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The University of New England

ASERA 2004

CONFERENCE PROGRAM

and

ABSTRACTS

7-10 July 2004
Armidale, NSW

UNE
The University of
NEW ENGLAND

ASERA 2004

For the 35th Annual Conference of the
AUSTRALASIAN SCIENCE EDUCATION
RESEARCH ASSOCIATION LTD

CONFERENCE PROGRAM

and

ABSTRACTS

Hosted by:
School of Education
Faculty of Education, Health
and Professional Studies

7-10 July 2004
Armidale, NSW

http://www.une.edu.au/asera/

UNE
THE UNIVERSITY
OF NEW ENGLAND

CRiLT
Centre for Cognition Research
in Learning and Teaching

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Introduction and Welcome

Welcome to Armidale and the University of New England for the 35th Annual Conference of the Australasian Science Education Research Association. The conference provides an important venue for science educators to discuss their research and share ideas about all aspects related to the teaching and learning of science at primary, secondary and tertiary levels. As a relatively 'new' member to the fold a few years ago, I was impressed by the expertise around me. Prior to attending my first ASERA I had only read the research papers, but to actually chat with the writers in an informal setting was amazing. Over the years I have found the group to be supportive, encouraging and nurturing of novice researchers with someone always on hand to offer constructive advice. So, I hope you enjoy the intellectual stimulation provided by the diversity of papers and the opportunity to catch up with 'old' friends while establishing new ones.

This year is a special occasion for UNE as we celebrate our 50 Years of Autonomy. I would like to thank our Vice Chancellor, Professor Ingrid Moses, for financially supporting our conference. My appreciation is extended to Professor Victor Minichiello, Dean of the Faculty of Education, Health and Professional Studies who has supported the conference and provided the Official Welcome. To Professor John Pegg for the sponsorship of the Centre for Cognition Research in Learning and Teaching (CRiLT) and Associate Professor Tom Maxwell, Head of the School of Education for additional in-kind support by way of staff. Finally, thanks to Steve Widders, Indigenous Coordinator at UNE, for welcoming our delegates on behalf of the Armidale Indigenous community.

On a more personal level I would like to acknowledge the expertise of Debbie Jenner and her invaluable contributions to all aspects of the conference. To Tony Brown, Terry Lyons, Rick Porter, Bruce Cameron, Alan Ernest and Liz Sozou for their assistance in organising the fine details of the conference and ensuring its smooth running including all the ICT. Also, to Rosemary Callingham, Neil Taylor and Gerry Corrigan for offering additional advice as required over the last 12 months. In closing, thanks to Sharon Gallon and Joy Kirby from the UNE Conference Company who handled the registrations and helped to 'balance the budget'.

I hope you have an enjoyable stay in Armidale and wish you every success for 2004.

Debra Panizzon
Conference Convenor
School of Education
University of New England

ASERA Program Overview

Wednesday 7th July

7.00-9.00pm	Conference Cocktail Party and Registration in Booloominbah, UNE. This includes a historical tour of the building.

Thursday 8th July

8.00-8.55am	Registration
8.55-9.30am	Official Welcome: Professor Victor Minichiello and Mr Steve Widders.
9.30-10.30am	Invited Speaker: Dr Fred Watson, Astronomer-in-Charge, Anglo-Australian Observatory, Coonabarabran
10.30-10.55am	Morning Tea — Book launch for Professor Peter Fensham
11.00-12.25pm	Presentation of Papers (two sessions)
12.25-1.25pm	Lunch
1.30-2.55pm	Presentation of Papers (two sessions)
2.55-3.25pm	Afternoon Tea
3.30-4.55pm	Presentation of Papers (two sessions)

