. Pre-service teachers' knowledge of science, enthusiasm for teaching science, attitudes towards science, and self-efficacy were found to increase across the unit. This positive change was reflected in 88% of the pre-service teachers teaching science on their 3-week practicum, with 61% of these using the modules to plan their science lessons. This research has been funded by the Australian Learning and Teaching Council.

11.10am Friday, 3rd July *Room: D2.212* *Chair: K. Tobin*

Transition from Traditional Lecturing to Problem-based and Case-based Learning in a Final Year Nursing Science Subject: exploring student learning and satisfaction

Alan Howgrave-Graham, Philip Rayment, Phillip Brook-Carter and **Peter Freeman**
School of Applied Sciences and Engineering, Monash University, Gippsland, Victoria, Australia

Many authors assert that Problem-based-learning (PBL) and Case-based-learning (CBL) modes of delivery stimulate students to think critically, analyse and synthesise information. To encourage students to engage more productively with course content we introduced a PBL/CBL teaching paradigm. Five years' data were collected for a longitudinal study covering the transition from traditional lecture-based course delivery to PBL/CBL in a third-level science (pathophysiology) subject of the Bachelor of Nursing course at Monash University. Quantitative and qualitative data were compiled from final examination results and from subject evaluations collected from students during each annual review cycle. Despite an evaluation of the exam papers revealing that these required higher level learning skills, student examination results improved significantly following the introduction of PBL/CBL. However, our study contradicts reports by other authors that PBL enhanced student satisfaction, as evidenced by our student feedback. This subject was our students' first experience of PBL/CBL, which may account for the apparent lack of student satisfaction. The implications of these findings are: The application of PBL/CBL has the potential to improve educational outcomes; that this form of delivery, if to be pursued, should be introduced early in the curriculum.

11.15am Thursday, 2nd July *Room: D2.212* *Chair: D. Goodrum*

An Investigation of Children's Interested Science Topics in Taiwan

Fu-Pei Hsieh
Kuang-Hua Primary School, Kaohsiung, Taiwan
Sung-Tao Lee
Department of Applied Science, Naval Academy

The purpose of this study was to investigate the science topics that children felt interested in for compiling science texts to improve their learning. This study was conducted in two phases. In phase one, an open-ended questionnaire (Interested Science Topics, IST) composed of textbooks, science-related ads and science news was designed and administered by 100 Fifth and sixth graders. In phase two, another 488 participants were invited to finish a five-point Likert IST scale (α=.944). The results indicated that the correlations between categories within questionnaire were ranged from .513 to .668 (p=.000) and one way ANOVA (F=67.997, p=.000) showed that science news (Mean=3.68, SD=.80) were the most interesting topic for children followed by textbooks (Mean=3.39, SD=.77). Besides, a statistically significant difference in interested topics was found when gender and grades were compared. Girls were much more interested in textbooks (t=-2.649, p=.008) and science news (t=-4.969, p=.000) and boys' focus were on science-related ads (t=4.358, p=.000). Furthermore, sixth graders also revealed greater interests in science-related ads (t=3.527, p=.000) and science news (t=3.538, p=.000) than fifth graders. Finally, some implications for future research and science teaching were also discussed.

11.10am Friday, 3rd July ***Room: D4.109*** ***Chair: L. Darby***

The Effects of a Nature of Science-Explicit Professional Development Program on Teachers' Science Teaching Practice

Hsuan-Ying Hsieh, **Shu-Fen Lin** and **Wen-Hua Chang**
National Taiwan Normal University
Mao-Tsai Huang
National Academy of Educational Research
Sang-Chong Lieu
National Hualien University of Education
Sufen Chen
National Taiwan University of Science and Technology

Cultivating an appropriate and adequate understanding of the nature of science (NOS) is one of the science education indicators. Science teachers often reported that implicit-NOS teaching would be enough to accomplish the goal. This study explored the effects of the professional development program on arousing the participant teachers' awareness of and improving their NOS-explicit teaching practice. 23-30 science teachers attended three five-day workshops in Fall 2008. They learned through inquiry-oriented activities, NOS-embedded activities, explicit discussions about NOS tenets reflected in the activities, practicing NOS-embedded teaching, and selecting video segments for reflective discussions in the workshops. Collected data includes videotapes, field-notes and teacher interviews during and after the program, classroom observation of four participants, and teacher and student interviews during and after their NOS-explicit science units. Results from constant comparative among the interview and videotape transcripts, observation notes, and teacher and student artifacts indicated that teachers became aware of the function of explicitly addressing NOS. The teachers were improved in carrying out explicit-NOS teaching in aspects of foregrounding and denoting NOS tenets. The teacher-centered interaction in the program played a significant encouraging role. The program guides, the discussions and reflection on teaching, and the instruction materials were recognized as supporting factors.

1.30pm Thursday 2nd July ***Room: 2.194*** ***Chair: G. Kidman***

The Investigation of Students' Emotional Engagement in the Inquiry-based Science Classroom

Ming-Chin Hsin, **Tsung-Hau Jen**, **Ying-Shao Hsu** and **Hung-Chia Chang**
National Taiwan Normal University

This study aims at investigating students' emotional engagement in learning activities in the Curriculum for Scaffolded Inquiry (CSI) in the subject of Earth Science. Students' engagement has been recognized as a powerful factor enhancing science literacy and achievement. Meanwhile, emotional engagement refers to students' reaction to peers, teachers, curriculum and school. Students' learning motivation and attitudes are closed associated with their emotional engagement. Founded on Piaget's cognitive development and Vygotsky's socio-cultural theory, CSI refers to adolescents' ability to operate hypothetical questions, and the help of scaffolding to promote their learning. This study applied qualitative research methods including interviews with teacher and students, as well as classroom observation in a senior high school in Taiwan. The data is to be analyzed with thematic approach and content analysis. The results reveal target students' emotional reactions to peers, teachers and the CSI curriculum, as well as teacher's observation. Moreover, students' emotional engagement is improved with the introduction of CSI that cooperation and interaction among teacher and students were noticed.

8.55am Saturday 4th July ***Room: D4.106*** ***Chair: B. Lewthwaite***

Using PODE Strategy to Enhance Children's Understanding of "Dissolving"

Chao-Ti Hsiung and **Yu-Chi Chao**
Department of Science Education, National Taipei University of Education, Taiwan

This article presents the results and the implication of the intervention of PODE(Prediction-Operation-Discussion-Explanation) in a 5th grade science classroom. PODE was modified from the idea of White and Gunstone's POE (Prediction-Observation-Explanation). The "observation" stage was interplayed by " hands-on " activity and " academic discussion" among children's science learning. 16 children (age: 9~10) participated in PODE-based "dissolving" science activity. Findings were described by the PODE intervention in relation to the children's characteristics of conceptual learning as well as the intention to search for the optimum model of PODE strategy. Based on the purpose of this study, PODE was implied as the conceptual conflict between "prediction" and "operation" was analogous to the phenomenon of overcoming the maximum static friction. It would motivate children's conceptual change autonomously. In addition, the "discussion" among peers would be the scaffolding for children's sustainable conceptual learning toward science.

10.30am Thursday, 2nd July ***Room: D4.109*** ***Chair: J. Robbins***

Reflection on the Current Situation of Elementary Science Teacher Education in Taiwan

Tung-Hsing Hsiung
National Taitung University
Chao-Ti Hsiung
National Taipei University of Education

To prepare higher quality teachers for elementary education, two important teacher education policies were implemented into the system in past two decades in Taiwan. One was transformed the elementary preservice teacher training system from junior college into university/college level in1987. The second was the announcement of Teacher Education Act by Ministry of Education in 1994, since then, comprehensive and technological universities were permitted to conduct elementary teacher education. However, without considering the facts of social changes, teacher education becomes a social crisis when supplies of certificated teachers are more then the schools need after 2002. To conquer the overabundance, teacher education institutes become the sacrifice under social context of "de-educationalized." This paper intends to discuss the peril situation of elementary science teacher education in Taiwan. Multi-dimensional information were collected through literature review, questionnaire survey, government reports, and websides search engine to refer the current situations of teacher education. To disclose the difficulties and challenges of elementary science education educators are facing, shaping of elementary teacher education program, department of science education in teachers college (university of education), courses that regulating in elementary preservice science teacher program are addressed. Suggestions of promoting elementary science teacher education are also proposed.

4.45pm Thursday, 2nd July ***Room: D2.211*** ***Chair: H. Kanasa***

Implementing Curriculum for Scaffolded Inquiry: examining the effect of scaffolding designs for inquiry

Ying-Shao Hsu, Wei-Hsiu Hsu and **Fang-Ying Yang**
National Taiwan Normal University
Ting-Ling Lai
Tamkang University, Taiwan
Meng-Jung Tsai
National Taiwan University of Science and Technology

The research team had been designing and developing an innovative earth science curriculum, Curriculum for Scaffolded Inquiry (CSI), for eleventh graders in Taiwan. The CSI incorporates several simulations and animations, as well as various scaffolding strategies to facilitate inquiry-based instruction. The curriculum includes four modules that cover the four areas (i.e. star movement, tide, tectonics, and water resource conservation). After a school teacher attended the PD workshops which focused on understanding of the inquiry-based instruction through the lectures, micro-teaching and discussions, he implemented the CSI in three classes for 10 weeks. The activity sheets for three classes were different according to scaffolding designs. The explicit version included prompts and advanced organizers in all the four modules. The gradual fading version included prompts and advanced organizers only in the first two modules. The implicit version did not include advanced organizers in any module. We compared students' inquiry abilities and practices among these three versions of scaffolding designs to indicate the effects of scaffolding on inquiry. Students who accomplished the gradual fading version of activity sheets performed better than students using the other two versions in inquiry practices and understanding of inquiry nature. We suggest that "fading" is important for scaffolding designs.

9.15am Friday, 3rd July ***Room: D4.107*** ***Chair: R. Cooper***

The Role of Representation in Teaching and Learning Astronomy

Peter Hubber and Filocha Haslam
Deakin University, Australia

The research described in this paper is designed around the notion that learning involves the recognition and development of students' representational resources. In particular, we argue that difficulties with concepts associated with processes involving the Sun, Moon and Earth, such as day and night, the seasons and phases of the moon, are fundamentally representational in nature. This paper describes a classroom sequence in Astronomy 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 teachers were videotaped using a combined focus on the teacher and groups of Year 8 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 Astronomy. 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 Astronomy, and the role of representations in learning and reasoning and exploring scientific ideas.

3.40pm Friday, 3rd July ***Room: D2.212*** ***Chair: W. G. Yang***

Investigating the Effects of an Innovative Scientific Curriculum- Does the 'Highscope Program' Really Work in Taiwan?

Jeng-Fung Hung and **Yu-Kai Chen**
Graduate Institute of Science Education, National Kaohsiung Normal University, Taiwan

The major purpose of this study was to investigate the effects of an innovative scientific curriculum, Highscope Program, which was carried out in Taiwan. The design mechanism of Highscope Program was 'bottom-up', and the curriculum goal was to develop students' inquiry skills and scientific thinking via newly science or technology issues. Eighty female tenth graders participated in this one-year curriculum, which was divided into two parts. The first part was concerning the basic knowledge construction exercises, and the second part was the practical laboratory experiments for students. To examine the effects, we developed a five dimensions evaluating framework which includes 'the gains and effects of students', 'the engagement and learning of students', 'the development and design for curriculum materials', 'the feedback and development for teachers', and 'the interactions and communications between students and teachers'. Data collections were including questionnaires, meeting records, classroom observations, and interviews. The results revealed Highscope Program plays an important role for both students' inquiry learning and teachers' professional development. This implies the Highscope Program in Taiwan does work and make some specific effects.

