ASERA 2002

Program plus abstracts plus attenders

FRIDAY JULY 12					
Time	**Raffles**	**Kingston**	**Savoy**	**Portside**	**Boardroom**
8.00 – 9.00 AM	**Registration**				
9.00 – 9.30 AM	**Welcome/Opening**				
9.45 – 10.25 AM	Richard White Developments, Opportunities, and Challenges in Research on Science Education *Chair: Dick Gunstone*	Robyn Turner Harrison, Waldrip & Prain Using Children's Curiosity In Science To Develop Language Skills *Chair:Robyn Gregson*	Hayashi Nakayama & Rumiko Kawano Japanese Science Teachers' Notion Whether Nature Is Explainable *Chair: Ken Kawasaki*	Judy Moreland, Jones, Milne, Harlow, & Chambers Mapping student progress in becoming technologically literate and strategies to … *Chair:Bev France*	Janette Head, Bucat, Mocerino, & Treagust Teaching and Learning about Organic Chemistry: A Representation for Every … *Chair: Tony Wright*
10.30 – 10.55 AM	**MORNING TEA**				
11.00 – 11.40 AM	Ann Harlow & Alister Jones The implementation of the technology curriculum in New Zealand: the results of national school sampling study *Chair: Megan Chambers*	Andreas Redfors & Hans Niedderer On the use of Cognitive Layers in describing a Learning Process about Electric Circuits *Chair: Trevor Bond*	Elisabeth Settelmaier & Peter Taylor Using autobiography to map an interpretive researcher's sensitivities towards her … *Chair: Rod Fawns*	Rowena Scott & Darrell Fisher Boys' & girls perceptions of their science teachers' interpersonal behaviour *Chair: Jacqueline Rojas*	Mogamat Hartley Investigation into the Effectiveness of a Science and Mathematics Outreach Programme for Disadvantaged… *Chair: Deb Corrigan*
11.45 – 12.25 PM	Peter Taylor & John W. Willison Complementary epistemologies of science teaching: Towards an integral perspective *Chair: Steve Ritchie*	Young-Min Kim & O-Gun Cho Middle school and University students' alternative ideas about magnet and electromagnetism *Chair: Richard White*	Daniel Tan, Goh, Chia, & Treagust Qualitative Analysis of Practical Work: Doing, Thinking and Understanding *Chair: Rod Watson*	Bronwen Cowie Student perceptions of formative assessment processes in science classrooms *Chair: Sally Birdsall*	Huann-Shyang Lin, Yang, & Hong Students' difficulties of learning in electrochemistry *Chair: Janette Head*
12.25 – 1.25 PM	**LUNCH**				

FRIDAY JULY 12 (cont)					
Time	**Raffles**	**Kingston**	**Savoy**	**Portside**	**Boardroom**
1.30 – 2.10 PM	Tony Wright Humanising Chemistry – Developing Chemical Pedagogical Content Knowledge *Chair: Bob Bucat*	Rod Fawns & Christine Redman Coding Elementary Contributions to Dialogue in Science Teaching: Individual … *Chair: Elisabeth Settelmaier*	**Symposium** Elizabeth McKinley & Peter Ninnes New challenges in science education	Chung-Chih Chen Developing a Two-Tier Diagnostic Instrument to Assess High School Students' Misconceptions of Geometric … *Chair: Bronwen Cowie*	Maree Baddock, Bob Bucat,&Graham Chandler Case study of a lecturer *Chair: Megan Ladhams*
2.15 – 2.55 PM	Jongwon Park & Ikgyun Kim Analysis of Students' Processes of Generating Scientific Explanatory Hypothesis *Chair: John Loughran*	Ken Kawasaki Confusing in the Conception "Reality": Is It Sensible or Insensible in Science Education? *Chair: Hayashi Nakayama*	*Chair: Judy Moreland*	Jenny Rogers & Bruce Waldrip Science contextualisation in teaching literacy to Prep children. *Chair: Donna Rigano*	June Friedel & David Treagust Science in New Zealand nursing education: a conceptual framework for the investigation.. *Chair: Peter Taylor*
2.55 – 3.25 PM	**AFTERNOON TEA**				
3.30 – 4.10 PM	Huan-Shyang Lin Students' understanding about the nature of science and their problem-solving strategy *Chair: Mogamat Hartley*	Vaille Dawson, Schibeci, & Edmonston What Are Students Attitudes to Biotechnology? *Chair: Christine Redman*	Ka Yin Leung A Study of Students' Alternative Ideas About Particulate Nature of matter in secondary schools in Hong Kong. *Chair: Chung-Chi Chen*	Trevor Bond Science Education and Cognitive Development: Does Piaget Measure Up? *Chair: Andreas Redfors*	MeganLadhams Zieba, Bucat, Mocerino&Treagust Teaching, Learning and Reaction Mechanisms *Chair: Maree Baddock*
4.15 – 4.55 PM	Verner Schilling The role of theory in practical work in physics education *Chair: Daniel Tan*	Bob Bucat, Baddock, Head, & Ladhams Zieba Recruiting Student Participants in Qualitative Educational Research at the Tertiary Level *Chair: Vaille Dawson*	Reyna Zipf & Allan Harrison The Terrarium Unit: A challenge to teachers' concepts of what is science teaching *Chair: Ann Harlow*	Marilyn Fleer Embedded and disembedded learning in socioculturally situated scientific activity *Chair: Alister Jones*	Kwanghee Jo, Park & Song Students' Conceptions of Pressure and Buoyancy in Korea *Chair: Huann-shyang Lin*

SATURDAY JULY 13					
Time	**Raffles**	**Kingston**	**Savoy**	**Portside**	**Boardroom**
8.15 – 8.55 AM	Rod Watson Formative Assessment in Practical Inquiry-based Learning *Chair: Cam McRobbie*	Chris Eams Learning to Work: Becoming a Scientist through Work Experience Placements *Chair: June Friedel*	Jim Woolnough, Cheetham, Rayner, & Moore Training physics teachers through flexible delivery *Chair: Mark Volkmann*	Ian Mitchell Making use of teacher research in teacher education *Chair: Jim Scott*	Gillian Kidman Textbook blunders: Are artists "improving" on the scientific concepts they are illustrating? *Chair: Chi-Yan Tsui*
9.00 – 9.40 AM	Mark Volkman, Sandra Abell & Marta Zgagacz Teaching Physics to Pre-service Elementary Teachers: The Challenges of Inquiry *Chair: Allan Harrison*	Louise Milne, Chambers, Moreland, & Jones Application of an analytical framework to describe young children's learning in technology *Chair: Elizabeth McKinley*	Peter Aubusson How Good is *Primary Investigations*? *Chair: Ian Ginns*	Jim Scott The Use of Video as a Stimulus to Professional Development *Chair: Ian Mitchell*	Chi-Yan Tsui & David Treagust Conceptual learning of genetics with multiple representations: An ontological perspective *Chair: Gillian Kidman*
9.45 – 10.25 AM	Hanna Arzi On Long-Term Complexities of Change *Chair: Russel Tytler*	Geoff Lawrance & David Palmer A study of science teacher education programs across Australia *Chair: Jim Woolnough*	Rick Connor & Micheal Matthews The International Pendulum Project *Chair: Paul McIlwee*	Kevin Watson, Robyn Gregson & Peter Aubusson Packaging Quality Teaching as a Curriculum Innovation *Chair: Geoff Rogers*	Jan Bulman & Allan Harrison Dilemmas Facing Primary School Teachers Of Science As They Implement A New *Chair: Chris Eams*
10.25 – 10.55 AM		**MORNING**	**TEA** *Poster Paper*	Jacqueline Rojas	
11.00 – 11.40 AM	Onno de Jong Developing Science Teachers' PCK: A Naturalistic Study of Teaching Models and Modelling *Chair: Peter Fensham*	Bev France & John Gilbert Public concerns about biotechnology: do biotechnologists share them? *Chair: Gillian Ward*	Ikgyun Kim, Yang, Jeong, & Park Student's responses on conflicting experiments with different strengths of ... *Chair: Hon Suen Ma*	Paul McIlwee Is a constructivist pedagogy tenable? *Chair: Michael Matthews*	Beverley Stanbridge Investigating a strategy for encouraging meaningful learning in High School science classes *Chair: Hanna Arzi*
11.45 – 12.25 PM	Peter Fensham Is Science Education a Field of Research? *Chair: Renato Schibeci*	Gillian Ward & Mavis Haigh Clarifying practicum relationships in secondary science teacher education *Chair: Keith Skamp*	Debra Panizzon, John Pegg, & Michaela Inglis Addressing changing assessment agendas: Experiences of secondary… *Chair: Peter Aubusson*	John Ridd Attainment in Maths and Science to Year 10 in Queensland: a tragedy in one Act. *Chair: Rick Connor*	Sumida Manabu Can post-modern science teachers change modern children's images of science? *Chair: Michael Michie*

SATURDAY JULY 13 (cont)					
Time	**Raffles**	**Kingston**	**Savoy**	**Portside**	**Boardroom**
12.25 – 1.25 PM	**LUNCH**				
1.30 – 2.10 PM	Russell Tytler The development of children's coordination of theory and evidence - perspectives from a longitudinal study *Chair: Onno de Jong*	Mavis Haigh Exploring practicum partnership roles in secondary science teacher education through metaphor analysis – a. *Chair: Bev France*	Mary Hanrahan The A-Z of engaging students in learning science. A: advocating affirmation, allowing adult autonomy, *Chair: Bev Stanbridge*	Allan Harrison Was Dalton's Atomic Theory Really as Revolutionary as Supposed? *Chair: Alberto Bellocchi*	Gillian Kidman Teaching 'space': Are our diagrams worth a thousand words? *Chair: Glenda Leslie*
2.15 – 2.55 PM	Keith Skamp, Boyes, & Stanisstreet Conceptions of air quality: an international study *Chair: Mavis Haigh*	Hon Suen Ma & John Loughran Creative activities: An experimental inquiry approach for science teacher education *Chair: Ikgyun Kim*	Mary Hanrahan An A-C of engaging students in learning science. C: common sense, cultural context, classroom… *Chair: Debra Pannizzon*	Michael Matthews The Distinction between Data, Phenomena and Theory in Scientific Theorising and in Science Education Research *Chair: Garry Hoban*	Jinwoong Song & Sook-Kyoung Cho Yet another pardigm shift?: From minds-on to hearts-on *Chair: John Ridd*
2.55 – 3.25 PM	**AFTERNOON TEA**				
3.30 – 4.10 PM	Russell Tytler & Helen Conley The Science in Schools Research project: Results and insights from a system wide change… *Chair: Mary Hanrahan*	Glenda Leslie & Renato Schibeci Factors affecting the teaching of biotechnology in lower secondary schools. *Chair: Jinwoong Song*	Geoff Rogers & Doug Hill Engaging spirituality in teaching and learning primary science. *Chair: Ka Yia Lung*	Dawn Garbett Early childhood student teachers' confidence and competence in the curriculum *Chair: Atsushi Yamashita*	Dianna Nichols & Allan Harrison Prolonged interaction with the natural environment: A study of students' cognitive and *Chair: Sumida Manabu*
4.15 – 5.15 PM	**AGM**				

SUNDAY JULY 14					
Time	**Raffles**	**Kingston**	**Savoy**	**Portside**	**Boardroom**
8.15 – 8.55 AM	Jinmee K. Hsieh Students' conceptions after 921 earthquake in Taiwan *Chair: Warren Beasley*	Sung-Yi Lee & Young-Min Kim Middle school students' ideas about electromagnetism and their conceptual change by the… *Chair: Chih-Ming Tu*	Richard Monypenny One way to represent learning and teaching science *Chair: Jongwon Park*		
9.00 – 9.40 AM	Warren Beasley & Jim Butler Senior Chemistry and Physics in Queensland: The Pedagogical Revolution *Chair: Jinmee K. Hsieh*	Russell Tytler & Bruce Waldrip Describing, supporting and monitoring school and teacher change: the Science in Schools ... *Chair: Mei-Yu Chang*	Chih-Ming Tu, Changlai, & Cheng The effects of constructivist's view of teaching strategies on 7th grade students' learning *Chair: Young-Min Kim*	Houn-Lin Chiu, Wu, & Chou The Awareness of Taiwanese Science Teachers on Learning Environments in Internet *Chair: Richard Monypenny*	
9.45 – 10.25 AM	Léonie Rennie & Gina Williams-Pearce Changing the Way Communities Think About Science: An Ambitious Project *Chair: Atsushi Yoshida*	Ken Appleton Activities That Work: How primary school teachers communicate aspects of their science PCK *Chair: Gaalen Erickson*	Masakata Ogawa A Stratified Knowledge Model for Comprehensive Science Education *Chair: Trish Bell*	H.M. Chen, Wen-Hue Chang,& Huey Por Chang Different gendered students' perceptions of classroom climate under a trial of an … *Chair: Bruce Waldrip*	
10.25 – 10.55 AM	**MORNING TEA**				
11.00 – 11.40 AM	Robyn Gregson Is Writing Important in Science? *Chair: Wilhelmina Van Rooy*	Donna Rigano, Stephen Ritchie & Trish Bell Scaffolding for Science Inquiry: Co-teaching in a Primary Classroom *Chair: Marilyn Fleer*	Sally Birdsall Dynamic Databases *Chair: Kwanghee Jo*	Ayumi Sugi & Atsushi Yoshida Gender Issues in Science Education in Japan – Research on Gender Bias of Junior High *Chair: Hisashi Otsuji*	
11.45 – 12.25 PM	Wilhelmina Van Rooy Curriculum Change: Biology Teachers' Response to Innovation *Chair: Nicole Hudson*	Mei-Yu Majorie Chang A case study of an elementary school teacher carries out a conceptual change teaching *Chair: Wen-Hua Chang*	Jacqueline Rojas Viewing Floating and Sinking through Digital Video Technology: Discovery of an … *Chair: Ken Appleton*	Hisashi Otsuji Confirming the idea "boys and girls learn differently" *Chair: Masakata Ogawa*	
12.25 – 1.25 PM	**LUNCH**				

2002

Day: Sunday	**Location: Kingston**
Chair: Gaalen Erickson	**Session Time: 9.45 – 10.25 AM**

Ken Appleton
Central Queensland University

Activities That Work: How Primary School Teachers Communicate Aspects Of Their Science PCK

Since Shulman suggested the notion of pedagogical content knowledge (PCK) in the late 1980s, there have been consistent attempts to further understand this proposed construct, or representation, of teacher-knowledge. Such studies have shown how PCK, and in particular, science PCK, is inter-twined with other forms of teacher knowledge and teacher beliefs. The group at Monash University have more recently attempted to understand science PCK held by secondary teachers, and to somehow "capture" this knowledge. I have attempted to understand the nature of primary school teachers' science PCK (see ASERA 2001), and how the generally limited science content knowledge of primary teachers may influence their science PCK. The role played by activities that work in supplementing or substituting for science PCK has been a part of this study. This paper reports on how these elements relate to the communication of aspects of science PCK by primary school teachers.