Friday 9th July

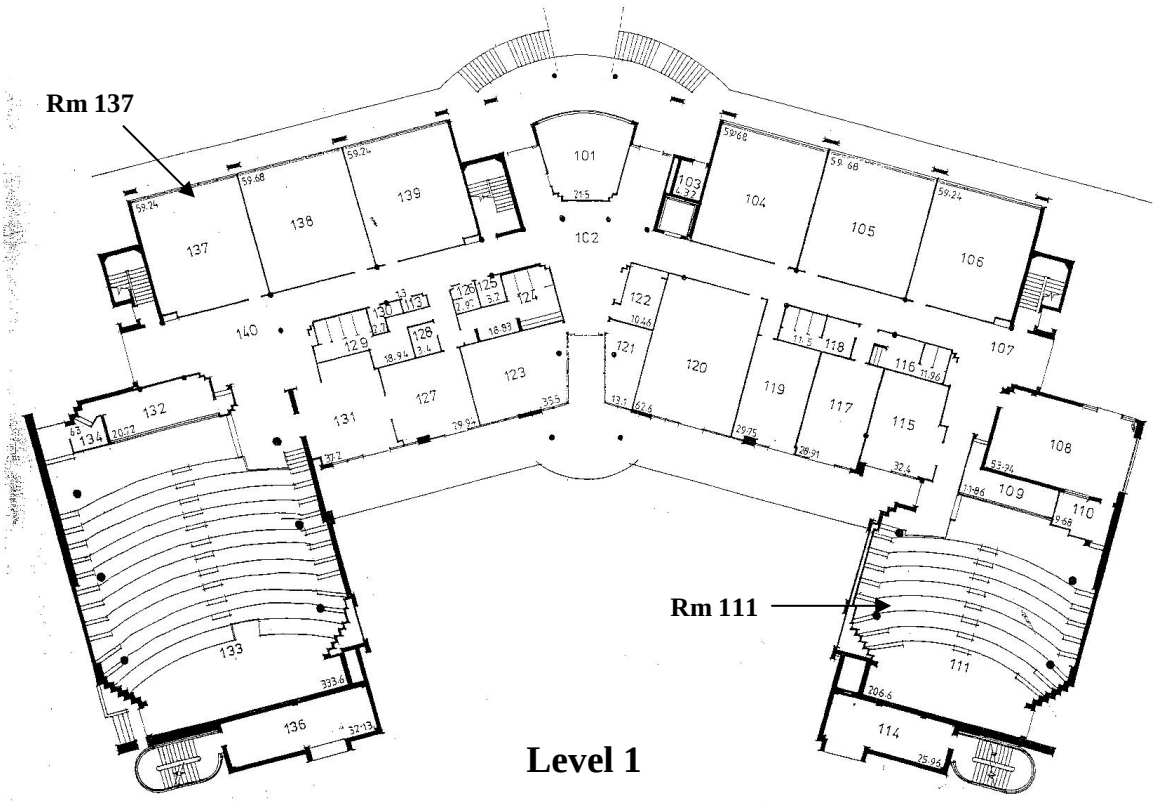
8.15-10.25am	Presentation of Papers (three sessions)
10.30-10.55am	Morning Tea
11.00-12.25pm	Presentation of Papers (two sessions)
12.25-1.25pm	Lunch
1.30-2.55pm	Presentation of Papers (two sessions)
2.55-3.25pm	Afternoon Tea
3.30-4.10pm	Poster Session - Presentation of Papers (one session)
4.15-4.55pm	AGM for ASERA LTD (Room 205)