10.30am Thursday, 2nd July ***Room: D2.212*** ***Chair: G. Hilton***

The Development and Validation of the Scientific Thinking Disposition Inventory

Jeng-Fung Hung
Graduate Institute of Science Education, National Kaohsiung Normal University, Kaohsiung, Taiwan
Fu-Pei Hsieh
Kuang-Hua Primary School, Kaohsiung, Taiwan
Sung-Tao Lee
Department of Applied Science, Naval Academy, Taiwan

So much effort has been made on the research of thinking disposition. What seems to be lacking is an appropriate instrument to measure related constructs. The purpose of this study was to develop a reliable and valid Scientific Thinking Disposition Inventory (STDI) for practical and academic uses. This study was conducted in two phases. In phase one, a 60-item draft of STDI was designed on the theory of thinking disposition. Three hundred and nine eighth graders in Taiwan participated for preliminary draft analysis. In phase two, another 171 participants were employed for construct validity test. The final version of STDI contained 44 items, the reliability coefficient was .952. One factor was extracted by principle component analysis, which is named as "Scientific Thinking Disposition". The factor loadings of all items were .739~.912 and the extraction sums of squared loadings in cumulative is 68.1%. Additionally, high achievement students (mean=39.04, SD=23.602) outperformed their counterparts (mean=24.21, SD=13.047) on scientific creativity test (t=3.739, p=.000) and classroom test of scientific reasoning (t=3.808, p=.000). These results indicated that STDI has quality reliability and construct validity. Finally, implications for future research and science teaching were discussed.

12 Noon Thursday, 2nd July Room: D4.109 Chair: C. Howitt

'I Can See Molecules': children's everyday ideas of particles of matter

Cheryl Jakab
The University of Melbourne, Australia

Many early 21st century major developments are based in the nanoworld technology. At the same time introductory chemistry curriculum guidelines focus on sensory description and classification of macro world material substances: solids, liquids and gases, physical and chemical changes and uses of materials. Chemistry learning is limited to the descriptive while the core atomic-molecular theory is often kept aside and made unavailable. Conceptual change researchers routinely claim ideas of particles exist only through schooling and that particle theory is beyond the capacity of young learners (Wiser and Smith, 2008).

From a cultural historical developmental framework perspective (Hedegaard and Fleer, 2008) the lack of molecular theory in early chemistry learning may not be assisting development. My project seeks to explore 6 to 11 years old children's meaning making while they are interacting with molecule artifacts in conversational interviews with an expert other.

Where do children contact 'molecule' ideas in everyday life? What do children in technological society afford available molecule artifacts? What is the 'molecular' semiotic toolkit learners could bring to chemistry experiences?

This research examines how existing particle *artifacts* may be acting as 'everyday' tools in child development, as compared to being 'scientific concepts' contacted only through schooling.

10.30am Thursday, 2nd July Room: D4.106 Chair: M. Hackling

ICTs in Primary Science Education: developing a community of learners to enhance scientific literacy

Beverley Jane, Marilyn Fleer and **John Gipps**
Monash University, Australia

The purpose of this paper is to show how ICTs facilitated communication between primary pre-service teachers that enabled a 'community of learners' to develop children's scientific literacy. Cultural-historical theory was used to frame a study that sought to explicitly go beyond thinking as being individualistic, and to show how thinking can also be considered as a collective endeavour. In particular the study identifies how thinking forms part of a 'community of learners' both virtually and in reality within classrooms. The study was able to make visible child and pre-service teacher interactional sequences that brought together everyday concepts and scientific concepts to support concept formation in science. The study revealed the dialectical relations between everyday concepts and scientific concepts for moving from an interpsychological level to an intrapsychological level. The collective, rather than the individual orientation, made such a perspective possible. Importantly, the use of ICTs facilitated communication between members of the collective.

4.00pm Thursday 2nd July *Room: 4.105* *Chair: K. Bingimlas*

A Case Study of Thai Chemistry Teachers and the Teaching and Learning of Chemistry

Pranom Japin and **Vantipa Roadrangka**
Faculty of Education, Kasetsart University, Thailand

Constructivist perspective has been used as an underlying discipline for Thailand educational reform. Keys to the reform of the learning and teaching profession are teachers, as they are considered to be crucial implementers of reform policies. This research examines the teaching and learning of chemistry in Thailand. The teaching practices of three chemistry teachers were investigated, using classroom observations, semi-structured interviews, and lesson plans as data sources. Data analysis involved an inductive process, categorical aggregation, and a search for correspondence and patterns. The study revealed that the method of teaching chemistry was in line with the National Science Curriculum Standards, chemistry textbooks, and teaching manuals. Learning objectives emphasized the cognitive domain of student learning outcomes and teaching practices emphasized presentation of information, class discussions, and activities in order to understand scientific concepts. Teachers' lesson plans mentioned the use of cooperative learning and the emphasis of science process skills, but these were rarely used. Comprehension of key concepts was assessed by using observation and questioning. All teachers mentioned that student characteristics, a lack of time, and school activities were factors influencing their teaching practices.

10.50am Saturday 4th July *Room: D2.212* *Chair: H. E. Fischer*

A Secondary Analysis of Taiwanese 8th Graders' Social Relationships in Science Class and Science Achievement

Tsung-Hau Jen and **Che-Di Lee**
National Taiwan Normal University, Taiwan
Chin-Lung Chien
National Chengchi University, Taiwan

This study examines the effects of the social relationships in science class on Taiwanese 8th graders' science achievement. A secondary analysis was conducted by structural equation modeling on the released TIMSS 2007 database of 4,046 Taiwanese 8th graders. Five latent variables are involved in the proposed model: Teacher-Student Relationship (TSR) and Student-Peer Relationship (SPR) are independent latent variables, Science Achievement (SA) is dependent variable, students' Positive Attitude Toward Science Learning (PATSL) and students' Confidence on Science Learning (CSL) are intermediates. The asymptotic covariance matrix and weighted least-squares method were applied to estimate parameters and to process the model fitting. The total sampled subjects were randomly assigned into two groups for processing the parameter estimation and using as a validation sample respectively. The results indicated that the goodness-of-fit indices met the required criterions in substance. Both the TSR and SPR exert significant positive direct effects on students' affective learning outcomes, but no significant direct effect on SA. TSR influences more on students' PATSL than their CSL. The SPR exerts more significant effects than TSR on both PATSL and CSL. Furthermore, the PATSL exerts more significant direct effect than CSL on SA. The implication for science education will be addressed.

11.35am Saturday 4th July ***Room: D2.193*** ***Chair: T. L. Tai***

Promoting Effective Small School Science: maximising students and teacher learning

Wendy Jobling, Coral Campbell and Gail Chittleborough
Deakin University, Australia

Data from the 2006/7 *Trends in International Mathematics and Science* study show that students from provincial and remote schools did not perform as well as those in metropolitan schools. Rural communities face unique challenges that affect the teaching and learning of science. This project investigated the impact of a science education intervention project that involved pre-service primary teachers, working in a small rural community of five primary schools. The teachers and pre-service primary teachers participated in a professional development program on *Bringing local science issues into the classroom.* The pre-service teachers took science lessons in the schools working with small groups of children. A follow-up session, two months later brought all the participants together for a Science Day in a Shepparton park. The project allowed pre-service teachers to gain valuable experience in a rural teaching environment, and while the sample size is small; all the pre-service teachers involved reported having a very positive experience in the rural schools. The teachers in the rural schools appreciated the opportunity to focus on science education and have contact with science educators. Some teachers followed up the professional development with classroom activities, and all teachers valued the program of science activities on Science Day.

8.55am Saturday 4th July ***Room: D2.212*** ***Chair: T. H. Jen***

Expanding the context for student learning of science: the conceptual development of the New Zealand Science Learning Hub

Alister Jones, Bronwen Cowie and Cathy Buntting
School of Education, University of WaikatoNew Zealand

Student engagement in science is an issue of international concern. Research indicates that one way to increase engagement in science is to involve students in authentic and relevant contexts that promote an enquiry-based stance. A key aspect to engaging students is to provide teachers with educative materials. In today's world teachers and students look to web-based materials for their own development and learning. This paper will provide a conceptual framework for the development of the New Zealand Science Learning Hub as well as describing the process of its development, its component parts and their relationship to the conceptual frame.

9.15am Friday, 3rd July *Room: D2.211* *Chair: Y. S. Hsu*

Changes in the Scientific Literacy of Middle Years Students During an Inquiry-Based Science Unit: a case Study

Harry Kanasa and **Kim Nichols**
Cooperative Research Centre for Sugar Industry Innovation through Biotechnology, The University of Queensland, Australia

This paper seeks to address the lack of consistency shown by previous studies to demonstrate a change in scientific literacy (SL) following an educational intervention. The case study describes the changes in the SL of middle years students (14-15 years old) who participated in a 10 week, inquiry-based unit designed to help students come to a personal stance on a current scientific issue "Should Australia grow genetically modified crops?". For the purposes of this study, SL has been reconceptualised to bring together and target three domains: affective, behavioural and cognitive. Drawing upon a variety of sources, a qualitative description of the learning journey will be provided to map the changes in each of the domains. As the unit proceeded, the students' ability to present arguments and questions (cognitive domain) improved while their attitudes (affective domain) became more polarised (more positive or negative). Student responses indicate this is due to participation in the unit. From the qualitative data, there was no discernible difference within the behavioural domain. This case study illuminates and confirms findings from the quantitative data concurrently collected in this project. The project demonstrates how it is possible to influence the scientific literacy of students within an educational context.

11.15am Thursday, 2nd July *Room: D2.194* *Chair: H. Lee*

Slowly Unpacking our Teacher Education Pedagogy: using slowmation to reflect on our practice

Stephen Keast, Rebecca Cooper, John Loughran and **Amanda Berry**
Monash University, Australia
Garry Hoban
University of Wollongong, Australia

Some science educators have been articulating their understanding of teacher education pedagogy for several years (Cooper & Keast, 2008; Keast, Cooper, Loughran, Berry & Hoban, In Press). In this paper they investigate what have they learnt about teacher education pedagogy through their use of slowmation in their teaching. "Slowmation" derived from "Slow Motion Animation" (simplified claymation), was used by the first two authors in their Science Methods course at Monash University. Introduced initially as a teaching procedure to engage preservice teachers with technology in science, the preservice teachers were asked to use slowmation during their teaching practicum and then reported back by showing their students' movies to the class and sharing their experiences. The authors collected data by audio recording the preservice teachers sharing their movies and through individual interviews of volunteers. Analysis of the data gave the authors insights into the usefulness of slowmation as a tool to assist preservice teachers to understand the pedagogy of teaching. But teaching in teacher education, like teaching in the classroom, is complex and messy with several different layers. Reflecting on their own pedagogical purposes and intent for using slowmation led the authors to better articulate and understand their own pedagogy of teaching teachers.

4.00pm Thursday 2nd July ***Room: D4.106*** ***Chair: P.Kurup***

Thai Science Teachers' Understanding and Practice of Inquiry-based Instruction

Jeerawan Ketsing and **Vantipa Roadrangka**
Faculty of Education, Kasetsart University, Thailand

In Thailand, inquiry-based instruction (IBI) has been continuously promoted by the Institute for the Promotion of Teaching Science and Technology since the 1980s. However, this teaching approach has not been extensively employed among science teachers due to ambiguous guidelines for the practice of IBI and confusion regarding the meaning of "inquiry". Accordingly, the understanding and practice of IBI by three science teachers, before they were in a collaborative action research group, was studied. It was found that the understanding and practice of IBI by these teachers partially complied with the Thai National Science Education Standards. Although these teachers understood the goals of science teaching, the essential components of the inquiry process, and their roles and their students' roles in an IBI class, they usually implemented their students' learning using 'cookbook' lab experiments and readings, as well as providing a summary and discussion of lab results for their students. As a result, students had a lower chance of becoming the centre of learning and the active constructers of their own knowledge. There were some factors which contributed to teachers' incomplete practice of IBI, including a lack of content knowledge, students who had no responsibility, and a lack of teaching and learning materials.

11.15am Thursday, 2nd July ***Room: D4.107*** ***Chair: C. Yuenyong***

Thai Undergraduate Students' Technological Capability and Attitude toward Science through Teaching and Learning about Biomolecules based on 7Es Learning Cycle

Sorakrit Khansophon
Faculty of Education, Khon Kaen University, Thailand

This research aimed to study Thai undergraduate students' technological capability and attitude toward science through teaching and learning about biomolecules based on 7Es learning cycle. The participants were 50 Kalasin Technological College Certificate students in Kalasin provice, Thailand. The teaching and learning about biomolecules through 7Es learning cycle was carried out for 5 weeks. The 7Es learning cycle consisted of seven stages including elicitation, engagement, exploration, explanation, elaboration, evaluation, and extension. Students' technological capability was collected during their learning by participant observation, students' task and journal writing, teacher and students' interview and teacher's reflection writing. Students' technological capability was interpreted from how they applied scientific concepts and other knowledge during developing tasks about biomolecules. These tasks involved planning, solving problem, designing, creative thinking, and producing. It found that students had difficulty in solving problems concerning technological process. However, biology teaching and learning through 7Es learning cycle allowed students to develop a positive attitude toward science that could be evident by students' aware and worthiness of science, confidence for science application, and motivation of science learning. The paper will discuss pathways of students' technological capability and positive attitude toward science of science teaching and learning in Thailand.