Day: Saturday	**Location: Raffles**
Chair: Russel Tytler	**Session Time: 9.45 – 10.25 AM**

Hanna J. Arzi
Tel Aviv, Israel

On Long-Term Complexities Of Change

Difficulties encountered in attempts for change are often attributed to a non-supportive school context. The present paper examines long-term change processes in a centre for science education in which the traditional school context was restructured in a culture of teacher team work and laboratory environment. The ten-year case study suggests that the restructuring of the context facilitated quality teaching and learning of science. The reactions of teachers in response to the same organizational conditions varied and appeared to depend, inter alia, on their prior career background and school teaching experience. Some new practices were found to be fragile and underwent regression over time. Based on the study, prior school habits of both teachers and students tend to become second nature and re-emerge as powerful barriers to lasting change. Long-term nurturing of an intended fundamental change is therefore needed.

Day: Saturday	**Location: Savoy**
Chair: Ian Ginns	**Session Time: 9.00 – 9.40 AM**

Peter Aubusson
University of Technology, Sydney

How Good Is *Primary Investigations*?

Primary Investigations (PI) is an extensive, whole school program of professional development, student and teacher resources for primary science. It has been used by teachers throughout Australia. In some States, it has been very popular. In others, less so. In this study, eighteen key players in science education who have influenced the development or use of primary investigations were identified and interviewed. These key players include teachers, university academics, consultants, senior departmental science curriculum officers and executive of science teacher associations. This paper reports the views of key players in four States. Perceptions of *PI*'s influence on teacher

confidence, student achievement and student attitude to science are outlined. Factors which have inhibited and promoted the use of *PI* are identified. The ways in which different science education environments influenced PI are considered. Implications for change in school science discussed.

Day: Friday	**Location: Boardroom**
Chair: Megan Ladhams	**Session Time: 1.30 – 2.10 PM**

Maree Baddock, Bob Bucat & Graham Chandler
University of Western Australia

Case Study Of A Lecturer

The evolution of the teaching and learning philosophies of a lecturer involved in an action research study, and how these changes influenced his class-room practice is described. The lecturer teaches in a chemistry department at the third-year tertiary level. As a consequence of his involvement in this action research study he increasingly moved away from traditional teaching approaches common at the tertiary level.

Day: Sunday	**Location: Raffles**
Chair: Jinmee K. Hsieh	**Session Time: 9.00 – 9.40 AM**

Warren Beasley & Jim Butler
University of Queensland

Senior Chemistry And Physics In Queensland: The Pedagogical Revolution

The challenge to change classroom practice has always been a tension for science teachers. For Queensland teachers the most radical change in pedagogy, experienced in a lifetime, is now expected following the adoption of a new generation of syllabuses for the teaching of senior school physics and chemistry. As always the ideal curriculum (QBSSSS Syllabus) has expectations beyond the present competence and belief structures of the trial teachers and the available resources. Essentially the syllabus requires a 180 degree turn around in pedagogy which will need to be consistent with a 'Context to Concept' teaching approach.

This contrasts with 50 years of a 'Concept to Exercises' methodology. Associated with such a radical change in pedagogy is a very different balance of student assessment instruments which are required to meet different syllabus outcomes. The balance is now very much in favour of student investigations (Scientific and Non-Scientific) evolving out of focus questions generated from a face to face interactions with the school generated contexts. This paper analyses the challenges facing teachers and students in 50 trial schools throughout Queensland and reports on their experiences and expectations after six months of a two year trial period.

Day: Sunday	**Location: Savoy**
Chair: KwangHee Jo	**Session Time: 11.00 – 11.40 AM**

Sally Birdsall
Auckland College of Education, New Zealand

Dynamic Databases

Nowadays incorporating ICT into your teaching programme is expected. Desktop publishing packages and other presentation software are readily available for children to construct reports, but what about other types of software?

Databases can be used by children to gather and process data from their investigations. In addition they can be a useful assessment tool, as they allow us to evaluate children's ability to identify trends and patterns in data.

This presentation will demonstrate ways of creating and using databases in your science classroom. A model for developing a database for primary classrooms will be offered. This model can be developed and used in a range of scientific contexts. Classroom examples will be shown.

Day: Friday	**Location: Portside**
Chair: Andreas Redfors	**Session Time: 3.30 – 4.10 PM**

Trevor G Bond
James Cook University

Science Education And Cognitive Development:
Does Piaget Measure Up?

While Piaget was given his chance to influence Australian science education in the 1970s and everyone knows all that Piaget stuff has been disproved, science teaching strategies deliberately based on Piagetian theory continue to have an impact in science classrooms in the UK. This paper argues that when appropriate psychometric strategies are implemented to construct measures of the two key variables, cognitive development and science achievement, then the relationships between them can be more clearly delineated. Results of a number of classroom investigations reveal moderate to high correlations between development and achievement, as well as the ceiling that development places on achievement. Further, the use of the Rasch model for measurement quantifies the impact that classroom science teaching strategies have on cognitive development and science achievement as genuine interval scale measures.

Day: Friday	**Location: Kingston**
Chair: Vaille Dawson	**Session Time: 4.15 – 4.55 PM**

Bob Bucat, Maree Baddock, Janette Head & Meagan Ladhams Zieba
University of Western Australia

Recruiting Student Participants In Qualitative Educational Research At The Tertiary Level

Science education researchers usually depend upon students as data sources. Which students? Supposing you are intending to conduct qualitative research within the tertiary system using a methodology that does not require a statistically random sample – such as case study, or interviews of a small number of students in a naturalistic study. There are issues of validity, ethics and practicality in the identification and recruitment of student participants. What is valid? What is ethical? What is practical?
This session will be conducted as a workshop and will be seeking insights and answers for the benefit of the workshop leaders.

Day: Saturday	**Location: Boardroom**
Chair: Chris Eams	**Session Time: 9.45 – 10.25 AM**

Jan Bulman & Allan Harrison
Central Queensland Universtity

Dilemmas Facing Primary School Teachers Of Science As They Implement A New Outcomes-Based Curriculum

During 2000-2002, the outcomes-based *Science: Years 1 to 10 syllabus* is being progressively implemented in Queensland schools. This paper explores the strategies used by two teachers as they planned, implemented and assessed a science unit as their contribution to the development of a professional development program for teaching-with-outcomes. The program aims to help teachers effectively accommodate the new syllabus. A qualitative case study uncovered dilemmas faced by the teachers, and elucidated their perceptions of the type of professional development that enables teachers to implement both the substance and the philosophy of the new syllabus. Key dilemmas identified by the teachers were the need for resources to provide content knowledge and activities, and sufficient time to plan and implement effective science lessons. The study established the need for on-going professional development, and a range of support to implement the new syllabus successfully.

Day: Sunday	**Location: Kingston**
Chair: Wen-Hua Chang	**Session Time: 11.45 – 12.25 PM**

Mei-yu Marjorie Chang
National Hsinchu Teachers College

A Case Study Of An Elementary School Teacher Carries Out A Conceptual Change Teaching

The purpose of this study was to investigate how an elementary school teacher carried out conceptual change teaching, with particular focus on the examination of students' preconceptions and induction of cognitive conflict. There was one elementary science teacher and 36 third graders involved in this study. Materials taught in the science classroom were based on the textbook provided by the school. The contents of the teaching materials involved planting tomatoes, temperature, properties of air, weather-observation, the body of animals, light, and the body of plants. The method used in this study was qualitative. Data collections were based on non-participant observations, interviews, and documentations, and lasted for three and half months. Findings of this study were: (1) Methods of the teacher used effectively to detect students' preconceptions included questioning, hands-on activities, group discussions and reports; (2) Methods used to initiate students cognitive conflicts were questioning to make prediction, explanation and then to experiment to argue, to compare, and to demonstrate, This study also found the major reason the teacher carried out the above activities smoothly was because the teacher understood the constructivist approach and questioned students appropriately.

Day: Sunday	**Location: Portside**
Chair: Bruce Waldrip	**Session Time: 9.45 – 10.25 AM**

H. M. Chen
National Changhua University of Education
Wen-Hue Chang & Huey Por Chang
National Taiwan Normal University

Different Gendered Students' Perceptions Of Classroom Climate Under A Trial Of An Interdisciplinary Curricular Module

Based on understandings of New Nine-Year Curriculum Reform in Taiwan, eight representative science teachers of a junior-high followed Palmer's Curricular Connection Model, developed and implemented an interdisciplinary module while they participated in a professional development program that operated in accordance with Loucks-Horsley & Stiles' 4-steps planning cycle framework. "What is happening in this classroom" was administered before and after executing the module, and an ANCOVA was conducted to explore the students' perceptions. According to post-scores from WIHIC, thirty students, balanced in gender and academic achievement in five trial classes, were interviewed. After triangulating with field notes and a researcher-made checklist, we found that female students are significantly higher than males on "Student Coherency" and "Cooperation", and significantly lower in all other five subscales, and familiarity with the teacher is an important influencing factor. Suggestions about using a team teaching approach to reach the goals of current curriculum reform are provided.

Day: Sunday	**Location: Portside**
Chair: Richard Monypenny	**Session Time: 9.00 – 9.40 AM**

Houn-Lin Chiu, Hung-Long Wu, & Chin-Yung Chou
National Kaohsiung Normal University, Kaohsiung, Taiwan

The Awareness Of Taiwanese Science Teachers On Learning Environments In Internet

A questionnaire was developed to investigate Taiwanese Science teachers' awareness about learning environments in Internet. The questionnaire included three parts: the basic information of the teachers, Likert scale questions, and open-ended questions. There were four dimensions in this questionnaire: Attitude toward using Internet, Awareness of resources in Internet, Awareness of interactions in Internet, and Awareness of Internet setting.

The findings were that more experience the teachers got, they tended to have more negative attitude to learning environments in Internet and also they used Internet lesser. Taiwanese science teachers are also shy to interact with their peers in Internet.

Day: Friday	**Location: Portside**
Chair: Bronwen Cowie	**Session Time: 1.30 – 2.10 PM**

Chung-chih Chen
National Kaohsiung Normal University, Taiwan

Developing A Two-Tier Diagnostic Instrument To Assess High School Students' Misconceptions Of Geometric Optics

In this study, a two-tier instrument is developed to diagnose Taiwanese high school students' understanding of geometric optics as it applies to the formation of shadows and images by mirrors and lenses.

In the development of the instrument, concept maps and propositional statements representing the knowledge required to understand the geometric optics are listed. Afterwards a paper-and-pencil test consisting of open-ended items are developed and administered to high school students. The answers are then analyzed and coded concerning the misconceptions. Interview with some of the students was followed up in case further explanation and clarification are needed. Based on the most often identified misconceptions, a two-tier instrument based on multiple choice tests is developed for assessing students' understandings of optics. Further information on the test results admistered to 250 students in Taiwan and representative students' misconceptions are presented.

Day: Saturday	**Location: Savoy**
Chair: Paul McIlwee	**Session Time: 9.45 – 10.25 AM**

Rick Connor & Michael Matthews
University of New South Wales

The International Pendulum Project

The pendulum is a near-universal topic in school science education programmes. It also played a central role in the development of Western science, timekeeping, music, navigation, mapping and culture. The pendulum was crucial in the establishment of Galileo's new science; while Richard Westfall remarked of Newton, that 'without the pendulum, there would be no *Principia'*. And it was central for Piaget's investigations of the mental development of children.