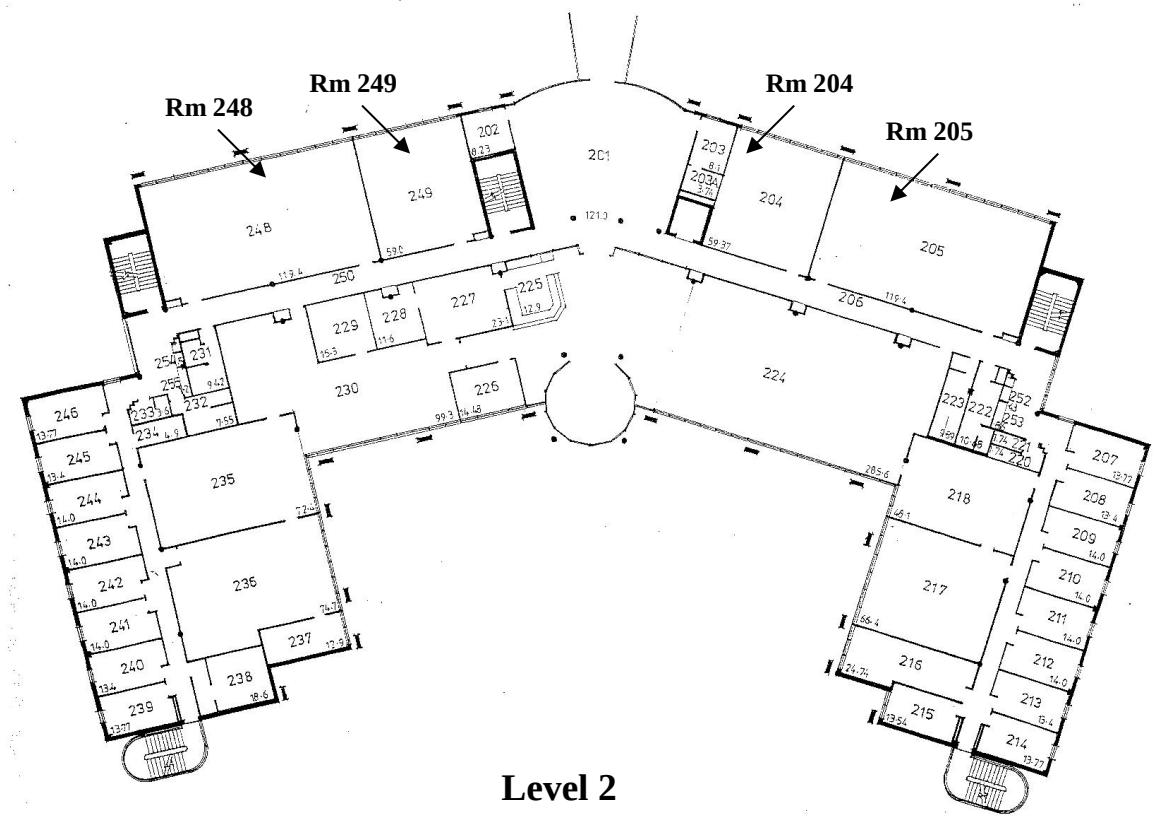
Saturday 10th July

8.15-10.25am	Presentation of Papers (three sessions)
10.30-10.55am	Morning Tea
11.00-11.40am	Presentation of Papers (one session)
12.00pm	Light lunch (before departure)

Maps

Faculty of Education, Health and Professional Studies Building





General Conference Information

Annual General Meeting
The ASERA Ltd Annual General Meeting will be held on Friday at 4.15pm in Room 205 in the FEHPS Building. All members are welcome to attend.

Chairing Sessions
Each session lasts 40 minutes. This allows 20 minutes for paper presentation and 20 minutes for questions. Please introduce the speaker, support the presenters by monitoring time and chairing the question part of the session.

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

Changes to the Program
Daily changes to the program will be posted outside of the presentation rooms.

Cocktail Party
Pre-conference registration will occur at the Conference Cocktail Party in Booloominbah on Wednesday 7th July 7.00-9.00pm. This will include drinks, nibbles and a historical tour of the building.

Conference Opening
The official welcome will be held in Lecture Theatre 111 on the lower floor of the FEHPS building on Thursday 8th July at 8.55am. Professor Victor Minichiello, Dean of FEHPS will officially welcome delegates while Mr Steve Widders, (UNE Equity Office) will provide an Indigenous welcome.

Conference Registration Desk
The conference registration desk will be located on the second floor of the FEHPS building. Help will be available from Debbie Jenner and Liz Sozou throughout the conference.

Conference Rooms
All rooms are located in the FEHPS building including rooms 204, 205, 248, 249 and 137.

Conference Dinner
The dinner will be held at Moore Park Inn on Friday 9th with pre-dinner drinks at 7.00pm. Price includes three course meal, drinks, entertainment and bus transportation.

The cost of the dinner is $80.00 and should have been included upon registration.

Entertainment for the evening will include 60s, 70s, and 80s music by Sidetrack, so come along be prepared to dance.

Special meal requirements should have been included with Registration. If additional request please see Debra Panizzon by Thursday 1.00pm.

First Time Presenters
For those presenters nominating as first timers it may be possible to provide a small refund once the funds for the conference have been finalised.

Meals
Morning and Afternoon Tea will be held on the second floor in the main foyer area of the FEHPS building. Lunches will be provided in the UNE Bistro area.

Medical and Health Services
For emergency aid please refer to information in registration bag.

Name Tags
Please wear name tags at all times, especially during meals and social functions (i.e., Conference Dinner). Name tags for accompanying persons can be arranged at the registration desk.

Parking
See leaflet in conference bag about parking requirements.