10.30am Thursday, 2nd July ***Room: D2.194*** ***Chair: M. C. Hsin***

Understanding Conceptual Status: teaching science through "slowmation" animation

Gillian Kidman
Queensland University of Technology, Australia

This paper is an exploration of conceptual change. It reports on a study which utilised Hewson and Lemberger's (2000) Conceptual Status Elements, and explores the unique contribution of *Slowmation Animation* in the conceptual learning of pre-service secondary science teachers. Fifteen short animations were produced by 60 participants in a single class lesson. Conceptual change was found to occur in approximately 80% of the participants when their animation topic challenged their understandings of the processes within the scientific concept. Participants reported an enthusiasm for *Slowmation Animation* as a method for learning how to learn, as well as for highlighting what they thought they knew, but didn't actually know.

9.40am Saturday 4th July *Room: D4.106* *Chair: C. F. Tsaur*

The Development of a More Comprehensive Scale of Levels of Openness for Inquiry Activities and Its Application on Teaching Practices

Bing-Hong Ku and **Meichun Lydia Wen**
Graduate Institute of Science Education, National Changhua University of Education, Taiwan
Chyong-Sun Chen
Department of Physics, National Changhua University of Education, Taiwan

During the past decades, inquiry has been one of the major issues for researchers, policy makers, and practitioners in science education community. Inquiry seems to be a word referring to effective science teaching and learning. However, there is still a lack of agreement on the definition, meaning, and image of inquiry. This makes it difficult for researchers and teachers to determine whether the classroom teaching is "inquiry-based" with an identical criterion. In addition, despite of having several types of classifications proposed by scholars, literature reveals the absence of a clear standard for researchers or teachers to distinguish among different levels of openness for inquiry in science activities. The above factors are interrelated and may have impeded the adoption and popularity of inquiry teaching. Therefore, the purposes of this article include: 1. to analyze the different viewpoints toward inquiry and to explain problems arising from the current existing taxonomies of levels of inquiry through the literature review, 2. to propose a new and more appropriate scale of openness for inquiry based on a systematic synthesis and, 3. to discuss the application of this new scale on teaching practices and to make suggestions for teacher professional development.

10.50am Saturday 4th July *Room: D2.193* *Chair: A. Hassan*

A Comparative Study of Senior and Junior High School Students' Attitudes toward Science and Views of Nature of Science

Pi-Chu Kuo
National Pingtung University of Education, Taiwan

The main purpose of this study is to reveal the differences between senior high school students and junior high school students in terms of factors affecting or affected by their attitudes toward science and views of nature of science. The participants of this study were 899 senior high school students and 943 junior high school students in Taiwan. Data were collected from 7 junior high schools and 4 senior high schools in Taiwan with a questionnaire including attitudes toward science and nature of science. Results obtained from correlation analyses have shown that: a) male and female students are significantly different in their attitudes toward science;.b) in junior high school level, gender is not an impact factor on views of nature of science; c) weather junior high or senior high, student attitudes toward science is significantly correlated with their learning attitude and performance in school, but the two factors do not influence or be influenced by their views of nature of science.

2.55pm Friday 3rd July *Room: D4.109* *Chair: B. France*

The Promotion of the Children's Environment Perception and Learning Motivation in the Social-interaction Classroom

Kuo, Shu-Chen and **Ku, Chih-Hsiung**
Graduate Institute of Science Education, National Dong-Hwa University

The purpose of this research is to describe how a science teacher designs the classroom environment through the social interactional perspective and how the five graders' learning motivation and perception of their classroom environment are promoted. For multiple and integrated data collected, continuously taking video, collecting the students' worksheets, teacher's instructional programs, teaching reflection, and students' interview are included during this process. In addition, two measurement instruments revised from WIHITC and MSLQ were employed to cross validate the interpretation of this research. The main findings were showed as follows: first, ways of social interaction classroom environment design include four stages: (a) draw the ideas and confirm the task, (b) design the experiment and small group report, (c) present the outcomes and inter-group evaluation, (d) apply the concept and ideas induction. Moreover, the design of the classroom environment through a social interactional perspective could encourage students to do inquiry learning and also promote their positive perceptions of the classroom environment; hence the students' learning motivation was stimulated. Whereas, the students would have different perception with the interaction, it is necessary for the further research to have a case of study about the correlation between the peer interaction and students' motivation.

8.30am Friday, 3rd July ***Room: D4.106*** ***Chair: J. Ketsing***

Impact of Knowledge Base for Socioscientific Argumentation and Informed Decision Making Regarding Global Warming Among Pre-Service Primary Teachers

Premnadh M. Kurup
LaTrobe University, Australia

Internationally there is strong acceptance to the view that science education should help people in making informed judgments and actions regarding socioscientific issues. Scientific literacy and understanding of environmental issues can provide a foundation for better socioscientific argumentation and informed decision-making about issues like global warming. This would empower communities to take appropriate actions for a sustainable future. Teachers of primary science must themselves be scientifically literate and would be in a position to make informed decisions about these issues if they are to effectively teach about environmental challenges facing humankind.

This study was conducted among 124 third year BEd primary teaching students in Australia. The students were provided with a professional learning intervention to enhance their knowledge and confidence to teach about global warming and used questionnaire and focus group interviews to evaluate the impact of the intervention during their second year. Further they were provided with scenarios to argue in groups to come to a decision to be taken based on evidences projected in their group in their third year. Data revealed that the intervention had positive impacts and enhanced their readiness for teaching about global warming and they could take informed decisions regarding global warming.

3.00pm Thursday 2nd July ***Room: 4.105*** ***Chair: M. Logan***

Physics Teachers' Views of Their Roles Related to Educational Reform in Thailand

Luecha Ladachart and **Vantipa Roadrangka**
Faculty of Education, Kasetsart University, Thailand

The purpose of this interpretative study was to examine physics teachers' views of their roles related to educational reform in Thailand. Participants included four physics teachers. Data was collected using individual semi-structured interviews and was analyzed using content analysis in order to construct assertions. Three assertions included (1) the physics teachers agreed with the notion of the learner-centered approach, but had problems in implementing this notion in their classrooms; (2) the physics teachers who had experienced development of a school-based curriculum did not agree with their roles as curriculum developers, while the physics teachers who did not have experience with school-based curriculum development were not sure of their roles; (3) the physics teachers agreed that doing research can help them improve their teaching practices, but that there were limitations to the research that they could do. The results of this study suggest that there is a need to build a shared understanding about goals and processes of school-based curriculum development among physics teachers, and that helping physics teachers to do research in order to implement the learner-centered approach can be a potential way to promote educational reform.

9.40am Saturday 4th July *Room: D2.194* *Chair: H. J. Arzi*

Enacting inquiry-based curriculum: lessons learned from a professional development program

Ting-Ling Lai
Tamkang University, Taiwan
Ying-Shao Hsu
National Taiwan Normal University, Taiwan

Recently, reform-based instruction has been emphasized in science education. While innovative curricula have been designed and developed for various contexts, the researchers notice the needs for the innovations to be sustained even when the designers or researchers depart (Fisherman & Krajcik, 2003). The Curriculum for Scaffolded Inquiry (CSI) is an innovative earth science curriculum for 10th and 11th grades of high school students in Taiwan (Hsu, et al. 2008). CSI incorporates several simulations and various scaffolding strategies to facilitate inquiry-based instruction. The professional development program for CSI emphases both the conceptual understanding and practice of inquiry teaching. The PD program included workshops, microteaching and practicum to train 10 in-service teachers in a year. The case study reports on 6 experienced science teachers' changes on the understanding of inquiry teaching and instructional strategies in the CSI modules. Participants' obstacles and concerns on implementation issues are reported. Lessons learned from designing a professional development program are also discussed.

2.15pm Thursday 2nd July *Room: 2.194* *Chair: S. Keast*

Indigenous Knowledge and Western Science: a case study of Aboriginal elementary students' science learning in Taiwan

Huei Lee
Graduate Institute of Science Education, National Dong Hwa University, Taiwan
Chiung-Fen Yen
Institute of Ecology, Providence University, Taiwan
Glen S. Aikenhead
Aboriginal Education Research Centre, University of Saskatchewan, Canada

This study focuses on how aboriginal tradition wisdoms are to be incorporated into the taught material and how students to learn Western Science through Indigenous Knowledge. The qualitative approach of Collaborative Action Research was adopted in this study, and the participants are twelve 4th grade Amis students in Hualien. From interviews of Amis grand old men inclusive of the elders, the chieftain, an retired teacher, and a teacher teaching Amis Language in the school, the researcher have a better understanding of 'time' and 'measuring time' in Amis culture. Students' alternative conceptions are inducted from the curriculums combining the cultural concept of measuring time and other references. The results showed that before combining the cultural concept of measuring time into curriculums, students have already the fragments of the cultural concept. After combining the cultural concept into curriculums, students have more interests and a complete understanding in their cultural time and time measuring concepts. A complete cultural concept helps students make a comparison to the textbook. Accordingly, they are proud of their own culture. On the other hand, students raised more interests in their cultural concept. In consequence, they want to develop it to create their own cultural time measuring tools.

8.30am Friday, 3rd July *Room: D2.194* *Chair: J. Arnold*

A Comparative Investigation of Students' Reading Comprehension Performances in Science Argumentative Text

Sung-Tao Lee
Department of Applied Science, Naval Academy, Taiwan
Fu-Pei Hsieh
Kuang-Hua Primary School, Taiwan
Yen-Wen Lin
An-Chao Primary School, Taiwan
Pei-Jun Chen
Chung-Sang Primary School, Taiwan

The purpose of this research was to compare students' reading comprehension ability relating to science argumentative text. Several copies of text were developed and validated for a reading task. Sixteen students (eight 5th graders and eight 6th graders) participated in this study. The qualitative data were collected by a thinking-aloud method, open-ended questionnaires, and interviews. The results indicated that competent readers can easily identify the conclusion and supported evidence in the text and were less likely to be persuaded by the text compared to their counterparts. Additionally, they can paraphrase the keywords in the text, and some unfamiliar words or sentences would not interfere with their reading comprehension as with the poor readers. Furthermore, it was also found that, although both groups of students liked underlining specific words or phrases to assist in their comprehension in the reading task, the competent ones were more efficient and organized.

4.45pm Thursday, 2nd July *Room: D4.109* *Chair: L. Rennie*

The Investigation of the Progression of Children's Scientific Thinking Skills in Taiwan

Sung-Tao Lee
Department of Applied Science, Naval Academy, Taiwan
Kuo-Chu Chien
Da-Lin Primary School, Taiwan
Pei-Jun Chen
Chung-Sang Primary School, Taiwan

The purpose of this study is to explore Taiwanese 5th graders scientific thinking skills development and the possible influences caused by different teaching approaches. Two classes of students (N=61) and their science teachers participated in this study. Six copies of children's scientific thinking skills test were developed, validated and administered within fifteen months. Four major elements in Toulmin's Argumentation Pattern were used as quantitative criteria for assessment and inter-rater reliability ranged from 0.81~0.94 ($p<0.05$). Repeated measures and stepwise regression analysis were used to evaluate children's developmental trends and search the important predictors for their thinking skills. Students' potential performance gaps probably caused by teaching were examined by analysis of covariance. The results indicated that both classes demonstrated yearly developmental curves in their scientific thinking skills and made significant improvements, however, the pro-inquiry teaching class outperformed the other class and revealed some delayed effects. Additionally, regression analysis showed that 27.1% and 14.6% of the variance in thinking performances can be explained by students' math abilities and different teaching approaches. Furthermore, the analysis of covariance indicated that students' thinking performances gap reached the significant level from the third test and implied a gradual influence of teaching on students thinking skills development.