The pendulum is a topic that can allow fruitful collaboration between science, mathematics, history, music, technology and literature classes. It is an ideal vehicle for teaching a great deal about the Nature and Methodology of Science. The pendulum also allows a great deal of basic physics, including the conservation laws, to be taught. This project aims to investigate and evaluate such collaboration and teaching.

Day: Friday	**Location: Portside**
Chair: Sally Birdsall	**Session Time: 11.45 – 12.25 PM**

Bronwen Cowie
The University of Waikato, Hamilton, New Zealand

Student Perceptions Of Formative Assessment Processes In Science Classrooms

Gaining insights into how students perceive and experience formative assessment is essential given it is they who must do the learning. Students need to be *able* and *willing* to disclose what they know, understand and can do if teachers are to participate with them in formative interactions. Students need to understand and share their teacher's goals if interactions are to be effective. This paper reports on student perceptions and experiences of classroom assessment and the range of factors that limit their ability and willingness to disclose their ideas.

Day: Friday	**Location: Kingston**
Chair: Christine Redman	**Session Time: 3.30 – 4.10 PM**

Vaille Dawson
Edith Cowan University
Renato Schibeci &Jo Edmonston
Murdoch University

What Are Students Attitudes To Biotechnology?

This is the second paper in the series on high school students' knowledge and understanding of biotechnology. Last year, we presented our analysis of the knowledge of 1,116 15-year-old students from 11 Western Australian schools. We now follow up with a report on the attitudes of these same students. Students were asked to read 15 statements about biotechnology and to draw a line to separate acceptable from unacceptable statements. Overall, the students hold a *wide range of beliefs* about what is an acceptable use of biotechnology. Their attitudes ranged from those of the 53 (6.0%) students who do not agree with the use of any living organisms in biotechnology to the 125 (14%) students who approve of all the stated uses of biotechnology, with a wide spread in between. Acceptance of the use of organisms in biotechnology decreased as we moved from microorganisms (>90 per cent approval) to plants (71-82%) to mammals (14%). In addition, some preliminary data on students attitudes of a group of students who had explicitly studied biotechnology will be presented.

Day: Saturday	**Location: Raffles**
Chair: Peter Fensham	**Session Time: 11.00 – 11.40 AM**

Onno de Jong
Utrecht University, The Netherlands

Developing Science Teachers' PCK: A Naturalistic Study Of Teaching Models And Modelling

First of all, the important concept of teachers' pedagogical content knowledge (PCK) is examined and some key elements are described. Secondly, several methods and techniques to explore PCK are reported. Thirdly, a naturalistic case study of the development of PCK within a group of prospective science teachers (all M.Sc.) is presented. The group has taken a post-graduate course module, incl. some teaching practice, on a central issue in science education: teaching models and modelling. The results indicate that the prospective teachers' knowledge of students' conceptions of models and modelling was promoted. Besides, the prospective teachers became aware of their own limited knowledge of appropriate models and modelling and ways to teach these issues. The absence of this knowledge can have caused the observed discrepancy between their teaching intentions (models as constructs) and their teaching practice (models as facts). Implications for (prospective) science teacher courses are discussed.

Day: Saturday	**Location: Kingston**
Chair: June Friedel	**Session Time: 8.15 – 8.55 AM**

Chris Eames
University of Waikato, Hamilton, New Zealand

Learning to Work: Becoming a Scientist through Work Experience Placements

How can students make the transition between academia and the workplace, and translate their academic learning into practice? Do work experience placements undertaken as part of their educational qualification aid the process of enculturation into the profession?

These questions form the framework for research into learning about working through a Co-operative Education programme at the University of Waikato. This research is a longitudinal study that is following a cohort of students as they pass through their degrees, which include two separate work experience placements. Data gathering is by semi-structured interviewing at various points of their studies and an interpretivist methodology is being employed to analyse the data. Alliances of the data to the theoretical ideas of social learning and communities of practice are being considered.

This paper will report on one case study that illustrates the thinking and praxis changes that one participant has undergone as he has progressed through his degree and particularly his work placements. The development of ideas of what it means to do research, and what it means to do science will be discussed. The implications for the training of new practitioners and the value of work experience components will be explored.

Day: Friday	**Location: Kingston**
Chair: Elisabeth Settelmaier	**Session Time: 1.30 – 2.10 PM**

Rod Fawns & Christine Redman
University of Melbourne

Coding Elementary Contributions To Dialogue In Science Teaching: Individual Acts Versus Dialogical Interactions

Science teaching has often been viewed, implicitly or explicitly by researchers in science education, as an institutionalised language system. So while we acknowledge participants choice in taking up positions and contrary positions in discursive practice the relationship is framed as an individual in a concrete interaction responding in terms of the institutionalised language system of school science. That is responding to a generalised other rather than a concrete particular other. We speak of 'teacher science' or "student science" in talk situated in the local moral order of schooling in and about science. However we know that there are multiple identity possibilities for teacher and student within the institutional moral order of distributed duties and responsibilities. Possibilities which can only be understood by looking at a particular interaction between a particular teacher and particular student.

> "Taking conversation as the starting point we proceed by assuming that every conversation is discussion of a topic and the telling of, whether explicitly or implicitly, one or more personal stories whose force is made determinate for the participants by that aspect of the local expressive order which they presume is in use and toward which they orient themselves." (Davies & Harre, 1999, 9.37).

Like many other institutionalised discursive practices, in the application of fixed administrative or scientific categories to an ever-changing social reality, coding might be described as 'situated decontextualising practice' Linell, 1992). The coding activity itself is of course dependent on, and constitutive of, particular scholarly goals and concerns. At the same time, it is an activity in which one is supposed to apply one single coding system in the same way to all kinds of discourse data.

But a science of coding is not possible, except as a practical matter. It is a method not a theory. It is a heuristic for dealing with data for some particular purpose. This does not make coding as such unreal or untrue. We argue that coding human interaction can be made logically compatible with dialogism. The application of coding requires efforts to create a "fit" between code and data – accommodation of categories, assimilation of data to existing categories.

Day: Saturday	**Location: Raffles**
Chair: Renato Schibeci	**Session Time: 11.45 – 12.25 PM**

Peter J. Fensham
Monash University

Is Science Education A Field Of Research?

Research in science education is now internationally almost 40 years old. This paper addresses the question, *In what senses is science education research a field of research?* It begins by establishing a number of criteria for recognising such a field. Some of these criteria are structural ones, such as the existence of conferences, journals, etc.. Research in science education clearly meets these. Other criteria are more concerned with aspects of the research itself, such as its researchers' questions, its use and development of theory and of methodologies its researchers employ to answer their questions. With respect to these criteria, some of the research measures up, but other published studies do not meet these criteria. Finally, there are a number of Outcome criteria, and how far these are being met will also be considered.

Day: Friday	**Location: Portside**
Chair: Alister Jones	**Session Time: 4.15 – 4.55 PM**

Marilyn Fleer
Monash University

Embedded And Disembedded Learning In Socioculturally Situated Scientific Activity

In recent times sociocultural theory has provided a powerful tool for framing and analysing research. In drawing upon Rogoff's (1998) three planes of analysis, this paper will explore situated sociocultural activity in science. Data gathered in a range of early childhood contexts were analysed using Rogoff's (1998) 3 planes of analysis (personal, interpersonal and cultural/institutional) to determine embedded and disembedded contexts for scientific thinking. Further insights were gained when findings were considered in light of Lave and Wenger's (1991) notion of legitimate peripheral participation and Wenger's (1998) concept of communities of practice.

Day: Saturday	**Location: Kingston**
Chair: Gillian Ward	**Session Time: 11.00 – 11.40 AM**

Bev France
Auckland College of Education, New Zealand
John Gilbert
The University of Reading, United Kingdom

Public Concerns About Biotechnology: Do Biotechnologists Share Them?

Much has been written about the need for improved communication between the science / technology community and 'the public'. The introduction of genetic engineering into New Zealand society currently appears to be at the 'participation' stage i.e. public submissions to the New Zealand Royal Commission, when represented within Gradwell's (1999) typology. Thus the time is right for 'the public' to ask major questions about genetic engineering and its possible consequences and for scientists / technologists to produce their responses. This is happening through the agency of the recent publication of the *Report of Royal Commission on Genetic Modification (New Zealand*) (2001), of media reports (e.g. New Zealand Listener) and of political action by interest groups (e.g. NZ Green Party).

A research programme that identified possible 'public' concerns about biotechnology has been published in the *New Zealand Biotechnology Journal* (France, Gilbert, Maddox, 2001) as a framework for scientists' responses. This lead to a series of replies on specific concerns by scientists [Blair (2001), Gilmour (2001), Glare & O'Callaghan(2001), Maddox (2001), McIntyre (2002). The paper is an analysis of the issues raised and the responses produced by scientists, as identified by discourse analysis (Gee, 1989). On the basis of this analysis, we propose a model with which to illustrate the communication problems that may arise during communication between scientists and 'the public' over biotechnological matters.

Day: Friday	**Location: Boardroom**
Chair: Peter Taylor	**Session Time: 2.15 – 2.55 PM**

J.M Friedel
Manukan Institute of Technology, New Zealand
David F. Treagust
Curtin University of Technology

Science In New Zealand Nursing Education: A Conceptual Framework For The Investigation Of Perceptions Of The Nursing Curriculum

This paper will outline a conceptual framework for the investigation of curriculum practice (Goodlad, 1979), and will discuss the application of aspects of this framework to the New Zealand nursing curriculum, in particular to the science components of this curriculum.

Preliminary data will be reported from a survey of the NZ Institutes and Polytechnics that deliver this curriculum to nursing degree students. This survey aims to establish perceptions of what Goodlad describes as the ideological curriculum and the formal curriculum. Whilst the nursing curriculum is laid down, and approved by, the NZ Nursing Council, it is likely that different institutions will interpret it in different ways. Differences between these perceptions of the curriculum will be discussed, and the implications, and consequences for nursing education will be highlighted.

The next stage of this research programme, which will involve the investigation of the perceptions of lecturers, nursing staff and students, relating to science and their own science self-efficacy, will be outlined and discussed.

Day: Saturday	**Location: Portside**
Chair: Atsushi Yamashita	**Session Time: 3.30 – 4.10 PM**

Dawn Garbett
Auckland College of Education, New Zealand

Early Childhood Student Teachers' Confidence And Competence In The Curriculum Area Of Science

The purpose of this pilot study was to examine early childhood student teachers' confidence and competence in the seven learning areas of the New Zealand Curriculum Framework (NZCF). In an attempt to describe and develop an explanation of the relationship between subject confidence and competence of student teachers, the preliminary findings are presented from an analysis of questionnaires, testing and focus group interviews. Study design and methods of collecting the data are detailed. An emergent set of assertions is presented to illustrate students' initial images and beliefs of their confidence and competence in curiculum areas and in science in particular.

Day: Sunday	**Location: Raffles**
Chair: Wilhelmina Van Rooy	**Session Time: 11.00 – 11.40 AM**

Robyn Gregson
University of Western Sydney

Is Writing Important In Science?

The number of students who are choosing Science in their senior years is dropping. One reason for this is that the students are finding the study of science difficult and are often disappointed in the results they get in science tests and examinations. These students believe they understand the work covered and are confused because they thought the answers they had written were good. However the way in which they expressed themselves in writing did not allow them to clearly demonstrate their knowledge and understanding of the scientific concepts they have studied. This paper will explore the depth of the problem that teachers observe in their students and the perceptions the students have of writing in science. The findings that will be discussed are part of a doctoral research program that is in its final stages.

Day: Saturday	**Location: Kingston**
Chair: Bev France	**Session Time: 1.30 – 2.10 PM**

Mavis Haigh
Auckland College of Education, New Zealand

Exploring Practicum Partnership Roles In Secondary Science Teacher Education Through Metaphor Analysis – A Case Study

Metaphoric imagery is central to our thinking as we make decisions within the myriad of our everyday contexts. Analysis of such metaphors may permit a window into otherwise unstated understandings. This paper will consider the development and expression of metaphors used by three associate teachers, a student teacher and a visiting lecturer to describe their professional relationships during a block practicum placement.

The practicum partners were interviewed regarding the roles and relationships developed during the practicum. They were also asked to explore and explain a metaphor that encapsulated their perception of their role.

The metaphoric images are explored and aligned with the participants' descriptions of their practice in order to uncover internal and external coherence and incoherence of the perceived roles.

Day: Saturday	**Location: Savoy**
Chair: Bev Stanbridge	**Session Time: 1.30 – 2.10 PM**

Mary Hanrahan
Queensland University of Technology

The A-Z Of Engaging Students In Learning Science. A: Advocating Affirmation, Allowing Adult Autonomy, Acknowledging Affect, And Advancing Authentic Science For All

Many students have difficulty understanding the concepts taught in science. However, my most recent research in science pedagogy suggests that it may be the discourse of science that alienates students before they have an opportunity to engage with the concepts. This paper makes an innovative move in combining cognitive and humanistic psychology to explore problems with conceptual change, cognitive engagement, motivation, self-

directed learning, and (the psychological) classroom climate. It concludes there is a way to engage most students while helping them improve their scientific literacy.