10.50am Saturday 4th July *Room: D4.106* *Chair: H. H. Chen*

Inuit Students Perceptions of Success and Pedagogical and Interactive Processes Influencing Success

Brian Lewthwaite and **Barbara McMillan**
University of Manitoba, Canada
Rebecca Hainnu
Quluaq School, Canada

This exploratory study investigates Canadian Nunavut Inuit Middle Years (Grades 5-8) students' perceptions of academic success and the classroom pedagogical and interactive processes influencing their success. The study is a part of a larger developmental project investigating the processes influencing the implementation of a science curriculum in Nunavut communities where students first language is Inuktitut and the aspiration is for their students to experience a bicultural science learning that recognizes the contributions of both, contemporary Western science knowledge and practices and the knowledge, values and processes of Inuit Quajimajatuqangit (IQ)[1]. Through a variety of data collection methods students and, to a lesser extent their teachers identify a variety of pedagogical and interactive processes that influence student success and their learning, in particular in science classrooms. Of significance is the importance students place on teachers that care not only for them as people, but also for their performance as learners. Based upon this information presented by students, a profile of what constitutes the characteristics of an effective teacher in promoting learning within a positive learning environment in Inuit schools is presented.

11.15am Thursday, 2nd July *Room: D4.109* *Chair: E. Blake*

The Effect of Mind Mapping on Fifth Graders' Creative Thinking and Achievement

Y. C. Li and **W. H. Chang**
Department of Life Science, National Taiwan Normal University, Taiwan

This study aimed to explore the impact of note-taking by utilizing a mind mapping strategy on students' creative thinking and science achievement. This study applied quasi-experimental design. The participants were 187 5th graders from six classes. The six classes were randomly assigned to three groups- a Mind Mapping group, a conventional note-taking group, and a control group. Students in the Mind Mapping group practised the strategy for ten weeks before the "Plant World" unit. Students' measures on "the Torrance test of creative thinking" and "the achievement test of plant concepts" were collected before and after the unit. From the ANOVA and ANCOVA on gained Torrance test scores and science achievement scores, we found that the Mind Mapping group outperformed the other two groups on scales of Fluency, Originality, and Resistance to Premature Closure in the Torrance test ($p < .01$) and Knowledge and Apply scales in the science achievement test ($p < .01$). Seventy-one percents of students self-reported that they accept and are willing to using mind mapping strategies in their future learning activities. Students' mind mapping notes will be used to illustrate how the students represent their understanding of plants. In addition to that, the implications on science teaching and learning will be discussed.

2.15pm Thursday 2nd July *Room: D4.106* *Chair: J. Bay*

Taiwanese Students' Perceived Levels of Understanding and Attitudes Toward Biotechnology

Chen-yung Lin and **Hsin-mei Li**
National Taiwan Normal University, Taiwan

In Taiwan, biotechnology could be taught to high school students. However, according to Chen and Raffan (1999), the biotechnological content is sparse, and more basic, compared to the UK biotechnology curriculum. A similar study could be found in Dawson and Soames' (2006) research, which showed that most 15-year old students knew very little about biotechnology, and most of them graduated from high school with minimum understanding of biotechnology (Dawson and Soames, 2006). This study accessed students' levels of understanding and attitudes towards biotechnology and students' levels of trust and sources of information towards biotechnology in Taiwan. By using stratified cluster random sampling, the sample population is targeted to seven and nine grades of junior high students among 40 schools and 11 grades of senior high students among 31 schools in Taiwan. The results of this study demonstrated that senior high school students had more understanding of biotechnology than junior high school students. Moreover, students' attitudes to biotechnology process are more likely to be positively related to plant and microorganism than vertebrate. This study also supported the view that there is a significantly positive relationship between students' understanding and attitudes.

1.30pm Thursday, 2nd July *Room: Costa Theatre* *Chair: M. Rafter*

Student Perception of a Web-based Self-directed Learning Environment in Southern Taiwan

Lin, Chien-Chung and **Huan, Kuo-Tung**
Meiho Institute of Technology, Taiwan
Chang, Yung-Sheng
Wen-Hua Elementary School, Taiwan
Lee, Chi –Jen
Chung-Luen Elementary School, Taiwan
Kuo, Shing-Chia
Metal Industries Research & Development Centre, Taiwan
Leou, Shian
Mathematics and Science Education, National Kaohsiung Normal University, Taiwan

The purpose of this study was to investigate the perception of web-based self-directed learning environment with elementary school students in southern Taiwan. There were 166 from a total of 920 schools in the southern island drawn in a stratified random sampling method. Three thousand and three hundred Grade 5 or 6 students were selected and administered with a standardized instrument. With the help of classroom teachers, a high return rate of 98% was achieved. The SPSS statistical software was applied to analyze the collected data.
The major findings were as follows:

1. Students from metropolitan and medium size cities significantly surpassed the less populated country towns and remote areas in the overall perceptions of the web-based self-directed learning environment.
2. There were no significant differences in gender and academic achievements among students from various population density areas.
3. As the population density level decreased, the variables of school location and then the grade year level became less significant in the perception surveys.
4. The most critical variable to make the perception difference among the eight variables was the accessibility of internet.

Implications and suggestions were made to the classroom teachers and related education officials to practicing the web-based self-directed learning.

8.30am Friday, 3rd July *Room: D2.212* *Chair: M. Hackling*

Using Reflective Practice of Assessment Promote Students' Argumentation and Conceptual Understanding in Asynchronous Discussions

Huann-Shyang Lin and **Zuway-R Hong**
National Sun Yat-sen University, Taiwan

This study explores the effectiveness of using assessment items with competing theories to encourage students practice collaborative argumentation in asynchronous discussions. The 30 undergraduate students from variety of departments worked in small groups and took turns to collaboratively discuss the given item's answer, reach a consensus, and post their consensual answer on the web. The remaining participants served as evaluators to reflect on the answer and provide comments. It was found that the students made significant progress on their argumentation ability and conceptual understanding of related scientific content knowledge. In the beginning of the study, the students of science major group outperform their counterparts on the level of understanding about the assessment item's scientific concepts, however consequently, at the end of the semester, no significant difference was found between the two groups neither on conceptual understanding nor on the argumentation ability.

11.10am Friday, 3rd July *Room: D4.107* *Chair: C. C. Chen*

The Non-science Majors' Critical Thinking in Scientific News about Socioscientific Issues

Shu-Sheng Lin and **Wei-Li Shyu**
Graduate Institute of Science Education, National Chiayi University, Taiwan

The research explored the non-science majors' critical thinking in scientific news regarding socioscientific issues, which included controversies about the effects of electromagnetic radiation, health risks of drinking coffee and the causes of global warming. Fifty-seven university students who respectively majored in education or humanities and arts in Taiwan participated in completing a questionnaire. Twenty students were further interviewed. The main findings indicated that all subjects showed similar critical thinking skills which includes finding out the key points in the news, judging the reliability of the evidence and making an inference based on evidence when reading the scientific news. If the information in the scientific news contains experimental processes, numerical data or its sources rather than personal experiences, most students would regard it as evidence. Moreover, most students were able to check experimental process, the sample representative and to evaluate the information sources, or use their own belief in evidence to judge the reliability of the evidence. When being asked to make a conclusion after reading the news, most of the subjects were inclined to value the importance of "avoiding risks to health." Compared with the conclusions they made after reading the other news, more students tended not to accept positive and negative effect caused by drinking coffee.

9.15am Friday, 3rd July *Room: D2.212* *Chair: B. Hanpipat*

The Study of Pupils' Discourse Strategies and Roles in Argumentation-Oriented Inquiry Activities

Yen-Wen Lin
An-Zhao Elementary School, Kaohsiung, Taiwan
Jeng-Fung Hung
Graduate Institute of Science Education, National Kaohsiung Normal University, Kaohsiung, Taiwan
Sung-Tao Lee
Department of Applied Science, Naval Academy, Kaohsiung, Taiwan

Based on sociological and philosophical studies of science, science educators have highlighted the need for argumentation discourse in students' learning. However, there is limited study in this regard. In this study, we extend recent work to explore students' discourse strategies and the roles they play in argumentation-oriented inquiry activities. The subjects include twenty-eight 5th graders from one elementary school at southern County in Taiwan. The research methodologies were mainly qualitative and quantitatively supplemented. Pupils' discourses were qualitatively coded and analyzed to understand their discourse strategies, relationships with science conceptual understandings, and related roles played in the dialogic argumentation processes. The results showed that children who were good at using discourse strategies can effectively promote their science conceptual understandings. Secondly, children's most often used discourse strategies in dialogic argumentations were four transactive question strategies ("clarify ?", "justify ?", "question ?" and "respond ?") and two transactive statement strategies ("respond" and "clarify"). Finally, based on their discourse strategy performances, the roles played by children in dialogic argumentations can be classified as "questioner and declarer", "questioner", "declarer", "mummer" and "mediator".

4.00pm Thursday 2nd July *Room: 4.107* *Chair: R. Tytler*

Exploring In-service and Novice Elementary Science Teachers' Professional Development in Taiwan

Chia-Ju Liu and **Chin-Fei Huang**
Graduate Institute of Science Education, National Kaohsiung Normal University, Taiwan
Yi-Chen Lin
Chung-cheng Elementary School, Taiwan

The main purpose of this study was to examine the differences of professional development between an in-service and a novice elementary science teacher using a resource folio. Two elementary science teachers participated in this study. The in-service teacher is a female who taught in elementary school for eight years. The novice teacher is a female, too. She taught in elementary school for one year. The instrument used in this study was the resource folio (Loughran, 2006). The participating teachers were required to write down their teaching plans on the resource folio first. After teaching, they reflected on their teaching practice by watching a video of their teaching. Research data included the content of the resource folio, classroom observations, and interviews. The results showed that the in-service teacher linked her teaching plans and practice better than the novice teacher. Also, she predicted the "children's science conceptions" of elementary school students better than the novice teacher. However, based on the interview, both of them mentioned that the resource folio can encourage their reflection.

11.55am Friday, 3rd July ***Room: D4.107*** ***Chair: L. Chatathicoon***

Citizen Science: engaging primary teachers with science

David Lloyd, Kathryn Paige, Sharon Russo and **Yvonne Zeegers**
School of Education, University of South Australia
Chris Daniels and Philip Roetman
School of Natural and Built Environments, University of South Australia

It has been well documented that primary teachers struggle to teach science, citing lack of time, limited content knowledge and limited confidence about what and how to teach science. One way of engaging reluctant primary teachers to teach science is to focus on 'nature' science. While such an approach could be debated, this research project is focused on encouraging primary teachers to teach science through involvement in a "Citizen Science" project. Citizen science involves researchers in engaging the public to collect scientific data within a cooperative framework. As such, the focus for this research project began with a team of science educators, environmental scientists and the local ABC working collaboratively on a state wide citizen science project called "Operation Possum". One element of the project involved primary teachers and their students collecting data in their immediate natural environment through the study of an iconic species - possums. The research investigated the impact of this community based project on the teaching of primary science through analysing the effectiveness of project management, curriculum materials, school community involvement and science learning in primary schools. Data was collected via surveys and telephone interviews. Information collected is being used to inform the development of strategies and materials for teaching the 2009 citizen science project, "Operation Magpie".

12 Noon Thursday, 2nd July ***Room: D4.105*** ***Chair: L. Ladachart***

Looking at Changes in Students' Attitudes To, and Interest In, Science, from Year Six, Primary School to Year Ten, Secondary School

Marianne Logan
School of Education, Southern Cross University, Australia

This longitudinal study looks at changes in 14 students' attitudes to, and interest in, science, from year six, primary school to year ten, secondary school. The participants included six students who were selected for a primary school opportunity class for academically gifted and talented students in years five and six (3 male and 3 female) and eight students who were in mixed ability year six classes, in three primary schools (4 male and 4 female). The study involved mixed methods of data collection, including individual interviews, focus groups, quantitative attitudinal questionnaires, and qualitative surveys. This paper outlines factors in science that interested and engaged these students in their science lessons each year in addition to aspects that these students disliked about the subject. The students' subject choices for senior high school and their career choices are discussed.