Day: Saturday	**Location: Savoy**
Chair: Debra Pannizzon	**Session Time: 2.15 – 2.55 PM**

Mary Hanrahan
Queensland University of Technology

An A-C Of Engaging Students In Learning Science. C: Common Sense, Cultural Context, Classroom Communities, Constructivist Curricula, Collins, Brown & Newman, Cambourne & Christie

As asserted in a companion paper proposing a psychological solution to the problem of developing improved scientific literacy for all, the way language is used in science may tend to alienate students. This paper summarises my research in science classrooms in relation to sociolinguistic theories. It addresses the development of scientific literacy as a holistic process, a process of personal change, the learning of a discourse, of a community practice, and as the teaching of genres. It concludes that if science has its own discourse, then this needs to be made more explicit both in preservice teacher education and in the science classroom.

Day: Friday	**Location: Raffles**
Chair: Megan Chambers	**Session Time: 11.00 – 11.40 AM**

Ann Harlow & Alister Jones
University of Waikato, Hamilton, New Zealand

The Implementation Of The Technology Curriculum In New Zealand: The Results Of National School Sampling Study

This paper describes the results of a national study to investigate the implementation of the technology curriculum in New Zealand Schools from years 1-13. The investigation of in the implementation of technology is part of a larger study being undertaken nationally in all curriculum areas (National Schools Sampling Study) to explore how effective the curriculum is in practice and how can the results inform future developments. The questionnaires were distributed to over 10% of New Zealand schools and 851 responses were obtained to the technology questionnaire. The key findings indicate that the most primary school teachers are aiming for curriculum coverage, have moderate levels of confidence but are concerned about curriculum over crowding. Year 7 and 8 teachers are mainly concerned about assessment whereas secondary school teachers are constrained by existing structure in schools.

Day: Saturday	**Location: Portside**
Chair: Alberto Bellocchi	**Session Time: 1.30 – 2.10 PM**

Allan G Harrison
Central Queensland University

Was Dalton's Atomic Theory Really as Revolutionary as Supposed?

The atomic philosophy began with the Greeks and the atomic theory came of age following John Dalton's research. One view is that scientific atomism developed seamlessly over this 2000 year period; another view is that Dalton's theory was a scientific revolution. I propose that atomism substantially changed during the 18C and 19C but the change was mostly evolutionary. Dalton's atomism is distinctive in the way it melds Newton and Boyle's

philosophical view of particles with the experimental data available in the early 1800s. Dalton, Gay-Lussac and Avogadro's differing interpretation of their experiments stalled the progress of the atomic theory for almost 50 years. There are distinct similarities between the effective science of the 18C-19C and the present and between the poor science of that period and student intuitive conceptions. I argue that there are useful teaching and learning lessons in studying the history of the atomic theory.

Day: Friday	**Location: Kingston**
Chair: Robyn Gregson	**Session Time: 9.45 – 10.25 AM**

Robyn Turner Harrison, Bruce Waldrip & Vaughan Prain
Latrobe University

Using Children's Curiosity In Science To Develop Language Skills

This small study, which examined the teaching and understandings of three teachers approaches to integrating science and literacy, supports research findings that there are a variety of methods of integration. Further, it describes some of the challenges which may be faced by teachers when integrating the curriculum, and adds to the literature supporting the findings that integrating science and literacy can lead to higher motivation levels for the children to read and write. This study presents evidence to contend that the more thorough the contextualisation of literacy skills with science, the greater the rate of engagement the students may be able to experience. The data shows that in each of the classrooms participating in the study, a variety of reading, writing and speaking and listening skills were developed in their science investigations. The genres seen as typically scientific, such as recounts, procedures and information texts, were utilized by all teachers. Finally, journal writing and narratives were also used by teachers with mixed results.

Day: Friday	**Location: Boardroom**
Chair: Deb Corrigan	**Session Time: 11.00 – 11.40 AM**

Mogamat Shaheed Hartley
University of Stellenbosch, South Africa

Investigation Into The Effectiveness Of A Science And Mathematics Outreach Programme For Disadvantaged Grade 12

The need to transform the South African education system has been a subject of intense debate and discussions for a number of years. Many intervention strategies adopted over the years by a variety of tertiary institutions, non-governmental organisations and others tried to address the needs in especially areas of mathematics, science and technology. In 1982 the University of the Western Cape (UWC) started an outreach programme in response to the crisis in black education and as part of its commitment to address some of the educational problems generated by the apartheid system. The Outreach Programme was directed at empowering both learners and teachers in spheres historically perceived as lacking in black education, particularly in Mathematics and Science. Although a great number of outreach programmes were and still are in operation in South Africa, very little research has been conducted to assess the effectiveness of outreach programmes. This paper deals with an application of a framework to study the effectiveness of an outreach programme in addressing the needs of disadvantaged learners in Grade 12 mathematics and physical science.

Day: Friday	**Location: Boardroom**
Chair: Tony Wright	**Session Time: 9.45 – 10.25 AM**

Janette Head & Bob Bucat
The University of Western Australia
Mauro Mocerino & David Treagust
Curtin University of Technology

Teaching And Learning About Organic Chemistry: A Representation For Every Purpose

When we teach and learn about organic chemistry at the tertiary level, we use a variety of different types of structural representation. Each type of representation is commonly used for different purposes, with different subject matter, and no type of representation is universally useful. This presentation will discuss why chemists use these different types of representation in a particular circumstance, and then describe results from current research into students' abilities to understand, interpret and appropriately use a range of structural representations.

Day: Sunday	**Location: Raffles**
Chair: Warren Beasley	**Session Time: 8.15 – 8.55 AM**

Jinmeei K Hsieh
National Chiayi University, Taiwan

Students' Conceptions After 921 Earthquake In Taiwan

This study involved both qualitative and quantitative methods to understand Taiwanese 5^{th} and 6^{th} graders' conceptions after an earthquake disaster occurred in central Taiwan on Sep. 21, 1999, called the 921 ChiChi earthquake. Sixty-five items in a paper-and-pencil test based on students' misconceptions were developed from the revisions of literature and interviews from the students to examine the children's understanding about earthquakes. The results revealed that there was a significant difference among six schools ($F=3.4$, $p<.05$). Students in school D, at ChiChi location, got the highest scores in the whole test. With the exception of School D, at ChiChi, there was no significant difference between male and female students. There was no significant difference between 5^{th} and 6^{th} graders except School D at ChiChi. The result also showed that Taiwanese students did not consider volcanoes and earthquakes to be related, and there was no significant difference between those schools situated nearby volcanoes and those situated elsewhere. The report suggested that reasons for earthquake activity are difficult for students to understand unless teaching is based on students' conceptions.

Day: Friday	**Location: Boardroom**
Chair: Huan-Shyang Lin	**Session Time: 4.15 – 4.55 PM**

Kwanghee Jo, Sangwoo Park & Jinwoong Song
Seoul National University, Korea

Students' Conceptions Of Pressure And Buoyancy In Korea

Fluid phenomena are some of the most commonly observed experiences in everyday life, and thus are frequently used in school science activities as well as in out-of-school science communications like mass media coverage. In the Seventh Korean National Curriculum of Korea, pressure and weight in water is included as one unit for grade six. Moreover, pressure and buoyancy are introduced in other units such as force, air pressure, weight, wind and so on. However, students' conceptions related to fluid phenomena have not been studied much in Korea and across the world. In this study, we focused on students' conceptions of fundamental fluid mechanics, especially pressure and

buoyancy. Questionnaries asked the physical meanings and conceptual relations between the concepts and other physical quantities. Elementary and secondary students in the Seoul area participated in this investigation and the results were analysed quantitatively as well as qualitatively.

Day: Friday	**Location: Kingston**
Chair: Hayashi Nakayama	**Session Time: 2.15 – 2.55 PM**

Ken Kawasaki
Kochi University, Japan

Confusing In The Conception "Reality": Is It Sensible Or Insensible In Science Education?

This paper presents science educators' strategy for teaching pupils to consider scientific reality in various cultural settings for science education. This strategy works on the basis of a distinction between "what exists" and "what ought to exist", namely appearance and reality. As a rule, "what exists" is explained in terms of "what ought to exist". Therefore, science teachers presuppose scientific explanation to be explained in terms of scientific reality. In the Western culture, scientific reality is definitely regarded as insensible. In the Japanese culture, however, "what ought to exist" consists of sensible things. Therefore, Japanese pupils are inclined to explain scientific phenomena they have just observed in terms of sensible things. Drawing their attention to this pupils' attitude, science educators can promote Japanese linguistic-cultural setting for science education. This strategy is applicable to other non-Western nations with proper linguistic-cultural interpretation.

Day: Saturday	**Location: Boardroom**
Chair: Chi-Yan Tsui	**Session Time: 8.15 – 8.55 AM**

Gillian Kidman
Queensland University of Technology

Textbook Blunders: Are Artists "Improving" On The Scientific Concepts They Are Illustrating?

A diagram in a science textbook has the potential to communicate important information to the reader. The reverse is also true where a diagram has the potential to communicate 'alternate frameworks' to the reader. This paper reviews the quality of diagrams in published textbooks. In textbooks there are a relatively large number of diagrams used, and unfortunately a large proportion of errors are also present. The question was asked: Are artists "improving" on the scientific concepts they are illustrating? It was found that many textbooks cover much the same subject matter, often in similar ways. As a result, there appears to be a perpetuation of errors where diagrams are not matching the facts. It is suggested that publishers, writers and artists pay attention to the quality of their diagrams.

Day: Saturday	**Location: Boardroom**
Chair: Glenda Leslie	**Session Time: 1.30 – 2.10 PM**

Gillian Kidman
Queensland University of Technology

Teaching 'Space': Are Our Diagrams Worth A Thousand Words?

The study of 'space' is part of most primary and secondary school science curricular, yet both students and teachers have 'alternative frameworks' of space phenomena. Teachers make available many diagrams and picture books on the assumption they make the understandings easier for the students. This paper reviews the presentation of 'space'

in a Year 6 classroom with particular attention to the students' understanding and interpretation of common diagrams used in the teaching. Many errors were found in the diagrams. The question addressed was: What does or does not go on in the mind of the student when s/he inspects a diagram during instruction? It was found that many students form 'alternative frameworks' from the diagrams presented, often at odds with those of science educators. An argument is made for both publishers and teachers to take special care in the selection of diagrammatic materials for students.

Day: Saturday	**Location: Savoy**
Chair: Hon Suen Ma	**Session Time: 11.00 – 11.40 AM**

I.Kim, D.Yang, S.Jeong
Chungbuk National University, Cheongju, Korea
Jongwon Park
Chonnam National University, Gwangju, Korea

Student's Responses On Conflicting Experiments With Different Strengths Of Discrepancies Between Preconception And Experimental Data

In this study, we investigated the students' responses on the conflicting experimental data with different strengths of mismatches between students' preconception and the results of experiments.

To do this, we examined students' preconceptions on the changes of current through an electric bulb as the applied voltage increased. After selecting the students who answered that the currents would linearly vary with the voltage, we divided them into six groups, and presented six experimental results with different strengths of discrepancies between students' preconception and the experimental data. The strengths of discrepancies were controlled by adjusting the percentages of deviations from the linear relation from 10 to 60%. After presenting data, we let students plot a graph, interpret the graph, and answer about the change of their prior ideas. As a result, it was observed that more students felt cognitive conflict and changed their own prior ideas as the percentage of deviation increased. And, interestingly, we observed the critical value of discrepancy in which the rate of conceptual change increased rapidly. This interesting finding could be observed in other tasks. Based on this finding, several comments for better understanding of the process of conceptual change were suggested.

Day: Friday	**Location: Kingston**
Chair: Richard White	**Session Time: 11.45 – 12.25 PM**

Young-Min Kim & O-Gun Cho
Pusan National University, Korea

Middle School And University Students' Alternative Ideas About Magnetism And Electromagnetism

It is important that we know which kind of ideas the students have about magnetism and electromagnetism before and after formal instruction. So the purpose of this research was to investigate the Korean students' alternative ideas about magnetism and electromagnetism.

For this research 31 subjects, 7th graders, were sampled from the applicants for gifted education in Pusan National University, who were nominated as science high achievers by their science teachers. And one average class, 35 students, was sampled from middle school, and 127 students from one university in Pusan city, Korea, for comparing students' ideas by ages.

Tools for investigation of the pupils' alternative ideas about magnetism were developed by the authors.

Research findings are as follows:

(1) Some pupils, even though they were science high achievers at school and university freshmen, think that a magnet can be separated into two magnets having only mono-pole.
(2) Most children think that the core of an electromagnet should be an electrical conductor, and many children and university students think that current in the coils flows through the core conductor. And it causes the core to attract iron nails.
(3) Many students, even being science high achievers and university freshmen, think that electromagnets do not affect pointing of compass needles around it, they answered that the compass needles always point south and north directions even though there is electric current close to them.