3.40pm Friday, 3rd July ***Room: D2.211*** ***Chair: Y. C. Cheng***

Grade 7 students' Normative Decision Making in Science Learning about Global Warming through a Science Technology and Society (STS) approach

Piyanuch Luergam
Faculty of Education, Khon Kaen University, Thailand

This study reported Grade 7 students' normative decision making in teaching and learning about global warming through a science technology and society (STS) approach. The participants were 43 Grade 7 students in Sungkom, Nongkhai, Thailand. The teaching and learning about global warming through a STS approach had carried out for 5 weeks. The global warming unit through a STS approach was developed based on the framework of Yuenyong (2006) that consisted of five stages including (1) identification of social issues, (2) identification of potential solutions, (3) need for knowledge, (4) decision-making, and (5) socialization stage. Data relating to students' normative decision making was collected during their learning by questionnaire, participant observation, and students' tasks. Students' normative decision making data were analyzed from both pre- and post-intervention and students' ideas during the intervention. The aspects of normative include influences of global warming on technology and society; influences of values, culture, and society on global warming; and influences of technology on global warming. The findings revealed that students have a chance to learn science concerned with the relationship between science, technology, and society through their giving reasons about issues related to global warming. The paper will discuss implications of these for science teaching and learning through STS in Thailand.

12.40pm Friday, 3rd July *Room: D4.109* *Chair: D. Treagust*

Chinese Teachers' Perceptions of the General Role of Culture in the Development of Science

Hongming Ma
Faculty of Education, Monash University

This paper reports a group of Chinese secondary school science teachers' perceptions of the general role of culture in the development of science. The purpose of the study is to investigate Chinese science teachers' understanding of the nature of science in relation to culture. The study is exploratory and interpretive based on semi-structured interviews with 25 Chinese secondary school science teachers. Findings show that, in general, these teachers tended to believe that cultural factors, both intellectual and non-intellectual, might influence the process of scientific research. Most of the teachers agreed that all cultures have scientific achievements and some cultural factors may influence the extent to which a society as a whole contributes to the development of science. However, no one agreed that the conclusion from scientific research is influenced by culture. The discussion focuses on teachers' understandings of the nature of science as they emerged from their 'culture talks' and is summarised from three perspectives, that of: science; the strategies and approaches to doing science; and, the status of scientific knowledge.

2.10am Friday, 3rd July *Room: D2.211* *Chair: R. T. White*

Grade 11 Student's Scientific Concepts and Decision Making Ability about Acid-Bases from Learning through Science Technology and Society (STS) Approach

Malila Chuanchuen
Chumphaesuksa School, Khon Kaen, Thailand
Chokchai Yuenyong
Faculty of Education, Khon Kaen University, Thailand

This research aimed to study Grade 6 students' scientific concepts and capability of decision making about acid-bases through science teaching based on a science technology and society (STS) approach. The target groups were 44 Grade 11 students in Khon Kaen Province, Thailand. The teaching and learning about acid-bases through a STS approach was carried out for 6 weeks. The research instruments include lesson plans of acid-base experiences based on a STS approach, a concept test, and a decision-making test. Data analysis was done by using statistics percentage. Findings revealed that the most students (90.9 percent) understood the concept of pH of the solution. Most students' incompletely understanding (2.3 percent) was related to the concept of acid-bases reaction theories. Most students' partial understanding (25 percent) was related to the concept of acid-bases dissociation. Additionally, all students displayed high capability of decision making about acid-bases. This implies that chemistry teaching through STS approach may be employed widely in Thailand in order to gain both students' acid-bases concepts and capability of decision making.

11.55am Friday 3rd July *Room: D4.105* *Chair: S. M. Rahman*

The Views about Physics and Learning and Teaching Physics Held by Conceptual Change Physics Teachers

Pamela Mulhall
Melbourne Graduate School of Education, The University of Melbourne, Australia
Richard Gunstone
Faculty of Education, Monash University, Australia

Particular approaches to teaching physics are often considered to be underpinned by particular views about physics and learning and teaching physics. In particular, conceptual change approaches tend to be associated with the views that physics (disciplinary) knowledge is socially constructed and negotiated by the scientific community, and that physics learners construct their physics understandings. A recent qualitative study found that a group of teachers who used conceptual change teaching approaches held similar views about learning physics but varied in their views about physics. The consistencies and inconsistencies between these teachers' views, and implications for teacher education, are discussed.

10.30am Thursday, 2nd July *Room: D42.211* *Chair: L. Xu*

Increasing Teachers' Content Knowledge by Developing Partnerships With Scientists

Dianne Nichols and **Sue Monteath**
Education Queensland, Australia
Dan Churach
Centre for Sustainable Resources Processing, Australia
Darrell Fisher
Curtin University of Technology, Australia

This study documents the progress of a group of middle school science teachers in Brisbane who incorporated content knowledge about the mining and mineral processing industries into their units of work. They were involved in a series of professional development events where they engaged with scientists working at the Queensland Centre for Advanced Technology (QCAT). Teachers were encouraged to form long-term professional relationships with the scientists while they investigated real-world scientific examples that they could use in their classroom practice. Time was provided for teachers to write units of work using these real world examples.

Research questions were developed to determine if the program increased the teachers' content knowledge therefore impacting on their pedagogical practice. Both qualitative and quantitative data were collected to determine teachers' attitudinal change towards the mining and mineral processing industries. The teachers completed a survey developed by Churach (2002) called the "Attitude Inventory". Teachers were also interviewed using follow-up questions to clarify their responses.

In all cases there was a positive shift in the attitude, the greatest being in "teachers getting to know and networking with scientists" and "overall knowledge of the mining and mineral processing industry". Also, if teachers were able to make links between the professional development events and the science curriculum, the teachers viewed the mining and mineral processing industries in a more positive light.

3.00pm Thursday 2nd July ***Room: 4.107*** ***Chair: L. Darby***

Group Work and Metacognition: a case study of biology students

Wendy S. Nielsen
University of British Columbia, Canada

Learners working in group contexts, such as problem-based learning, bring metacognitive knowledge, skills and behaviors to group activity. Behaviors include how one attends to aspects of the learning situation, makes choices and decisions along a learning path, and, exerts deliberate control over the learning process. These behaviors are consequential for both individual learning and group activity. How learners bring this individual knowledge into a group context for learning was the focus of the study, which involved high school biology students who were studying invertebrate biology.

The study used a framework of cultural historical activity theory in order to view metacognition and metacognitive behaviors as mediating influences in the context of the learning system as student groups were tasked to solve problems together. Calling up their own background knowledge as they engaged in collective meaning-making meant that others in the group benefited, on many levels, from group interaction. But, before the group engaged in collective meaning-making, the individuals within it first negotiated belonging to the group and willingness to participate. These are aspects of individual metacognition applied to the social context of the group, and where metacognition as an construct of individual learning behavior becomes consequential for group learning activity.

11.35am Saturday 4th July ***Room: D4.109*** ***Chair: T. Wright***

"Miss, it's cool but I don't understand it!": the challenges of teaching genetics using new technologies

Amy Nisselle
Biomedical Multimedia Unit, and Department of Paediatrics, The University of Melbourne, Australia; and Genetics Education and Health Research, Murdoch Childrens Research Institute, Australia
Gregor Kennedy
Biomedical Multimedia Unit, The University of Melbourne, Australia
MaryAnne Aitken
Genetics Education and Health Research, Murdoch Childrens Research Institute, Australia
Sylvia Metcalfe
Genetics Education and Health Research, Murdoch Childrens Research Institute, Australia; and Department of Paediatrics, The University of Melbourne

Genetics is a rapidly-evolving subject that can be difficult to understand and requires up-to-date teaching resources. Educational technologies may overcome some of the difficulties of teaching genetics, such as visualising abstract phenomena and simulating experiments. Teachers in Australia and internationally are also encouraged to include these technologies in their classroom practice. While the classroom use of genetics educational technologies has been documented in the past, little has been written about their evaluation. This study used a framework of social constructivist learning theory and learning designs to investigate the classroom experiences of Victorian teachers and students when using genetics educational technologies. Ethnographic classroom case studies were used to address three research aims: a) does the activity used accommodate approaches to both teaching and learning in the classroom?; b) how does the learning design of the technology-based learning activity fit within the learning design of the classroom?; and c) are there barriers and/or facilitators to the classroom use of educational technologies? The evaluation revealed that genetics educational technologies were most useful when incorporated into learning designs that included multiple representations. The educational technologies also increased student interest, engagement and motivation to learn, however, the teacher was still required to scaffold student learning.

3.40pm Friday 3rd July ***Room: D2.194*** ***Chair: K. Doyle***

Teachers' Content Knowledge in Physics Related Science Classes in Primary and Secondary Schools

Annika Ohle, Hans E. Fischer
University Duisburg- Essen, Germany

International studies reveal that student motivation, interest and achievement have declined in German secondary schools. There are hints that the teacher's content knowledge (CK), in particular, is a predictor for quality of teaching and students' learning outcomes and that primary and secondary school teachers differ considerably in their CK. The aim of this study is to measure the level of teachers' CK in the topic "states of matter and in between transitions" and to investigate the influence on teaching and students' residual achievement. Therefore videos from n= 30 teachers in primary school science classes will be analysed and students' achievement is determined with a pre- post test. To measure teachers' CK in primary as well as secondary schools, a test has been developed to measure their CK at three levels of complexity: knowledge about facts, relations between facts and overarching concepts. After a pilot study with n= 80 teachers from primary and secondary schools the test has been standardised with n= 150 primary school teachers. First results of these studies and ideas for the videoanalysis will be presented.

8.30am Friday, 3rd July ***Room: D2.211*** ***Chair: H. P. Chang***

History and Philosophy in Science Teaching – an international project

John Oversby
Reading University, UK

The Relevance of Science Education project (ROSE, 2009 and 2004) has indicated a lack of motivation towards schools science. Unfortunately, the questionnaire ROSE used did not include questions on History and Philosophy of Science (HPS). The History and Philosophy in Science Teaching (HIPST) project is dedicated to inserting that perspective into science teaching in schools, museums and other non-formal centres.

The presentation will outline some theoretical issues, such as the use of historical contexts to facilitate working with and understanding the Nature of Science, the role of historical experiments to develop authentic inquiry methods, and the role of histories of science to overcome differential gender and cultural backgrounds.

Exemplary material from two UK HIPST web sites will form a major set of data at this stage. One is devoted to the place of instruments in scientific theory-making, in the conceptual contexts of temperature and heat. The second uses the idea of paradigm shift in the conceptual context of acidity. The value of a VLE in a collaborative project working at multiple levels will be explained.

12 noon Thursday, 2nd July ***Room: D2.212*** ***Chair: M. L. Changlai***

Constructivist-informed Teaching: the role of motivation

David Palmer and **Vicki Parkes**
School of Education, University of Newcastle, Australia

This presentation will be a position paper in which the authors will propose that in spite of all the research on constructivism, we have yet to address one of the basic elements of constructivist-informed teaching – motivation. Constructivist theory implies that motivation is essential to meaningful learning, yet it has been largely ignored in extant models of constructivist-informed classroom practice for science. Some possible reasons for this will be explored, and the authors will draw on motivation theory to propose a solution to this problem.

2.15pm Thursday, 2nd July *Room: D2.211* *Chair: S. Witt*

Robert Williams Wood and the Joy of Physics

W. P. Palmer
Associate, Curtin University of Technology, Australia

Robert Williams Wood is remembered (if he is remembered at all) for a single event in his life. He was the American who exposed Blondlot's error in believing that he had discovered N-rays. This has to be amongst the most often repeated story in modern physics and is interesting and exciting as it shows science at its best and at its worst. However usually in the telling of this story, Robert Williams Wood's own history and important discoveries are omitted. This paper is intended to restore the balance and tell the story of a man with a long and distinguished career who actually enjoyed practical physics.

10.50am Saturday 4th July *Room: D4.109* *Chair: C. T. Hsiung*

Grade 11 Thai Students' Analytical Thinking Processes about Fluid in Science Projects

Teinchai Phanusit and **Jiraporn Tapsai**
Khon Kaen University Demonstration School, Thailand

This study reported Grade 11 students' analytical thinking processes about fluid in a science project. The participants were 40 Grade 11 students in Muang, Khon Kaen, Thailand. Students' analytical thinking processes about fluid in a science project were collected from students' science projects, rubric scores and informal interview. The finding revealed that there were interesting science projects that reflected students' analytical thinking process. The paper will clarify students' science projects in process of analytical thinking in content, relation, principle and systems. This study has implication in science teaching and learning for enhancing students' analytical thinking processes.

2.10pm Friday 3rd July *Room: D4.105* *Chair: H. Dhindsa*

Theorizing Effective Formative Assessment of Learning in Junior Secondary Science

Vaughan Prain
La Trobe University, Victoria, Australia
Bruce Waldrip
Monash University, Victoria, Australia

There is now broad agreement that student learning in science entails understanding and integrating the linguistic, visual, mathematical and embodied modes of this subject to construct science concepts and reasoning processes. However, the theoretical basis for assessment approaches that support this account of learning remains under-developed. In this paper we focus on a theoretical account of formative assessment of this learning to inform practice. Black and Wiliam (1998), in their seminal study of formative assessment, theorized various conditions for this feedback by teachers and students to modify effectively teaching and learning activities. These were: (a) students need both the skill and the will to address the gap between their current and desired understanding, and (b) the teacher and students need shared understandings of the demands of the task or tasks, and criteria for success. More recently, Hackling, Peers, and Prain (2007) claimed that science learning is enhanced when students develop understanding of concepts and processes in science through engaging in guided investigations related to a sequence of representational and re-representational work. Our paper considers the implications of these conditions for effective formative assessment, drawing on illustrative examples of teacher and student feedback in junior secondary science topics.

11.10am Friday, 3rd July ***Room: D2.211*** ***Chair: C. Malila***

Categorising Children's Responses to Science Diagrams

Christine Preston
The University of Sydney, Australia

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 as 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. Of further interest was whether and in what ways the diagrams enhance children's knowledge and understanding of concepts. Semi-structured interviews with Year 3 and Year 5 children from one primary school were used to elicit preconceptions of specific science concepts and to record their interpretations of related science diagrams. Follow up interviews determined any changes in children's conceptual schema and in their interpretation of the diagrams. The results revealed a broader range of responses than previous studies into children's understanding of science concepts. The range and nature of responses posed a problem for the researcher in how to categorise them in a way that helps understand patterns in children's thinking. Presentation and discussion of the analysis methods will provide a new way of interpreting and analysing children's responses to open ended questions.

8.55am Saturday 4th July ***Room: D4.109*** ***Chair: J. Tapsai***

Building a Picture of Teacher Practice Promoting Student Investigations in the Chemistry Classroom

Mary Rafter
School of Education, The University of Queensland, Australia

Queensland has seriously heeded the research recommending inquiry as a way of engaging students in science. The current senior chemistry syllabus incorporates inquiry learning explicitly by mandating extended experimental investigations (EEIs). After years of teaching to content driven syllabuses, the role of the teacher in successfully implementing a student-directed activity such as an EEI requires new pedagogical content knowledge. How do effective teachers create, manage and sustain a productive student-centred learning environment? This paper will describe the practice of experienced teachers as they implement an EEI in the chemistry classroom. A pilot study provided the opportunity to develop a method of analysing the expert knowledge teachers display during interaction with students involved in inquiry learning. A collection of case studies is being developed using quantitative and qualitative evidence from interviews and classroom observations in order to identify the roles that teachers assume and the critical thinking involved in developing the pedagogical content knowledge unique to implementing chemistry EEIs. This will lead to the development of professional learning resources for teachers faced with inquiry learning in a high stakes situation as required in an extended experimental investigation.

2.55pm Friday 3rd July *Room: D4.105* *Chair: Y. Zeegers*

Current Status of Science Teaching at Junior Secondary Level in Bangladesh -Towards Developing Professional Learning Communities Among Science Teachers

S. M. Hafizur Rahman, John Loughran and **Amanda Berry**
Faculty of Education, Monash University, Victoria, Australia

The current reform efforts in Bangladesh require a substantive change in how science is taught; an equally substantive change is needed in professional practice. This study will investigate the current status and quality of junior secondary science education in Bangladesh. One of the main purposes of this study is to identify a framework through which the development of Professional Learning Communities (PLC's) will work toward upgrading classroom practice to reach international standards of science education. This paper addresses the research question: What is the current status of science teaching practice in junior secondary level in Bangladesh? This paper examines the teaching load of science teachers and how it impacts their teaching; their views about teaching and students' conceptions in science; how they find difficulty with their subject knowledge and pedagogy in planning a lesson and how they collaborate with their colleagues to improve their practice. Data have been drawn from a baseline survey that includes administration of a general questionnaire to 174 science teachers from six divisions in Bangladesh and interviews of selected 16 science teachers to unpack how they confront their problems regarding their current practice. The findings of this study have implications for the understanding of science teachers' attitudes, opinions, behaviours and characteristics in large populations of individuals towards developing PLC's amongst them.

9.15am Friday, 3rd July *Room: D4.109* *Chair: S. T. Lee*

Case Studies from the Scientists in Schools Project

Léonie J. Rennie and **Christine Howitt**
Curtin University of Technology, Western Australia

The Scientists in Schools (SiS) Project is an initiative of the Australian Government Department of Education, Employment, and Workplace Relations. The Quality Outcomes Programme provided funding to the Commonwealth Scientific and Industrial Research Organisation (CSIRO) to manage a pilot project from June to December 2007, which we reported on at ASERA 2008. In the extended project from January, 2008 to June, 2009, SiS continued to establish sustained partnerships between scientists and school communities with the aim of promoting better science education and awareness of science and science-related careers. Our evaluation of the outcomes of the extended project included data collected by interviews with participating teachers and scientists in two states and one territory, survey data from students, and online surveys of teachers and scientists from every Australian State and Territory. In this paper, we report on three detailed case studies that demonstrate different ways that scientists contributed to school science in primary schools. We examine the outcomes of SiS for students, teachers and scientists, and identify the factors which led to the success of these particular partnerships. The findings suggest several prerequisite conditions that lead to success in this kind of school-community partnership.

11.55am Friday, 3rd July ***Room: D4.106*** ***Chair: P. Cox***

Gender in Science Education: two decades on

Léonie J. Rennie
Curtin University of Technology, Western Australia

Two decades ago, gender was a major focus in science education. In the 80s and 90s, various policies and position statements aimed at improving the participation and performance of girls in science. The Australian Science Teachers Association published their *Policy on Girls and Women in Science* in 1987, and a special issue of the *Australian Science Teachers Journal* with a gender focus in 1989. During the 90s, it was realised that girls were not under-performing in science and the focus swung to boys. Now gender gets little mention in curricular discussions. The broader term social justice is used, hiding gender issues amongst socio-economic, indigenous and other matters. Interestingly, the three sets of PISA results so far indicate no overall differences in performance between boys and girls in Australia. Perhaps there are no gender issues to worry about.

This session aims to promote interactive discussion amongst participants about questions such as: What is the current position of gender in science teaching and learning in Australian educational institutions? Is there any contemporary research or other focus on gender in science education? If so, is it needed? If not, is this OK?
I look forward to a stimulating session of shared ideas!

1.30pm Thursday 2nd July ***Room: D4.109*** ***Chair: C. T. Hsiung***

Children's Scientific and Technological Thinking in Block Play: a cultural-historical perspective

Jill Robbins, Jacinta Bartlett and **Beverley Jane**
Faculty of Education, Monash University, Australia

Following the Australian Government's 2006 *Science Engineering and Technology Skills Audit Summary Report,* the need for research into preschool and primary school science, engineering and technology education was identified as a major priority (DEST, 2007). While a significant amount of research exists on young children's thinking in science there is a dearth of current studies that focus on young children's thinking in design technology, and few have been conducted in the context of block play. This is somewhat surprising given that resources such as wooden blocks and construction sets (for example, Lego, Duplo and Brio), which frequently require children to work like engineers, are used daily in most Australian early childhood centres.

This paper will report on a study located in three Victorian preschools which aims to make a contribution to this research space. Informed by cultural-historical theory (Vygotsky, 1987-1999), and using an interactionist approach, the study addresses the extent to which semiotic mediators, such as drawing, wooden blocks, and, importantly, talk between teachers and children, can develop children's scientific and technological thinking (creativity, innovation, evaluation, problem solving), and advance their block building skills. It is envisaged that the study will lead to enhanced understandings of how early childhood teachers can support young children's creative thinking, especially in relation to investigating, designing, producing and evaluating, as well as developing their understandings of the foundations of physical science.

9.40am Saturday 4th July *Room: D4.107* *Chair: G. Chittleborough*

Socially Responsible Science as a Step towards Scientific Literacy: supporting teachers, challenging students

Elisabeth Settelmaier
School of Education, Curtin University of Technology, Australia
Peter Taylor
Science and Mathematics Education Centre, Curtin University of Technology, Australia
Julia Hill
Perth Modern School, Australia

Abstract: This paper presents the results of a mixed-methods study on a project titled 'Socially Responsible Science' which was funded through an Australian Schools Innovation in Science Technology and Mathematics (ASISTM) grant in 2006.The project set out to give teachers some effective resources with which to enhance their science teaching in relation to topical social issues that would link with broad learning outcomes that develop skills within the realms of *collaborative problem solving, evidence based decision making, critical thinking and critical reflection*, consistent with the development of scientific literacy. The project developed writing, and instructional skills within a cadre of teachers so that the broader education community could refer to a body of experience for advice if this teaching model is utilised more widely. Eight teachers in six schools have produced dilemma activities that are now available on a specially designed website that is linked to, and hosted by, the *Science Teachers Association of WA* for all teachers to use. The methodology consisted of ethnographic participant classroom observations and interviewing as well as the implementation of a specifically designed instrument, the Values, Learning Environment Survey (VLES).

9.15am Friday, 3rd July *Room: D4.106* *Chair: T. L. Wang*

Beliefs and Willingness to Act About Global Warming: comparing secondary students' responses in Australia and England

Keith Skamp
School of Education, Southern Cross University, Australia
Eddie Boyes and **Martin Stannistreet**
Environmental Education Research Unit, University of Liverpool, England

Australian secondary students' (Grades 7 to 10; n=500) beliefs about the effectiveness of various actions in reducing global warming and their self-reported willingness to take actions related to those beliefs were reported at ASERA 07 (see forthcoming RISE article). In the present paper those survey responses are compared with a similar cohort of secondary students in England (n=934). Although beliefs about effectiveness of actions were similar in the two groups, English students were generally less willing to take most actions. In general, both cohorts were less inclined to act in proportion to the strength of their beliefs, although this was stronger for some specific actions. Further analysis of these data suggest that 'education' may be more effective in altering behaviour/decisions for more actions with English than Australian students. Possible interpretations and implications of these findings will be proffered for discussion.

4.45pm Thursday 2nd July ***Room: 2.194*** ***Chair: M. Hanrahan***

Citizen Scientist and Scientist Citizen: resolving a fundamental tension in science education

Dorothy V. Smith
RMIT University, Australia

Since the 1980s, science education policy was driven by the idea that meaningful learning of science could and should be extended to all students, not just those with interests in science related careers. The development of this idea, mainly, although not exclusively under the slogan of scientific literacy, was influenced in the 1990s and early 2000s by a societal shift towards market liberalism and the advancement of a new style of individualism, a climate of standardised testing and narrowing of the public vision (and that of curriculum bureaucrats) of what science curriculum might mean. I argue that the account of science given at present by science education, especially in secondary schools, can at best produce scientist citizens – laypeople who are equipped to deal with scientists on the scientists' terms. I draw from theories of science, its position in society, the role of community in determining scientific truth and an examination of the impact of market liberal thinking on education in Victoria to establish the need to take seriously the perspective that a scientist is also a citizen. I show that this perspective has power to resolve simply some of the key dilemmas of science education.