Day: Saturday	**Location: Kingston**
Chair: Jim Woolnough	**Session Time: 9.45 – 10.25 AM**

Geoff Lawrance & David Palmer
University of Newcastle

A Study Of Science Teacher Education Programs Across Australia

This session will report the results of a DETYA EIP (Evaluations and Investigations Program) project carried out during 2001. The study was designed to describe practices in science teacher education programs across Australia, with the aim of encouraging cross-fertilisation of ideas between institutions. Telephone interviews were used to obtain information from science education specialists at all Australian universities involved in teacher education. Information was obtained about the structure of programs offered, estimates of enrolments, interesting or innovative features, and constraints/ difficulties for the programs. The presentation will consist of a brief overview of the main findings with respect to each of the terms of reference.

Day: Sunday	**Location: Kingston**
Chair: Chi-Ming Tu	**Session Time: 8.15 – 8.55 AM**

Sung-Yi Lee & Young-Min Kim
Pusan National University, Korea

Middle School Students' Ideas About Electromagnetism And Their Conceptual Change By Teaching Using Generative Learning Model

The purposes of this study were to investigate middle school students' conceptions about electromagnetism and their conceptual change by teaching using the generative learning model.
The subjects, four classes, for this study were sampled from two schools, two classes from a boys' middle school, the other two from a girls' middle school in the same area of Pusan city in Korea. One class from each school was the experimental group, and the other class was the control group. Tests were applied before and after instruction based on generative learning model.

Many students thought that the core of an electromagnet should be an electrical conductor, and that the current in the coils flows through the core of an electromagnet. And many students thought that the current in the core causes the magnet to attract iron pins. More students in the experimental groups than control groups changed their ideas towards scientific conceptions, and the difference between the two groups was statistically significant.

Day: Saturday	**Location: Kingston**
Chair: Jinwoong Song	**Session Time: 3.30 – 4.10 PM**

Glenda Leslie
Murdoch University

Factors Affecting The Teaching Of Biotechnology In Lower Secondary Schools

A questionnaire was administered to science teachers of Year 10 students in secondary schools to first, to elicit reasons that lead teachers to avoid biotechnology, and second, to identify what they believe is the help required that would encourage them to teach biotechnology. Biotechnology is an important emerging area of knowledge for students because of the impact it will have on the environment, health care and their life decisions. For students to make informed decisions, they will need knowledge of the choices available and the consequences of such choices. By helping teachers to recognise the knowledge and skills they require for teaching biotechnology, we can begin to develop principles of effective pedagogy in this area. Preliminary results from the analysis of the questionnaire data will be presented.

Day: Friday	**Location: Savoy**
Chair: Chung-Chi Chen	**Session Time: 3.30 – 4.10 PM**

Ka Yin Leung
The Open University of Hong Kong

A Study Of Students' Alternative Ideas About Particulate Nature Of Matter In Secondary Schools In Hong Kong

This study aims to investigate the "concepts" which secondary school students have on the topic of particulate nature of matter to explore the possible source of their alternative ideas.

Research on this aspect of studying alternative ideas about particulate nature of matter is rather unusual in Hong Kong. The methodology of this research was based on some similar findings in foreign countries.

Two questionnaires with open-ended type questions and multiple-choice questions type were administered to students, aged 15 - 19, in seven secondary schools in Hong Kong. The test results were categorized according to the level of sophistication of the answers and the popularity of the set options. Fifty-seven students were selected for an interview after the survey.

The results of this research showed that the meaningful learners performed significantly better than the rote learners. It is envisaged that some educational and research implications of the findings might improve the educational direction of teaching chemistry in Hong Kong.

Day: Friday	**Location: Raffles**
Chair: Mogamat Hartley	**Session Time: 3.30 – 4.10 PM**

Huann-shyang Lin
National Kaohsiung Normal University, Taiwan

Students' Understanding About The Nature Of Science And Their Problem-Solving Strategy

The purpose of this study was to examine the relationship between students' understanding about the nature of science and their problem-solving strategy. A total of 620 year 8 students took the first and the second conceptual

problem solving tests as well as the survey of the nature of science questionnaire. Eight of them were selected for follow-up interviews. The result of stepwise multiple regression indicated that the sub-scale of the nature of scientific method consistently appeared as the best predictor of student problem-solving ability. It was also found that problem-solving strategies were varied between the students who were high scorers and those who were low scorers on the nature of science survey.

Day: Friday **Location: Boardroom**
Chair: Janette Head **Session Time: 11.45 – 12.25 PM**

Huann-shyang Lin & Thomas C Yang
National Kaohsiung University, Taiwan
Zuway-R Hong
University of Minnesota, USA

Students' Difficulties Of Learning In Electrochemistry

The purpose of this study was to investigate the difficulties of student learning in electrochemistry, The answers of an open-ended test on electrochemistry from a group of 9th graders 12th graders, and college chemistry majors students were compared and analyzed. The result of frequency analyses of student misconception and additional interview data revealed that a higher percentage of college students misunderstood the function of the electrolytes in an electrochemical cell than did the 9th and 12th graders. It is likely that more advanced study of chemistry does not necessarily result in better understanding for some particular basic concepts. More importantly, if these concepts were not thoroughly clarified, students' misconceptions may become more firm and widespread as they progress on leaning chemistry from secondary school to college. It was also found that the student misconceptions could be related to the pictures and statements of textbooks and classroom instructions.

Day: Saturday **Location: Kingston**
Chair: Ikgyun Kim **Session Time: 2.15 – 2.55 PM**

Hon Suen Ma
Hong Kong Institute of Education
John Loughran
Monash University

Creative Activities:
An Experimental Inquiry Approach For Science Teacher Education

Experimental investigation and the use of inquiry have been well noted as essential elements for the provision of effective science teaching and learning in schools. However, there are many different views on how the teaching of science through inquiry can be applied in primary schools. In Hong Kong, science is integrated with health education and social studies and is taught in the form of a combined subject—General Studies.

In this paper, surveys on teaching General Studies have found that teachers rarely or only occasionally carry out experimental inquiry activities in teaching the science part of the General Studies curriculum in Hong Kong. Many reasons for not conducting experimental inquiry activities in schools have been highlighted and one of the major reasons is that teachers themselves generally feel less than competent to do so.

The first author has been attempting to address this difficulty with student teachers through the overt use of experimental inquiry approaches in his teacher education program. In this research, a group of practicing teachers enrolled in the Bachelor in Education (part-time mode) were guided to design some simple experiments or they designed their own experiments in the learning process of some selected science units. Pre- and post-tests were

conducted to study the impact on knowledge construction and participants' views about implementing experimental inquiry of this kind were also canvassed.

This paper considers the influence and impact of this approach on student teachers in an attempt to begin to address the outstanding difficulty (sense of inadequacy to teach science) that is prevalent for many Hong Kong General Studies teachers.

Day: Saturday	**Location: Boardroom**
Chair: Michael Michie	**Session Time: 11.45 – 12.25 PM**

Sumida Manabu
Ehime University, Japan

Can Post-Modern Science Teachers Change Modern Children's Images Of Science?

The 20th Century is the century of progress in science and technology. Since science and science education have spread around the world, we are now able to compare our children's science achievement in the world. However, there are very few studies on children's hidden presuppositions to perceptions about science and scientists in non-western countries, especially in Asia. In this study, Asian children's images of science and scientists are investigated by using the Draw-a-Scientist-Test Method. It includes areas of China, Indonesia, Korea, the Philippines, and Japan. Asian children's images reveal some kinds of amalgams of their indigenous science and western modern science. The results show that experiences of Asian countries in globalization of science education contain many issues about culture, language, and gender in education. It is the legacy of the 20th century of which Post-modern science teachers should take care in their science classrooms.

Day: Saturday	**Location: Portside**
Chair: Garry Hoban	**Session Time: 2.15 – 2.55 PM**

Michael Matthews
University of New South Wales

The Distinction Between Data, Phenomena And Theory In Scientific Theorising And In Science Education Research

It is important in science to distinguish data from phenomena, and both of these from theory. The data are observed, phenomena characteristically are not. Scientific laws and theories are about the phenomena, not about the data. If this is understood, then perhaps a number of enduring puzzles about science, science learning and research in science teaching become clearer. This is a frankly exploratory paper that will investigate this potentially useful line of analysis.

Day: Saturday	**Location: Portside**
Chair: Michael Matthews	**Session Time: 11.00 – 11.40 AM**

Paul McIlwee
St. Catherine's College, Trinity College Dublin

Is A Constructivist Pedagogy Tenable?

What teachers do in their classrooms depends on many factors but should one of them be a consideration of a constructivist view of learning? Millar (1989) has pointed out that such a view does not imply a constructivist pedagogy. This paper reports on a study that examines the relative changes that take place in students' understanding of the process of boiling as a result of formal methods of teaching and a cognitive conflict approach. The argument is made that the role of the teacher is to bring pupils nearer to the 'truth' in a scientific sense and that in dealing with the complexities of learning the teacher must make judicious use of both formal and informal approaches. The problem at the moment is an overuse of a transmission method of teaching. This is particularly true in Ireland but similar concerns have been expressed by Bentley (1998) in the USA and by the DETYA in a report on the status and quality of teaching in Australian schools (2001).

Day: Friday	**Location: Savoy**
Chair: Judy Moreland	**Session Time: Symposium 1.30 – 2.55 PM**

Elizabeth McKinley
University of Waikato, New Zealand

Educating For Rationality: Science Education, Indigenous Peoples And History

Aotearoa New Zealand has, since colonization, undergone a 're-naming' or 'worlding' exercise – from the re-labelling of physical features of the landscape through to the compulsory English medium schooling in Maori schools. This 'worlding' has targeted, in particular, *te reo Maori* (the Maori language). This paper examines how this 'worlding', since times of contact between Maori and European, has occurred and its historical and continuing implications for science education in Aotearoa New Zealand.

Day: Friday	**Location: Savoy**
Chair: Judy Moreland	**Session Time: Symposium 1.30 – 2.55 PM**

Elizabeth McKinley
University of Waikato, New Zealand
Dr Peter Ninnes
University of New England

Science For All? New Challenges To Science Education For The 21st Century

Since Peter Fensham's paper 'Science for all', published almost 20 years ago, the wider community of scientists in Aotearoa New Zealand and Australia remains predominantly white, suggesting science and science education practices fail miserably to be truly inclusive of a diverse range of peoples. Our contention in this paper is that the current theorizing, research and practice in science education is totally inadequate to even begin to address this issue, particularly for the indigenous populations of the countries. At the same time, we do not think that there is a simple solution. We will argue that in order to provide a quality science education for all, then we have to present a 'warts and all', rigorous and critical science education that takes account of and recognizes a number of things. First, the complicity of science in a range of worthwhile and unflattering social phenomena that have formed the basis of closely held attitudes regarding science and its practices. Secondly, the diverse experiences and backgrounds of students need to be theorized without essentializing and 'othering'. Thirdly, the recognition and cognisance of the existence of diverse ways of understanding the world, including the contingent and contextualized 'nature' of various knowledges, that includes science knowledge. And fourthly, the need to move away from simplistic, 'evangelical' accounts of science and conceptual correction models of science education towards a focus on acknowledging complexity and teaching students to apply scientific knowledge in a wise and appropriate way.

Day: Saturday	**Location: Kingston**
Chair: Elizabeth McKinley	**Session Time: 9.00 – 9.40 AM**

Louise Milne, Megan Chambers, Judy Moreland & Alister Jones
University of Waikato, New Zealand

Application Of An Analytical Framework To Describe Young Children's Learning In Technology

This paper will describe a framework for describing how young students (5-6 years) learn in technology and the methods employed to undertake the analysis of student work. Case studies of analysed student work will be presented. These case studies show the complexity of learning in technology, what young children can achieve and associated teaching strategies. The holistic aspects as well as the associated variables will be highlighted. Also shown will be how we can use the analysis of student work to enhance teaching practice in technology.

Day: Saturday	**Location: Portside**
Chair: Jim Scott	**Session Time: 8.15 – 8.55 AM**

Ian Mitchell
Monash University

Making Use Of Teacher Research In Teacher Education

Over the last 18 years, teacher researchers in the Project for Enhancing Effective Learning (PEEL) have developed a rich body of wisdom about improving the ways students learn. Much of this is now on a database that is proving to be a unique and valuable resource in teacher education courses. It fulfils several purposes. It allows the (very sensible) maxims that litter such courses to be richly connected to practice. It provides both teacher educators and their students with a wide range of innovative ideas for teaching, provides users with new ways of organizing these ideas about practice and it provides ways by which student teachers can begin a journey of innovation and adaptation. In this session I will demonstrate the database and share lessons I have learnt about using this resource in both pre and in-service education.

Day: Sunday	**Location: Savoy**
Chair: Jongwon Park	**Session Time: 8.15 – 8.55 AM**

Richard Monypenny
James Cook University

One Way To Represent Learning And Teaching Science

Learning and teaching at tertiary level is complex. One way to represent this complex system is to use a systems thinking framework. Such a framework can help us to understand better, can help us to make learning more relevant, and can help us to manage this complex system better.

This paper first briefly explores the current literature linking systems thinking and learning and teaching science at tertiary level. Second, it briefly outlines an example in learning and teaching project management. Third, it attempts to encourage science educators to explore further the links between systems thinking and learning and teaching science at tertiary level.

Day: Friday	**Location: Portside**
Chair: Bev France	**Session Time: 9.45 – 10.25 AM**

Judy Moreland, Alister Jones, Louise Milne, Ann Harlow & Megan Chambers
University of Waikato, New Zealand

Mapping Student Progress In Becoming Technologically Literate And Strategies To Enhance This Progress

This paper will describe a framework for describing how students progress in learning technology. Gaining insights into progression is essential if we are to enhance student technological literacy. We describe the characteristics of learning technology in terms of students developing understanding of the nature of technology, dimensions of student technological practice (holistic) and generic and specific conceptual, procedural, societal and technical aspects. This framework was developed from our initial examination of student work over the last three years and includes 1500 pieces of student work as well as teacher interviews and lesson plans. We are now applying this framework to examine a national sample of 3% of student work at years 4 and 8. Initial evidence of progression will be discussed. In the second part of the paper we examine ways in which we have enhanced student performance in technology.

Day: Friday	**Location: Savoy**
Chair: Ken Kawasaki	**Session Time: 9.45 – 10.25 AM**

Hayashi Nakayama & Rumiko Kawano
Miyazaki University, Japan

Japanese Science Teachers' Notion Of Whether Nature Is Explainable

Clearly, there is a difference between "to observe nature" and "to contemplate nature": what is obtained from nature in observing is not the same as is obtained in contemplating. Structural linguistics explains this difference by "syntagmatic relation". Since each language establishes innate syntagmatic relations to the language concerned, it is highly probable that even in science lessons Japanese teachers differently obtain from "nature" through the Japanese equivalent of "to observe": "kansatsu". In order to reveal this, we conducted a questionnaire survey whether "nature" is explainable, and received answers from 76 science teachers. Almost all of them do not agree that "nature" is explainable. Referring to the proverb "To see is to believe", some of them stress the importance of contemplating phenomena and having their images, and appreciate pupils' expressing phenomena without words. In Japan science teachers must have different notions about "to observe" and "to describe" from those of science teachers in western countries.

Day: Saturday	**Location: Boardroom**
Chair: Sumida Manabu	**Session Time: 3.30 – 4.10 PM**

Dianna Nichols & Allan Harrison
Biloela State High School and Central Queensland University

Prolonged Interaction With The Natural Environment: A Study Of Students' Cognitive And Affective Change

When a Queensland high school introduced a new Multi-Strand Science program, the focus of its environmental studies unit changed. The traditional single visit to an unfamiliar environment was replaced with many visits to a local environment. The study investigated the degree to which prolonged engagement with the local environment brought cognitive and affective changes in the students' attitudes. Quantitative data were collected using the Questionnaire of Teacher Interaction (QTI) and a variety of qualitative methods including reflective journal writing, complex reasoning questions, a field report and a free form essay were used to probe students' ideas. Quantitative

data suggest that the class' perception of the teacher was positively enhanced and qualitative data support this finding. Qualitative data indicated that the students' attitudes towards the environment also rose over the same period. Ideally, these tools can be used to probe the extent of changes in students' attitudes over time.

Day: Friday	**Location: Savoy**
Chair: Judy Moreland	**Session Time: Symposium 1.30 – 2.55 PM**

Peter Ninnes
University of New England

Paying Attention: Science Education, Diversity, And A Catalogue Of Possibilities

In this paper I explore some of the possibilities for science education and science curriculum when we pay serious attention to cultural and social diversity issues. Drawing on an ongoing set of research projects in Australia, Canada and Aotearoa New Zealand, I examine issues related to curriculum material selection, analysis, and development, and explore the implications for science teachers and curriculum specialists.

Day: Sunday	**Location: Savoy**
Chair: Trish Bell	**Session Time: 9.45 – 10.25 AM**

Masakata Ogawa
Kobe University, Japan

A Stratified Knowledge Model For Comprehensive Science Education

Recent research in knowledge production has revealed different types of knowledge (for example, Mode I and Mode II) in our contemporary era. In scientific and technological knowledge realm, we can also try to examine whether or not our knowledge is a mixture of different types of knowledge. This paper aims to propose and discuss a stratified knowledge model, where different types of knowledge derived from respective ways of life are embedded in a form of multi-layer, for deliberating the way how comprehensive science education in different types of society should be. As such ways of life, 1) hunting-gathering, 2) agricultural-nomadic, 3) manufacturing-industrial, and 4) techno-informatic are identified, and scientific and/or technological knowledge in any contemporary society is interpreted as such a multiple form of knowledge with different proportion of respective type of knowledge. Several implications of the model to comprehensive science education in contemporary era are discussed.

Day: Sunday	**Location: Portside**
Chair: Masakata Ogawa	**Session Time: 11.45 – 12.25 PM**

Hisashi Otsuji
Ibaraki Univeristy, Japan

Confirming The Idea "Boys And Girls Learn Differently"

This paper tries to support the assertion that *boys and girls learn differently* through empirical data analysis.

The author divides subjects of university students into two groups from their responses to a questionnaire. The first group had common tendencies which are typical in boys, while the second group had tendencies typical in girls. Then, all subjects were given a certain everyday life situation to solve. Each subject chose one instructional approach from two: algebraic approach or model operation approach. Indicating the relations between gender tendencies and the performance due to the type of instructions, the importance of gender sensitive learning approach will be claimed.

Day: Saturday	**Location: Savoy**
Chair: Geoff Rogers	**Session Time: 11.45 – 12.25 PM**

Debra Panizzon, John Pegg & Michaela Inglis
University of New England

Addressing Changing Assessment Agendas: Experiences Of Secondary Science Teachers

Recent changes to secondary science syllabus documents in New South Wales require teachers to identify what their students know and what they can do. The move away from using quantitative measures as the sole means of assessing students has led teachers to consider both the purpose and types of assessment used in their classrooms. This paper describes the initial experiences of secondary science teachers in rural schools in New South Wales as they begin to explore the changing nature of assessment and the implications it has for their own classroom practice. The science teachers had completed the first-year of a two-year study during which time they attended a series of four workshop sessions and received ongoing consultative support. Two important findings emerged from the involvement and experiences of teachers from this initial year. First, teachers used the assessment responses provided by students to gauge scientific understanding in such a way that it identified both strengths and weaknesses. Second, teachers considered the assessment responses as a means of improving their teaching practices so as to enhance student learning. The study is now in its second-year, with teachers currently working on a number of different aspects related to assessment that are contextually relevant to their own teaching situations.

Day: Friday	**Location: Raffles**
Chair: John Loughran	**Session Time: 2.15 – 2.55 PM**

Jongwon Park
Chonnam National University, Korea
Ikgyun Kim
Chungbuk National University, Korea

Analysis Of Students' Processes Of Generating The Scientific Explanatory Hypothesis

In recent research, it was found that generating the explanatory hypothesis which could explain the conflict phenomena was important for conceptual change. In this study, we investigated how students generated the explanatory hypothesis. To do this, we assumed four stages of generating the hypothesis: observing the phenomena - generating causal questions - exploring the relevant information - suggesting a new explanatory hypothesis. Six college students were interviewed according to the assumed four stages. As a result, it was found that students explored the information in two types of spaces in order to generate the hypothesis, that is, the space of background knowledge and the space of experiment, and the levels of the hypothesis suggested by students could be classified into an auxiliary hypothesis and a new theoretical hypothesis. Finally, we could identify four types of sources for the new explanatory hypothesis, and from the findings, implications for improving the conceptual change through scientific inquiry activity were suggested.

Day: Friday	**Location: Kingston**
Chair: Trevor Bond	**Session Time: 11.00 – 11.40 AM**

Andreas Redfors
Kristianstad University, Sweden
Hans Niedderer
University of Bremen, Germany

On The Use Of Cognitive Layers In Describing A Learning Process About Electric Circuits

Learning processes of three college students (prospective elementary school teachers) in the content area of electric circuits have been investigated in a tutorial study. Empirical evidence of cognitive development is coming from an interpretive analysis of transcripts of six tutorial sessions, in which the students use hands-on experiments and special computer software. Data from 1991 are re-analysed with respect to a new theoretical model of cognitive development assuming the use of cognitive layers, both during the learning process and at its end. We believe that the empirical data can be explained by assuming that the state of the learner's cognitive system at any time is an association of co-existing models, i.e. that there are different layers of the cognitive system. A cognitive system is a model of a student's mind constructed by the researcher.

Day: Sunday	**Location: Raffles**
Chair: Atsushi Yoshida	**Session Time: 9.45 – 10.25 AM**

Léonie J. Rennie
Curtin University of Technology
Gina Williams-Pearce
Australian National University

Changing The Way Communities Think About Science: An Ambitious Project

One of the outcomes of the Commonwealth Government Report entitled *The Status and Quality of Teaching and Learning of Science in Australian Schools* was a project contracted to the Australian Science Teachers Association to increase the community's awareness of science, what science is and what science can do. The project developed a science-awareness raising model that is currently being field-tested by schools and their communities in most Australian States and Territories. The essential challenge for the project was to involve members of the community in a project that changed how they thought about science. This paper describes the development of the project and focuses on perhaps the greatest research challenge: how to determine whether people change their ideas about why science is important; why time is spent on it at school; and why scientific literacy is a desirable outcome of schooling for all students.

Day: Saturday	**Location: Portside**
Chair: Rick Connor	**Session Time: 11.45 – 12.25 PM**

John Ridd
James Cook University

Attainment In Maths And Science To Year 10 In Queensland: A Tragedy In One Act

For the highly sequential subjects Maths and Physical Science the quality of student experiences and outcomes in Years 8/9/10 is of prime importance. The significance of early Secondary years is re-emphasised in the recent 'Longitudinal Survey of Australian Youth' which showed a high correlation exists between literacy/numeracy performance in Year 9 and final ENTER results. This paper examines Years 9 and 10 in Queensland. It

demonstrates that as a consequence of the legislative framework there is no real knowledge of the condition of Science and that the only Maths study gives cause for serious concern. Syllabi for rigorous Maths and Physics in Year 11/12 emphasise the importance of Maths as a tool. There is hence a discontinuity at the Year 10/11 interface. As a consequence many students are poorly prepared for rigorous Maths and Physical Science courses in Year 11 with probable deleterious effects on enrolment numbers and outcomes.

Day: Sunday	**Location: Kingston**
Chair: Marilyn Fleer	**Session Time: 11.00 – 11.40 AM**

Donna Rigano, Stephen Ritchie & Trish Bell
James Cook University

Scaffolding For Science Inquiry: Co-Teaching In A Primary Classroom

This paper reports on one aspect of a study that investigates the impact of the application of a relatively new model of professional development, known as "coteaching", at a primary school. It demonstrates the significance of scaffolding children's participation in science activities as they progress towards initiating self-selected science inquiries. In collaboration with the classroom teacher, the authors implemented an inquiry approach to science teaching in a Year 1 / 2 composite class. Through a participatory research design involving classroom observations, discussions between participating researchers, and interviews with parents and students, this paper provides an interpretive account of how scaffolding is an essential element in the coteaching model. This scaffolding process incorporates building a science-like discourse community within the classroom, as well as providing a supportive context for teachers to transform their science teaching beliefs and practices.

Day: Saturday	**Location: Savoy**
Chair: Ka Yia Lung	**Session Time: 3.30 – 4.10 PM**

Geoff Rogers
Queensland University of Technology
Doug Hill
Charles Sturt University

Engaging Spirituality In Teaching And Learning Primary Science

In recent years there has begun to be a resurgence of interest in educating the so called *whole* child in response to an over emphasis on basic skills teaching and measuring outcomes particularly in English and Mathematics. In some places this has led to an increasing interest to incorporate aspects of spirituality in the curriculum. In this paper initial primary teacher education students at a regional Australian university were asked to explore and discuss their beliefs about notions of spiritualty and possible links to science teaching and learning. A survey was one of the instruments used to obtain data together with focus group discussions and informal interviews with individual students. Arising from the findings a number of implications for teacher educators are suggested. It is maintained that these implications are able to assist future primary teachers work towards using science teaching and learning as a vehicle for fostering and nurturing children's spiritual growth and development.

Day: Friday	**Location: Portside**
Chair: Donna Rigano	**Session Time: 2.15 – 2.55 PM**

Jenny Rogers & Bruce Waldrip
Latrobe University

Science Contextualisation In Teaching Literacy To Prep Children

The study explores how contextualualised learning of science and literacy can enhance the development of literacy skills and conceptual understandings for children in the Preparatory year of schooling. The sample was one class of Prep children in which thematic integration of the curriculum was claimed to be practiced. Data was collected through observations, teacher records, student work samples and post-test interviews.

The results of this study indicate evidence of children's developing literacy skills even when the development of science concepts ware often incidental. The children were stimulated to learn through science and post-test interviews revealed they were often able to express conceptual understandings beyond their ability to read and write. It is argued that student learning would be enhanced to a greater extent through a program that more clearly identified specific and relevant science concepts, whilst using language as the vehicle for teaching and learning those concepts and developing literacy skills.