11.55am Friday, 3rd July ***Room: D2.194*** ***Chair: W. Sumranwanich***

Between Literature and Method: looking anew at ways to support sustainable primary school science

Julian Smith and **Natalie Brown**
Faculty of Education & CALT, University of Tasmania, Australia

This paper is first and foremost about efforts to create a space within which beginning researchers can "look anew" and contribute towards the ongoing quests to support science teaching, learning and research. The presentation will use as *a* point of reference the surprising [dis]connect revealed when a three-part heuristic [*1. Unfolding activity; 2. Development of individual agency; 3. The practice of community*], which features within the conceptual framework of the presenters PhD thesis, was used to "look anew" at her teaching intentions and practices planned in relation to her role as tutor in primary science for beginning pre-service teachers at the University of Tasmania. The context that will be presented is auto-ethnographic in nature. The purpose of this presentation is to invite delegates to critically comment on the *socio-distributed* conceptual framework, as constructed by the presenter, for use in her [exploratory case study] PhD research project titled: *In support of sustainable primary science: Using socio-distributed perspectives to explore development and transformations in pre-service teachers' [primary] science pedagogy and teacher identity.*

2.55pm Friday 3rd July ***Room: D2.194*** ***Chair: J. Smith***

The Study of Science Education Undergraduate Students' Understanding about Nature of Science through Inquiry Cycle (5Es)

Wimol Sumranwanich
Faculty of Education, Khon Kaen University, Thailand

This research aimed to study undergraduate students' understanding about nature of science. The participants were the first year undergraduate students who enrolled in 232110 the nature of science and technology, academic year of 2008. Research design was action research. The intervention include eight lesson plan (16 hours) The 1st – 7th lesson plan allowed students to learn science based on inquiry cycle (5Es) with reflected the learning activity they done to clarify the issues related to the nature of science. The 8th lesson plan, the activity of puzzling box allowed student teachers to come explicitly up with the nature of science. Research instruments include the test for exploring students' understanding about the nature of science, teaching reflection form, and students' journal writing. The test for exploring students' understanding about the nature of science revealed that 46.6 percents of students had higher achievement score than 60 percents. The teaching reflection and students' journal writing suggested that the scientific worldview, scientific inquiry and scientific enterprise should be clarified for linking the relationship among them after finishing of teaching and learning activities of the nature of science. Teaching activities should pay more attention in the issue of scientific enterprise.

12 noon Thursday, 2nd July *Room: D2.211* *Chair: K. Eggington*

Kinetics, Stoichiometry and Acid Properties: how do these come together?

Kim Chwee Daniel Tan
National Institute of Education, Nanyang Technological University, Singapore
David F. Treagust and **L. Chandrasegaran**
Science and Mathematics Education Centre, Curtin University of Technology, Australia
Mauro Mocerino
Department of Applied Chemistry, Curtin University of Technology, Australia

In chemical kinetics, in addition to concepts on kinetics, stoichiometry concepts and the characteristics of the reactants are often involved when comparing the rates of different reactions, making such comparisons very challenging for students at all levels, including pre-service science teachers. Consequently, four multiple-choice items were developed to determine 150 pre-service science teachers' understanding of the kinetics of acid reactions. Each item compared two different acid reactions under similar conditions and respondents were required to select from the graphs provided the best graphical representation for the two reactions. Respondents were also required to provide a reason to explain their particular selection in each item. Three additional items on the dissociation of sulfuric acid and excess/limiting reagents were also included to provide additional data on the pre-service teachers' understanding of acid dissociation and excess/limiting reagent involved in the four items on kinetics. The results showed that the pre-service teachers generally did not explicitly relate the features of the graphs to the specific reactions, and their ambivalence regarding the stoichiometric concept of excess/limiting reagent and misunderstandings about the dissociation of acids interfered with their reasoning of the reactions.

2.10pm Friday, 3rd July *Room: D2.212* *Chair: G. Hilton*

Improving the Quality of Teaching and Learning Science in Urban High Schools by Transforming and Reproducing Culture Produced in Cogenerative Dialogue

Kenneth Tobin and **Reynaldo Llena**
The Graduate Center, City University of New York, USA

We present what we learned from an ethnography undertaken in an urban school in New York City in a four-year ethnography. The study employs multi level data and analyses, including macro, meso and micro levels of social life. The research involves students in their third year of high school during which they studied the Living Environment. Melissa, their teacher, in her first year of teaching, decided to use cogens when students requested she do so. The reason for the student request was the need, from their point of view, to improve the quality of the learning environments so as to increase their prospects of passing a statewide examination that was needed for high school graduation. We use conversation analysis of excerpts identified as salient from the ethnography of two lessons and one cogenerative dialogue. We show that culture produced in the cogen is subsequently enacted in the science class, evident in changed teacher and student roles and the fluent enactment of practices that afford expanded agency, identity change, and increases in appropriate performance. In the context of the topic of immunology we show how sociocultural lenses provide alternative ways of understanding teaching, learning, identity change, and achieving science.

12.40pm Friday, 3rd July *Room: D4.107* *Chair: A. Alsulaimani*

Writing Stories about a Socioscientic Issue: developing students' conceptual understanding and attitudes toward science

Louisa Tomas and **Stephen M. Ritchie**
Queensland University of Technology, Australia

International assessments of student science achievement, and growing evidence of students' waning interest in school science, have ensured that the development of scientific literacy continues to remain an important educational priority. This quasi-experimental study involving both quantitative and qualitative data sources investigated the extent to which an online science-writing project on the socioscientific issue of biosecurity improved Year 6 students' scientific literacy. Children from the treatment class wrote a series of *BioStories*; that is, hybridised short stories that integrate scientific information with narrative storylines. The students' stories were quantitatively analysed using a series of specifically-designed scoring matrices that produce numerical scores that reflect students' developing fundamental and derived senses of scientific literacy (Norris & Phillips, 2003). The results suggest that writing the stories helped the students become more familiar with biosecurity issues, develop a deeper understanding of related biological concepts, and improve their enjoyment and interest in science. Implications for research and teaching are also discussed.

3.40pm Friday 3rd July *Room: D4.109* *Chair: H. Ma*

Approaches for Enhancing Chemistry Teaching and Learning by Emphasising the Macro/Submicro/Symbolic Types of Representation

David F. Treagust
Curtin University of Technology, Australia
John K. Gilbert
The University of Reading, UK

Chemistry has received considerable attention as a difficult and abstruse subject that is deemed lacking of interest and irrelevant to contemporary needs. Part of this problem may be created by teachers' high expectations of students to learn about the representational triplet - macro, submicro, and symbolic types - in chemical education. However, research has shown that such expectations are misplaced and that understanding the relationships between these representations can lead to conceptual difficulties. This paper describes teaching and learning approaches used by researchers from a range of countries to address these concerns by overtly focusing on the relationships between the three levels of representation. Approaches that address the issues raised include investigating structure–property relationships, the role of visualization, the role of practical work, the role of historical material, action research and computer simulations/animations.

2.15pm Thursday 2nd July *Room: 4.105* *Chair: L. Danaia*

A Study of the Relationship Between High School Students' Force Diagram Representations and Capability of Physics Problem-Solving

Hsing-Kuo Tsai
Graduate Institute of Science Education,
Chin-Chang Chen and **Huey-Por Chang**
Department of Physics, National Changhua University of Education, Taiwan

The purpose of this study was to explore the types of high school students' force diagrams and the relationship with the capability of problem-solving, and to analyze the reasons for the students' imperfect performance of drawing force diagrams and problem-solving. A total of 163 high school students were administered to the physics problem-solving written test, and 28 of them were interviewed to explore their thinking process when reading problems and the reasons why they draw the force diagrams and solve the problems unsuccessfully. The study showed that the force diagrams some students drew in the test differed from their intrinsic ones in mind; successful problem-solving required correct force diagrams, but many students failed, because of their misconception that resultant force had a reacting force. Furthermore, the result indicated that the main reasons of their imperfect performance were mistaken system selection, faulty recognition of external force on system, and misconception of Newton's third law.

11.35am Saturday 4th July *Room: D4.106* *Chair: B. H. Ku*

A Development of Inquiry-type Chemistry Laboratory Curriculum

Tsaur, Chyi-Feng
Taipei Municipal Jianguo Senior High School, Taiwan

The current chemistry laboratory courses of senior high schools in Taiwan are almost like a recipe for cooking (validation experiment). Our students can not be interested in scientific explorations without exploring and creation. The Ministry of Education claimed that "active exploration and research" is one of the ten basic abilities of high school students (the Ministry of Education, 2000). However, there is no related curriculum of chemistry in this respect.

This study is a sub-project of a three year High-scope Program in Jian-Guo Senior High School (Taipei) sponsored by National Science Council, Taiwan. The goal of this project is to investigate the following questions: (1) How to develop innovative chemistry laboratory curriculum for senior high school students? (2) How to develop methods to evaluate students' modeling capabilities in chemistry experiments? (3) How to carry out the inquiry-type experiments in high school chemistry laboratory? (4) How to develop an elective course in high school?

The research methodology of this project adopted action research method, using "Cognitive Apprenticeship" and modeling approach as the framework of curriculum-design, to collect data for improving the innovative laboratory curriculum.

Last year (the first year of this sub-project), we have already developed two topics of inquiry-type chemistry experiments. One is about complex formation; another is about electrochemistry and nano-technology. These experiments are still operating in 2008-2009. The focus of this article is sharing our experience of curriculum development and preliminary analysis of the data in the second year.

8.30am Friday, 3rd July *Room: D4.107* *Chair: Y. C. Lin*

Reasoning Through Representation in Science Classrooms

Russell Tytler, Vaughan Prain and **Filocha Haslam**
Deakin University, Australia

There is now a growing consensus that learning science at school entails students learning the literacies of a specific discourse community, one that uses a range of subject-specific and general representational tools to construct and justify evidence-based claims about the natural world (Lemke, 2004; Moje, 2007). These literacies include the integration of knowledge, reasoning skills, and subject-specific procedures, enabling students to know, for example, why and how to use different representations to develop justifiable inferences from data, and know how to develop persuasive explanations for this community. There is also growing acceptance that these representational tools are crucial epistemological resources for speculating, reasoning, contesting explanations, theory-building, and communicating. In this way science at its core involves a representational trail from the perceived or proposed attributes of real phenomena to theorised causal accounts, and that to understand the nature of science is to understand this process. In this paper we use selected video, interview and student workbook data from an upper primary school classroom undertaking units of work on animals, energy and evaporation to show a. how the multimodal representations of science support a range of reasoning processes central to knowledge building in science, and b. the centrality of representations in student construction of reasoned accounts of phenomena.

10.00am Friday, 3rd July *Room: D4.109* *Chair: H. Y. Hsieh*

Curriculum Integration: challenging the assumption of school science as powerful knowledge

Grady Venville
University of Western Australia
Léonie Rennie
Curtin University of Technology, Western Australia
John Wallace
University of Toronto, Canada

On the one hand, it is argued that disciplinary approaches to high school curriculum that include the teaching and learning of traditional, sharply defined subjects like physics, chemistry, biology and algebra provide students with specialised knowledge that enable rigorous explanation of focused aspects of the world. On the other hand, integrated approaches to schooling are seen to better reflect the realities of students' experiences outside school by making learning more applied, more critical, more inventive and more meaningful. This paper will explore this 'curriculum tension' by examining seven issues including that: 1. Curriculum integration defies definition; 2. Curriculum integration is a contentious issue, 3. Real world science is complex and integrated; 4. Science is described in metaphors as both an 'holistic' and 'fragmented' discipline; 5. A variety of factors impact on the implementation of an integrated curriculum; 6. The nature of science learning from integrated curricula is difficult to define and assess; and, 7. The issue of what constitutes 'powerful knowledge' in school science is debatable.

4.45pm Thursday 2nd July *Room: D4.106* *Chair: K. Skamp*

Association between Teacher Brain Hemispheric Preference, Science Teaching Strategies, Gender, and Student Brain Hemispheric Preference

Tzu-Ling Wang
Department of Life Science, National Taiwan Normal University, Taiwan

The purpose of this study was to investigate the relationships between teacher brain hemispheric preference, science teaching strategies, gender, and student brain hemispheric preference. The participants included the 4 elementary school science teachers and 133 fourth- and fifth-grade elementary school students in Taiwan. There were four data sources: Teacher Demographics Questionnaire to describe teacher background information, Human Information Processing Survey to identify teacher brain hemispheric preferences, Style of Learning and Thinking to identify student brain hemispheric preferences, and classroom observation field notes. Quantitative data including scores on surveys were statistically analyzed, whereas qualitative data including classroom observation field notes were qualitatively coded and categorized according to hemispheric preferences. The findings are as follows: (a) Science teacher hemispheric preference was not related to science teaching strategies; (b) Gender was not related to science teacher hemispheric preference; (c) Gender was related to science teaching strategies. Male teachers employed more types of right-brain teaching strategies for a greater percentage of instructional time. Female teachers employed more types of left-brain teaching strategies for a greater percentage of instructional time; (d) Some teachers' science teaching strategies were partially related to student hemispheric preferences.