Day: Saturday **Location: Foyer**
Chair: **Session Time: Morning Tea**

Jacqueline B. Rojas
Curtin University of Technology
Terence Gan & Nancy J. Pelaez
California State University, Fullerton, USA

POSTER PAPER:
Comparison Of Ideas About Human Blood Circulation For Fifth Grade Students Versus Prospective Elementary Teachers

A previous study reported that prospective elementary teachers (PETs) had problems understanding diffusion and the blood pathway. This study compared the pre-instruction conceptions about human blood circulation for fifth grade students versus PETs. Few children mentioned Oxygen or air; none mentioned Carbon Dioxide. Like PETs, most fifth graders believed that blood flows throughout the body, but no fifth graders distinguished arteries from veins. 27 % of children and 19 % of PETs could not show how blood returns to the heart from the extremities. An alternative conception, shown by 69 % of children and 35 % of PETs, depicted blood leaving the heart and traveling from extremity to extremity before returning. Apparently inaccurate ideas about blood circulation develop independent of instruction, whereas problematic ideas about gas exchange are a by-product of instruction. Results suggest that elementary instruction address fifth graders' inaccurate blood path ideas; leaving gas exchange to more careful study in secondary school.

Day: Sunday **Location: Savoy**
Chair: Ken Appleton **Session Time: 11.45 – 12.25 PM**

Jacqueline B Rojas
Curtin University of Technology

Viewing Floating And Sinking Through Digital Video Technology: Discovery Of An Alternative "Movement" Conception In English Language Learners

This study explored conceptual understanding of floating and sinking through interviews about instances to reveal the beliefs held by fifth grade students on this phenomena. Pictorial prompts stimulated conversations with children who were learning English as a Second Language, in an effort to provide more comprehensible input for response. Implementing this time-intensive interaction around a single subject in a self-contained, multi-subject classroom was made possible through the use of digital video technology. Review and coding of video recordings made by a university undergraduate allowed the classroom teacher to reflect on an alternative "movement" conception

discovered among one-third of her students. Discussion of the results with science education faculty and their community service learning students during weekly seminars enabled the teacher to take this alternative conception into account in monitoring her classroom instruction. Collaboration among university faculty, classroom teachers, and undergraduate science majors was the key to bridging research into practice.

Day: Friday	**Location: Raffles**
Chair: Daniel Tan	**Session Time: 4.15 – 4.55 PM**

Verner Schilling
University of Southern Denmark

The Role Of Theory In Practical Work In Physics Education

A case study involving a physics class in upper secondary school will be presented. The purpose of this case study has been to study the interrelation between theory and experiment when students work on experimental problems, the understanding of which involve physics theory to a considerable degree. The study has concentrated on the students' difficulties with establishing a theoretical understanding of a specific experimental situation, and on the develpment of their ideas of which problems may be asked in the context of an experimental situation. With reference to these case studies as well as to theoretical considerations, it will be argued that at this level of physics education there is a strong interrelation between theory and experiment, and that students can, and indeed often must, develop their theoretical understanding in the course of working on experimental problems.

Day: Saturday	**Location: Portside**
Chair: Ian Mitchell	**Session Time: 9.00 – 9.40 AM**

Jim Scott
NSW Department of Education and Training

The Use Of Video As A Stimulus To Professional Development

The NSW Department of Education and Training has provided its secondary science consultants with a CD-ROM containing video images and related sound of seven science teachers working with their students. The video footage contains examples of good responses by those teachers to new demands placed on science teachers by the recently released science syllabus for secondary students in Years 7 to 10. Feedback on the ways in which the consultants have been using the video with science teachers will be provided and a preliminary assessment, based on that experience, of the relative value of this resource as a stimulus for ongoing professional development given.

Day: Friday	**Location: Portside**
Chair: Jacqueline Rojas	**Session Time: 11.00 – 11.40 AM**

Rowena Scott
Central Queensland University
Darrell L. Fisher
Curtin University of Technology

Boys' & Girls Perceptions Of Their Science Teachers' Interpersonal Behaviour

Girls typically outperform boys on secondary science examinations in Brunei. Significantly more girls than boys are streamed into top classes. Students in teacher-centred classrooms seated at separate desks, often with the boys at the front of the class, is the custom in this Islamic society. Do teachers interact in the classroom differently with boys

from with girls? An investigation into primary science classrooms seemed a worthwhile starting point. Numerous observations were collected as qualitative data. Also all students in 23 typical primary schools in Brunei responded to a version of the Questionnaire on Teacher Interaction (QTI). The QTI has been demonstrated to be a useful tool to determine perceptions of eight aspects of teachers' interpersonal behaviour: leadership, helping/friendly, understanding, student responsibility and freedom, uncertainty, dissatisfied, admonishing, and strict. Associations between students' perceptions of their teachers' interpersonal behaviours and their external examination result in science were investigated.

Day: **Friday** **Location:** **Savoy**
Chair: **Rod Fawns** **Session Time: 11.00 – 11.40 AM**

Elisabeth Settelmaier & Peter C Taylor
Curtin University of Technology

Using Autobiography To Map An Interpretive Researcher's Sensitivities Towards Her Subject/s

In this paper we shall argue that autobiography can be a useful means of establishing the personal/professional significance of research into teaching and learning. According to Denzin and Lincoln (2000) the gendered, multiculturally situated researcher approaches the world with a set of ideas (ontology), that specifies a set of questions (epistemology) that are then examined (methodology) in specific ways. The ontological, methodological, and epistemological choices related to the research can be traced back to the researcher's autobiography. Autobiography can thus help educators map their growing consciousness by identifying nodal moments in their lives and by revealing patterns of experience. We shall illustrate our argument with the example of how the first author's autobiography strongly influenced her research choices. Relating her upbringing in post-war Austria to an inquiry into moral education within a science education context allows for reinterpretation for both, reader and writer.

Day: **Saturday** **Location:** **Raffles**
Chair: **Mavis Haigh** **Session Time: 2.15 – 2.55 PM**

Keith Skamp
Southern Cross University
Eddie Boyes & Martin Stanisstreet
University of Liverpool, England

Conceptions Of Air Quality: An International Study

This international study (England, Greece, Hong Kong, Australia) obtained survey data about conceptions of the nature and composition of polluted and unpolluted air, biological consequences of air pollution, acid rain and greenhouse effect and what students believe could be done about reducing air pollution. The items were formulated by the Environmental Education Research Unit, University of Liverpool, following a range of student interviews. It is the first major Australian study of specific student environmental science conceptions. A pilot run determined that the items were suitable for Australian students. A random sample (n~1500) was selected from NSW Government schools with approximately equal numbers from city and regional centres and students across years 6, 8 and 10. Data analysis was across themes, age ranges, gender and location (city/country and across nations). Pedagogical implications are discussed, e.g., of student views about the importance of education, obligation, legislation or taxation as a way forward.

Day: Saturday	**Location: Boardroom**
Chair: John Ridd	**Session Time: 2.15 – 2.55 PM**

Jinwoong Song
Seoul National University, Korea
Sook-Kyoung Cho
Pohang University of Science and Technology, Korea

Yet Another Paradigm Shift?: From Minds-On To Hearts-On

Since science began to be taught in schools, school science education has experienced many substantial changes in its goals and nature over the period. The historical changes are usually referred by some key terms, like, science for common things, heuristics, general science, inquiry, scientific literacy, science for all, misconceptions. To characterize these changes, science educators frequently use some slogan-like analogies referring a part of human body to indicate the movement of science education during a particular period of time: for example, 'Hands-On' for inquiry movement during 1960s-70s, 'Minds-On' for constructivist movement during 1980s-90s. In this presentation, we briefly summarize the overall historical development of science education, then further expand the analogies to cover the overall historical process, that is, Ears-On $\rightarrow$ Eyes-On $\rightarrow$ Hands-On $\rightarrow$ Minds-On. In addition, to illustrate new directions of science education of the 21st century, we propose a new analogy, 'Hearts-On' science education, and also discuss the meanings and implications of 'Hearts-On' analogy by illustrating how this analogy can be applied to reflect various current changes in science education (e.g. from school to society, from convergent to divergent, from knowledge to wisdom, from learning to participating, from understanding to feeling, from science as a discipline to as a culture). In addition to some possible ways of delivering 'Hearts-On' science education, a parallel historical change between school science and science museums will be discussed.

Day: Saturday	**Location: Boardroom**
Chair: Hanna Arzi	**Session Time: 11.00 – 11.40 AM**

Bev Stanbridge
St Mary's College, Cairns

Investigating A Strategy For Encouraging Meaningful Learning In High School Science Classes

This paper describes the development and subsequent evaluation of a teaching strategy designed to enhance meaningful learning in science classes. The strategy, which is based on a radical constructivist pedagogy, was used to teach two consecutive, term-long units to six successive cohorts of 13 and 14 year old High School science students.

Qualitative data concerning the evolving nature of students' constructs and their attitudes towards a significantly different approach to teaching and learning along with measurements of changes in the levels of sophistication of students' understanding of science experiences and changes in their apparent cognitive abilities were used to assess the success of the strategy.

The presentation will focus mainly on the actual nature of the strategy and its implementation in the classroom.

The implications of the findings of this research for teaching science and for generating further avenues for investigation will be discussed.

Day: Sunday	**Location: Portside**
Chair: Hisashi Otsuji	**Session Time: 11.00 – 11.40 AM**

Ayumi Sugi & Atsushi Yoshida
Aichi University of Education, Japan

Gender Issues In Science Education In Japan – Research On Gender Bias Of Junior High School Students And Their Science Teachers

The gender difference on students' achievements and their interests in science have been studied in Science Education in Japan. On the other hand, the TIMSS study pointed out that the ratio of Japanese students (8^{th} graders) who have interests towards science were only 56%, that is the lowest in results of 20 countries enrolled. Moreover, the mean of female students differs from male students (TIMSS,1995). The result indicates that the Crisis of Losing Interests in Science occurs in female junior high students. Matsumura (1993) pointed out that school education has caused gender differences in students' development, as well as, the programs are required to make improvements in school education and teachers.

In this paper, we describe gender unbalance of junior high school science education. As the first stage，222 junior high school students were studied by a questionnaire about gender issues in science class. The findings are following;

1) Declining physics enrolments for female students are more remarkable than male students.
2) Male students feel better about science classes and teachers than female students.
3) Many female students feel that school science is useless in every day life and their future.
4) Many students feel that teachers chide male students more than female students, male students more frequently play with the laboratory instruments, while female students faithfully follow laboratory procedures and record results.

Day: Friday	**Location: Savoy**
Chair: Rod Watson	**Session Time: 11.45 – 12.25 PM**

Kim-Chwee Daniel Tan, Ngoh-Khang Goh & Lian-Sai Chia
Nanyang Technological University, Singapore
David F Treagust
Curtin University of Technology

Qualitative Analysis Of Practical Work: Doing, Thinking And Understanding

Previous research has shown that Grade 10 students in Singapore find inorganic chemistry qualitative analysis of practical work difficult to understand and to carry out, and unrelated to what they learned in class. An instructional package on qualitative analysis developed to explicitly teach the concepts, process and metacognitive skills involved in qualitative analysis. The theoretical framework of the instructional package is based mainly on studies by Woolnough and Allsop (1985) on practical work and Driver and Oldham (1986) on constructivist lessons. The activities are designed to allow students to have tacit knowledge and understanding of the reactions, reagents and apparatus involved in qualitative analysis. There is a gradual development of the manipulative, observational and inferential skills that students need, and the application of what they have learnt to plan, execute and evaluate experiments to identify unknown samples. The teacher plays an important role – an expert for the students to model.

Day: Friday	**Location: Raffles**
Chair: Steve Ritchie	**Session Time: 11.45 – 12.25 PM**

Peter C Taylor & John W Willison
Curtin University of Technology

Complementary Epistemologies Of Science Teaching: Towards An Integral Perspective

For over 20 years, science education has been a site of considerable struggle between adherents of the competing epistemologies of 'objectivism' and 'constructivism'; recently, proponents of 'personal constructivism' and 'social constructivism' have locked horns. In this paper, we argue that, in the interest of creating greater equity of access amongst students to a much richer encounter with science, science teachers should consider adopting an integral perspective. We propose 'dialectical complementarity' as a potentially productive way of considering unity-in-diversity amongst opposing epistemologies. We illustrate the viability of an integral perspective with a brief account of a one-year study into the scientific literacy of a class of junior high school students. From the extensive literature on scientific literacy, a set of complementary but distinctive metaphors was developed - 'student as recruit', 'student as judge' and 'students as scientists'. The framework was employed to examine the quality of student learning in both science and non-science classes.

Day: Saturday	**Location: Boardroom**
Chair: Gillian Kidman	**Session Time: 9.00 – 9.40 AM**

Chi-Yan Tsui & David F Treagust
Curtin University of Technology

Conceptual Learning Of Genetics With Multiple Representations: An Ontological Perspective

This paper examines conceptual learning of genetics in twenty-four Year 10 students from an ontological perspective. The study was part of a larger research project about genetics reasoning with multiple external representations (MERs). Genetics is a difficult topic to teach and learn. The study used an interpretive research approach with a multidimensional conceptual change framework that incorporates ontological, social/affective, and epistemological perspectives. Over six weeks, the science teacher taught genetics in whole class discussion, and engaged his students in computer activities of BioLogica, an interactive program that features linked MERs. Data were from multiple sources including classroom observations, interviews, and online tests. Data analysis indicates that gene conceptions of most students were not sophisticated. Pre-/post-instructional interview concept maps of each of the four student interviewees reveal a unique pattern of progression along the ontological pathway. The results were largely consistent with students' motivations/interests and prior knowledge, and the teacher's teaching.

Day: Sunday	**Location: Savoy**
Chair: Young-Min Kim	**Session Time: 9.00 – 9.40 AM**

Chih-Ming Tu, Miao-Li Changlai & Yeong-Jing Cheng
National Taiwan Normal University, Taiwan

The Effects Of Constructivist's View Of Teaching Strategies On 7th Grade Students' Learning Photosynthesis Concepts

This study investigated the effects of "constructivist's view of teaching" and "conventional teaching" strategies on students' understanding of photosynthesis concepts. The results showed that constructivist's teaching strategies

helped students gain a better understanding of some concepts while conventional teaching did better in developing students' understanding of other concepts. There were no significant differences between the effect of the two teaching strategies on students' understanding of the concepts of "The purpose of photosynthesis is to produce nutrients by utilizing the carbon dioxide and water to support growth and development of plants."

Day: Saturday **Location: Raffles**
Chair: Mary Hanrahan **Session Time: 3.30 – 4.10 PM**

Russell Tytler
Deakin University
Helen Conley
Victorian Department of Education and Training

The Science In Schools Research Project: Results And Insights From A System Wide Change Initiative

The Science in Schools Research Project is now into its third year, involving 225 primary and secondary schools across Victoria. The aim of the project has been to develop and validate a strategy for schools in general to improve their science teaching and learning. The project is due to report at the end of the year, generating materials, advice, and research findings. This paper will overview the essential elements of the strategy and plans for its extension across the system. A variety of research outcomes will be described, concerning student learning and attitudes, changes in teacher practice and beliefs, and the nature of the change process. The paper will discuss the complexity of coordinating and aligning research methodologies to provide clear results for public consumption, as well as insights into teaching and learning and change processes at appropriate levels of complexity.

Day: Saturday **Location: Raffles**
Chair: Onno de Jong **Session Time: 1.30 – 2.10 PM**

Russell Tytler
Deakin University

The Development Of Children's Coordination Of Theory And Evidence - Perspectives From A Longitudinal Study

This paper describes results from a study which has been tracing twelve individual children's science learning and conceptions across their first four years of schooling. The paper describes children's performance on tasks which require them to use evidence to generate or evaluate knowledge claims in different content areas. A number of dimensions have been generated to characterise children's approaches to exploration and knowledge construction, which demonstrate the interrelationship between knowledge and scientific reasoning. The paper presents a preliminary analysis of whays in which these dimensions can be used to characterise children's changing scientific reasoning over the first four years of schooling.

Day: Sunday **Location: Kingston**
Chair: Mei-Yu Chang **Session Time: 9.00 – 9.40 AM**

Russell Tytler
Deakin University
Bruce Waldrip
Latrobe University

Describing, Supporting And Monitoring School And Teacher Change: The Science In Schools Research Project

The Science in Schools Research Project worked with 126 schools across Victoria in 2001. The change strategy involves a coordinated whole school approach supported by systemic features which include a framework for describing effective teaching and learning, and a variety of supporting resources. This paper describes the nature of the strategy, the factors identified as determining the change process and the interpretive process by which these have been developed, and the various measures used to describe and monitor school wide aspects of teacher change. These different windows into change will be used to compare the different pathways and issues for primary and secondary schools, and to discuss the possibility of generating indicators that will assist researchers in describing and supporting the change process within a whole school context.

Day: Sunday	**Location: Raffles**
Chair: Nicole Hudson	**Session Time: 11.45 – 12.25 PM**

Wilhelmina Van Rooy
Macquarie University

Curriculum Change: Biology Teachers' Response To Innovation

In July 1999 the Board of Studies NSW released five Stage 6 science syllabi for implementation in NSW secondary schools in 2000. This paper, part of a larger study which examined the beliefs, values and attitudes of experienced biology teachers, reports on the changing perceptions of two biology teachers from the large study over a 2.5 year period from November 1999 until March 2002.

Five semi-structured interviews were conducted with teachers from November 1999 to April 2002 to gather qualitative understandings about HSC biology classrooms; Teachers were viewed as expert practitioners; Results indicate that teachers have a sophisticated conceptualisation of biology teaching, are open to curriculum innovation provided that a set of teaching and learning criteria are meet including what they termed adequate professional support; Of interest are the changes in teachers' thinking about their teaching when faced with inevitable change and how this is portrayed in their classroom practice.

Day: Saturday	**Location: Raffles**
Chair: Allan Harrison	**Session Time: 9.00 – 9.40 AM**

Mark Volkmann & Sandra Abell
University of Missouri, USA
Marta Zgagacz
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Teaching Physics To Pre-Service Elementary Teachers: The Challenges Of Inquiry

The purpose of this study was to understand how the professor, teaching assistant, and students perceived inquiry-based science instruction in a physics course designed for elementary education majors. During the teaching of a 6-week electricity unit, the professor and the teaching assistant experienced several tensions: knowing when and how to tell the scientifically accurate answer; deciding when and how to introduce scientific terminology; and recognising when to rely on intuition vs. the curriculum. They also continually negotiated their respective science teaching orientations. The students experienced frustration with the inquiry approach related to the conflicts they perceived between the course and their views of learning, science content, and assessment. Inquiry is difficult to initiate for professor, teaching assistant, and students, but if learning through inquiry is to become a reality in today's elementary schools, then pre-service teachers must experience it. Breaking the cycle of poor science instruction is well worth the effort required to initiate inquiry practices.

Day: Saturday	**Location: Kingston**
Chair: Keith Skamp	**Session Time: 11.45 – 12.25 PM**

Gillian Ward & Mavis Haigh
Auckland College of Education, New Zealand

Clarifying Practicum Relationships In Secondary Science Teacher Education

Tertiary teacher education providers, school based teacher educators and student teachers work together for quality teacher education. The two authors of this paper worked with pre-service science student teachers, their associate teachers and their visiting lecturers in order to (I) problematise the partnership relationships within this crucial triad and (ii) with a view to identifying factors critical to the the pre-service progress of the beginning science teacher. This paper describes the findings from this study and raises questions regarding these partnership relationships.

Day: Saturday	**Location: Portside**
Chair: Peter Aubusson	**Session Time: 9.45 – 10.25 AM**

Kevin Watson, Robyn Gregson & Peter Aubusson
University of Western Sydney

Packaging Quality Teaching As A Curriculum Innovation

Curriculum packages have been developed that attempt to build in quality teaching. This is not new or innovative. However, what is innovative is when such packages are based on a new and different view of teaching and learning so that both implementing teachers and their students become the focus of active learning. Therefore, the success of the innovation depends on the ability of curriculum developers to package their product so that the appropriate pedagogy is accessible to teachers and is of interest to students.

This paper outlines research that assessed the effectiveness of two different curriculum packages to promote a constructivist teaching approach to science by high school teachers. Eleven science teachers from six schools attended professional development workshops at which the learning/teaching theory supporting the curriculum packages was examined using experimental activities, videos, discussions and readings. The main ideas embedded in the curriculum materials that teachers were likely to find new and different were also explored. The teachers implemented the different packages with support from each other in the form of discussions and from the research team as additional workshop professional development and school visits. The findings suggest that the amount of 'support' present in the curriculum packages was so overwhelming in both volume and complexity that it hindered the implementation process. In some cases the curriculum packages improved the quality of teaching and learning in terms of student understandings and meeting curriculum outcomes, while in other cases teaching and learning deteriorated.

Day: Saturday	**Location: Raffles**
Chair: Cam McRobbie	**Session Time: 8.15 – 8.55 AM**

Rod Watson
King's College, London

Formative Assessment In Practical Inquiry-Based Learning

This study explores the use of formative assessment in the context of practical science investigations in classes from year 4 (age 8/9) to year 9 (age 13/14). The model for formative assessment used has the following components: a

model of progression for the investigation; procedures for sharing the educational aims; procedures for assessing achievement leading to diagnosis of students' educational needs; and procedures to make explicit what must be done to reach the aims. Seven teachers who used aspects of formative assessment were identified. Twenty lessons were observed, conversations audio-taped and samples of students' written work studied. These data were analysed using the components of the formative assessment model as a template to explore which aspects of formative assessment had been used and to explore the effects on students. The paper gives some examples of what can be done to improve practice and what can go wrong.

Day: Friday	**Location: Raffles**
Chair: Dick Gunstone	**Session Time: 9.45 – 10.25 AM**

Richard White
Monash University

Developments, Opportunities, And Challenges In Research On Science Education

The paper reflects on developments in research, and identifies opportunities and challenges for researchers. It summarises the three remarkable features of the science education research of the second half of the twentieth century, and identifies three opportunities and two major challenges that the twenty-first century brings. The three features are the explosion in amount of research, the revolution in style, and the growth of international contacts. The three opportunities are study of learning from the Internet, international comparisons, and previously neglected learners. The two challenges are maintaining energy in research and increasing influence on practice. The paper describes the conditions that have supported research, and speculates on their continuation. It suggests conditions that are necessary for research to remain vibrant, and the nature of research that might be done.

Day: Saturday	**Location: Savoy**
Chair: Mark Volkmann	**Session Time: 8.15 – 8.55 AM**

Jim Woolnough
University of Canberra
A. Cheetham, J. Rayner & L. Moore

Training Physics Teachers Through Flexible Delivery

This paper describes a program implemented this year to train science teachers in NSW government high schools to teach senior physics. A cohort of secondary science teachers, predominantly from rural high schools, are being sponsored by the NSW Department of Education and Training in a Graduate Certificate Course, which provides a curriculum combining first year university level physics topics and pedagogy. Delivery of the course is though a three-pronged approach, combining an extensive web site using the WebCT on-line teaching package, a textbook, and two intensive residential programs, one in each semester.

Preliminary results of evaluations of the program highlight the particular pressures involved in the delivery of this sort of program, for both students and staff. Feedback from a cohort of qualified and experienced educators, who have previous experience of learning science at a tertiary level, provides a particularly sharp focus on the adequacies and inadequacies of the program and provides some general insight into the place of flexible delivery modes in science education.

Day: Friday	**Location: Raffles**
Chair: Bob Bucat	**Session Time: 1.30 – 2.10 PM**

Tony Wright
Massey University, New Zealand

Humanising Chemistry – Developing Chemical Pedagogical Content Knowledge

Chemists have been reluctant to taken up the challenge offered more than a decade ago by Lee Shulman when he introduced the idea of pedagogical content knowledge. This paper will explore an approach to developing pedagogical knowledge that involves examining common chemical concepts introduced in high school and early university from both the chemist's and the teacher's perspective. The process reveals that the concepts are not the dry, antique ideas found in many current curricula. Rather, they have a rich history that illustrates the ragged stop-start human process of science. By focussing on the small individual parts of the framework of chemistry, the approach provides a foundation for the developing pedagogical knowledge and at the same time uncovers the large gaps that exist in the chemical education research literature.

Day: Friday	**Location: Boardroom**
Chair: Maree Baddock	**Session Time: 3.30 – 4.10 PM**

Meagan Ladhams Zieba, Bob Bucat, Mauro Mocerino & David Treagust
University of Western Australia

Teaching, Learning And Reaction Mechanisms

The results of a PhD study into teaching and learning about reaction mechanisms in tertiary Organic Chemistry courses will be discussed. Of particular interest are the language issues and the implied misleading meanings that can be conveyed by certain phrases. This presentation will also consider the appropriateness of the usage of single-particle representations and multiple-particle representations for particular purposes.

Day: Friday	**Location: Savoy**
Chair: Ann Harlow	**Session Time: 4.15 – 4.55 PM**

Reyna Zipf & Allan Harrison
Central Queensland University

The Terrarium Unit: A Challenge To Teachers' Concepts Of What Is Science Teaching

This paper discusses how teachers interpret an outcomes-based science syllabus and use it to design open-ended and interesting secondary science units. The study was set in an independent secondary college and focused on the implementation of a new syllabus in Year 8. A tension existed between two groups of teachers. One group was excited and willing to experiment with the new syllabus in terms of content, pedagogy and assessment. The more traditional group focused on how they could adopt the new syllabus but retain much of their previous pedagogy and assessment practices. A longitudinal long-term engagement methodology was employed. The data were qualitative and showed that new and innovative planning, teaching and assessment approaches are crucial to the success of outcomes-based learning. Despite careful planning, there were discrepancies between the ideal outcomes-based unit and the actual teaching and learning. Without an innovative and supportive environment, teaching for outcomes is inhibited.

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