2.55pm Friday, 3rd July *Room: D2.212* *Chair: K. Gooding*

Development of a Learning Interest of Science Writing Questionnaire

Meichun Lydia Wen and **Hsiao-Ju Huang**
Graduate Institute of Science Education, National Changhua University of Education, Taiwan

The purpose of this study is to validate a questionnaire which measures students' learning interest of science writing. This questionnaire was developed based on both previous research on science writing and the theory of learning interest. A pilot study was conducted to select proper items included in the questionnaire before this study. The sample included 350 6th to 8th graders from central Taiwan. The results of factor analysis merged five subscales, including (1) topic of science writing, (2) type of science writing, (3) purpose of science writing, (4) audience of science writing, and (5) production of science writing, and total variance explained was 58.25%. The Cronbach alpha value and inter-subscale correlation coefficients indicated good reliability and construct validity. Results of t-tests and ANOVAs showed that 6th and 8th graders scored significantly higher than 7th graders ($F=4.266$, $p<0.05$) in their interest of science writing. In addition, students had higher learning interest of the types of science writing than others. Sixth graders scored significantly higher than seventh graders ($F=3.692$, $p<0.05$) at the purpose of science writing subscale. There was no gender difference in students' learning interest of science writing. Conclusions and discussion were made to provide further implication of this questionnaire.

10.00am Friday, 3rd July *Room: D2.211* *Chair: C. Preston*

Treasures from the Past

Richard T. White
Monash University, Victoria, Australia

The reference lists of science education research articles rarely include publications from more than twenty years earlier, which indicates that some once-popular topics are no longer studied. In some cases this is because the research was complete, while in others more studies could have been done to the benefit of theory or practice. This paper provides examples of both. It recommends a small number of former studies that researchers might revisit, either because of remarkable results that merit replication or because of the strength of their relevance to teaching.

10.00am Friday, 3rd July *Room: D4.106* *Chair: H. L. Chiu*

Sustainable Science for a Non-Traditional Schooling Context: developing a framework of practice

Kimberley Wilson, David Lake and Sue McGinty
James Cook University, Australia

Edmund Rice Education Australia Flexible Learning Centres (EREAFLCs) operate within a social inclusion framework to 'walk with' young people who have disengaged from the traditional schooling system. Students attending the centres face multiple stressors in their everyday life as well as significant barriers to achieving success in the classroom environment. Addressing the immediate literacy and numeracy concerns of students as they present at the centres has left little time to develop strategies for engaging students with traditionally 'difficult' subjects such as science. In addition, there is very little research material available to assist teachers in the development of teaching and learning strategies for science education that deal with the unique situation of the flexible learning context. The aim of this research is to build a framework for guiding scientific teaching practice in the context of working with students with complex needs and diverse backgrounds. The 'Re-Engaging Disadvantaged Youth Through Science' Project originated as a partnership between Edmund Rice Education Australia, James Cook University (Townsville) and the Australian Research Council, who provided funding for the three-year project.

11.15am Thursday, 2nd July *Room: D2.211* *Chair: W. P. Palmer*

Becoming a Teacher: an interpretive inquiry into the construction of pre-service teachers' teaching identity

Steven C. Witt and **Peter C. Taylor**
Concordia University, Wisconsin, USA

Teachers need to know the content they teach and how to teach. Learning to teach, however, is a complex endeavor involving more than learning content and methods. Learning to teach involves constructing a new identity and negotiating previous identities and educational beliefs. Exploring our teaching identity through critical reflective practice is at the heart of this research project. Research into teacher's professional identities is a relatively new line of inquiry in teacher development. This study is an interpretive inquiry into how pre-service teachers construct their teaching identity during a course on Developmental Reading at Concordia University in Wisconsin. Data was generated through critical reflective writings, including autobiographical stories, journals, online interactions, and interviews. This study examined both the beliefs students have about teaching literacy and teaching science. This project examines how these beliefs impact their developing teaching identity. During this study the researcher also critically examined his own shifting teaching identity and his beliefs about science and literacy.

9.40am Saturday 4th July *Room: D4.109* *Chair: A. Nisselle*

Exploring the Disciplines – Perspectives from Physics, Biology, History and Music in the Classroom

Tony Wright
The University of Queensland, Australia
Peter Freebody and **Tim Allender**
The University of Sydney, New South Wales, Australia
Nan Bahr
Queensland University of Technology, Australia
Penny Van Bergen
Macquarie University, New South Wales, Australia

Four disciplines; physics, biology, history and music, have been the target of a three-year project examining teachers' awareness and explication of disciplinarity in the classroom. The project has involved two rounds of data collection; initially observing a variety of Queensland classes exploring the range of practice, and then a second round in which particular teachers have been identified to observe expert practice. Data has been collected through classroom observations, teacher and student semi-structured interviews together with samples of student work.

The focus on the four disciplines has highlighted differences between the subjects and we have found that these are particularly apparent in the views and practices of the expert teachers. The comparison of physics with biology provides a clear picture of how very different disciplines are taught. Aspects include the different questions that are asked, evidence collected and explanations that are constructed. This provides a useful commentary on the challenge that faces teachers in the classroom, especially those working outside their chosen field. The comparison with history and music provides a wider perspective and insights that have direct relevance for educational practice and policy.

Project data is being analysed to provide perspectives on current issues ranging from the differing nature of teacher's pedagogical content knowledge, to assessment and curriculum topics including interdisciplinary studies and integrated curricula.

1.30pm Thursday, 2nd July *Room: D2.211* *Chair: D. Nichols*

Teaching and Learning the Particle Model in a Year-seven Science Classroom

Li Hua Xu and **David Clarke**
University of Melbourne, Australia

The particulate nature of matter is one of the most important ideas in science. In particular in chemistry, it is believed to be fundamental to every topic (Harrison & Treagust, 2002). Despite its importance, many studies found that students across different age groups had difficulties in understanding the ideas behind the particulate nature of matter and its associated concepts (Driver *et al.*, 1985; Driver & Leeds National Curriculum Science Support Project., 1994). Rather than focusing specifically on student conceptions, this paper attempts to provide detailed accounts of how the particle model was constituted in interactions in a year-seven science classroom, and how it was employed by the students to explain the phenomena of melting and boiling, as well as the phenomenon of expansion. Two distinct but interrelated theoretical lenses have been used in the analysis: Distributed Cognition (Hutchins, 1995) and Variation Theory (Marton & Tsui, 2003). Both analyses show that the students tended to employ macroscopic explanations to understand changes undergone by matter in spite of the teacher's effort to progressively move from the macroscopic appearances to the underlying microscopic explanations. However, each analysis also points to different sources for such a tendency. Some practical implications will also be discussed.

10.30am Thursday 2nd July ***Room: 4.107*** ***Chair: K. Elliot***

The Effects of Science Problem-based Learning on Science Related Attitudes, Cognitive Strategies and Self-directed Learning for Senior High School Students

Kun-Yuan Yang
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Miao-Li Changlai
General Education Center, China University of Technology, Taiwan

The purposes of the research were to implement the science PBL teaching model for tenth graders in Taiwan and to investigate the effects of the science PBL teaching model on science related attitudes, cognitive strategies and self-directed learning by quasi-experimental design and qualitative analysis. Forty-eight students of the experimental group by problem-based learning and forty-two students of the control group participated in the research. Results of the research showed that the effects of science problem-based learning were significantly better than those of conventional teaching on the students' scores of Cognitive Strategies Inventory and parts of Self-directed Learning Scale. The effect of science related attitudes between these groups was not significantly different.
Through the data analyzed from videotapes, field-observation, students' portfolios and opinion survey of the experimental group, there were many better performances in the aspects of collaboration, SDL and learning motivation of students. During self–study stage, the analysis of verbal interaction for three groups of students showed that there were total 641 utterances and 76.4% of them were task-related. Science PBL was effective to promote the cognitive and social skills for senior high school students.

12.40pm Friday, 3rd July ***Room: D2.212*** ***Chair: J. F. Hung***

The Effects of Text-Reediting and Science Language Teaching on Seventh Graders' Nervous System Learning

Wen-Gin Yang
Graduate Institute of Science Education, National Taiwan Normal University, Taiwan

Science learning is always facilitated by the use of appropriate language. This study aimed at comparing students' understanding by re-editing the text and integrating the features of language into science instruction. A current text of nervous system was selected as Target text and then re-edited as R-text based upon the features of language of science inspired by functional linguists. These two texts are identical in terms of the amount of content words involved. A two (texts) by two (modes of teaching) experiment was conducted. Two 7th grade classes, totally eight classes, were assigned to read the texts and then taught with Common language or Science language instruction. A test, composed of Misconception and conceptual learning sub-scales, was administrated before reading, before and after teaching. The coefficients Alpha of these two scales are 0.87, 0.84, and 0.91 for the test. The results found that 1) R-text reading clarifies students' misconception more effectively ($F=6.88$, $p=.00$) and also helps them construct new understanding ($F=6.59$, $P=.01$); 2) science language teaching produces significant effect on conceptual understanding than the other mode of teaching ($F=29.49$, $p=.00$); 3) while reading is effective in eliminating existing misconceptions, mode of teaching is more important in learning new concepts.

10.00am Friday, 3rd July *Room: D2.194* *Chair: P. Fensham*

The Effects of Science Texts on Students' Reading Comprehension

Chia-Cheng Yeh and **Wen-Gin Yang**
National Taiwan Normal University, Taiwan

This study aimed to explore the effects of different science texts on students' reading comprehension. Three texts on 'photosynthesis' of current junior high science textbooks were excerpted as target texts (H-text, K-text & N-text); three corresponded texts (D_H, D_K , and D_H text) were re-edited to explicate the semantic implications of nominal groups, zero pronouns, part-of and kind-of discourses in the light of systemic functional linguistics and features of Mandarin. A pretest-posttest control group experiment was designed. Total 308 sixth graders were randomly assigned to read the 6 texts in this study. Findings showed that, students read the re-edited versions performed better comprehension than the current versions. Though all texts supported low prior knowledge students to clarify misconceptions and to acquire new conceptions, D_H, D_K & D_N texts did improve readers' comprehension than their counterparts. Furthermore the high prior knowledge students who read the current version texts regressed in comprehension performance. It seems that the strategy of text re-editing developed in this study, i.e., considering the features of Mandarin together with the 'language of science', improves science learning with much fewer side effects for all students.

1.15pm Thursday 2nd July *Room: 4.107* *Chair: S. Khansophan*

Constructing Pedagogical Content Knowledge for Applying Philosophy of Sufficiency Economy into Physics Teaching through Science Technology and Society (STS) Approach: first year result

Chokchai Yuenyong and Kongsak Thathong
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Marc de Vries
Faculty of Technology Management, Eindhoven University of Technology, the Netherlands

The philosophy of sufficiency economy (PSE) has been developed and advocated by His Majesty the King of Thailand Bhumibol Adulyadej based on His accumulative experiences in rural development. The Thailand Ministry of Education stipulated the application of the PSE into teaching and learning. In science education, the PSE infusion may enhance science learning by focusing on the relationship between science, technology, and society. The implementation of the science technology and society (STS) approach in science teaching may give students the chance to make decision based on value judgments of the PSE. This research aimed to enhance 5 physics teachers to construct their knowledge base for applying PSE in science teaching through implementing of the STS physics unit. Five participating teachers adopted material of STS physics unit that infused the PSE perspective and then developed their own units. The study explicates such a knowledge base. The research demonstrates the pedagogical content knowledge (PCK) that originates from our cooperation with the participating teachers. The pathway of teachers' constructing PCK will be discussed in order to provide information for synthesizing the model of science teacher professional development for science teaching with the PSE infusion. This study has implications for science teacher professional development.

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