Phone
There are phones available throughout the University, however a phone is available in the Foyer of the Faculty of Education, Health and Professional Studies to contact taxis if required. Ask Debbie Jenner or Liz Sozou for assistance.

Security
Any problems with security at any time, ring 6773 2099.

Taxi
Taxis can be organised by phoning 131008 and maxi-taxis are also available for group bookings.

Program

Abstracts

Rich and formative assessments: perceptions, purpose and practice

Unaeza Alvi
Monash University & Aga Khan University-Institute for Educational Development

Friday 8.15 in Room 248
Chair: David Treagust

Formal testing and examination has remained the most prevalent mode of assessments, however, it is under constant criticism, for reasons of its narrow scope, norming, de-motivating, testing of atomized and low level knowledge and its back wash influence on the teaching and learning processes. Hence, a need for a paradigm shift towards wider school-based assessment reform and the use of alternative and formative methods of assessment to promote the teaching and learning processes and assess a deeper and wider range of knowledge and skills is strongly proposed by many. (Gipps, 2002; Hargreaves, et. al., 2002; Black, P., 1998; Gitomer & Duschl, 1998). However, due to limited research evidence and in-depth understanding of teacher's practices, purposes and the complexities involved in the implementation processes of such practices, any large scale implementation is yet to be evidenced. Hence, this qualitative, case-study investigated this particular phenomenon to develop and present an in-depth and holistic view of assessment practices. Beginning with a brief discussion of assessment, this paper presents the case study of both, teachers' and academics' perceptions and the implementation of assessment and reporting practices. The paper concludes with the author's arguments and recommendations for the implementation of rich and formative assessment practices.

Professional development in primary science

Ken Appleton
Central Queensland University

Friday 8.15 in Room 204
Chair: Young-Min Kim

In a series of research projects into professional development for teachers in primary science, the data led me to a professional development model in which mentoring played a key role. Mentoring has been recognised as an important means of personal and professional development in many fields, including teaching. In this paper, I review the findings from the research projects to identify factors that led to transformational change for the participating teachers and compare these factors to those reported more generally in the mentoring literature*. The paper concludes with a proposed model for science professional development based on this comparison, which could be adapted for systemic use.

*Kochan, F.K. (2002). *The organizational and human dimensions of successful mentoring programs and relationships*. Greenwich, CT: Information Age.

Challenging changes in secondary science teacher education

Peter Aubusson
University Technology Sydney

Friday 9.45 in Room 204
Chair: Leonie Rennie

Teacher education has become the subject of increasing scrutiny and general reviews often recommend change. This paper reports the author's perceptions of and reflection on an evolving, "end on" secondary science teacher preparation programme. It outlines the reasons for change, some difficulties encountered and some steps taken to address these. The case to change the secondary teacher education programme considers how general criticisms of teacher education are influencing an ostensibly successful programme. Despite it success and attractiveness, the programme appeared to have a key problem. Specific modifications to the programme are presented which set out, primarily, to increase the relevance of the teacher education experience. The reflection on the programme change reports how university culture and development of partnership between school and university

present a challenge. The aim of the paper is to promote discussion among science teacher educators about developments in 'end on' teacher education.

Large-scale systematic professional development for science teachers

Peter Aubusson[1] & Jim Scott[2]
[1]University Technology Sydney, [2]NSW Department of Education and Training

Saturday 8.15 in Room 204
Chair: Kevin Watson

This paper reports a study of voluntary participation by 403 government schools in NSW (almost 20% of schools in the system) in professional development designed to improve the teaching of secondary science and primary science and technology (the syllabus in NSW combines science with technology in the K-6 years). Professional development programs that improve practice in a sustained way are work-based and focus support, for a prolonged period, on aspects of practice that teachers themselves want to improve. The elements of the program reviewed in this paper sought to replicate this brief. The paper describes the form and amount of support provided to the participating schools and indicators of teachers' perceived impact on their practice. Further longitudinal research is required to assess the extent to which anticipated changes to practice are sustained, how they actually may be manifested in science classes and how they influence student learning outcomes.

From listener to investigator: student roles during pedagogical innovation

Warren Beasley
The University of Queensland

Thursday 4.15 in Room 248
Chair: Bronwen Cowie

During periods of pedagogical and assessment innovation following the review of the design of course syllabuses both students and teachers are faced with new challenges to learn how to learn again. For many experienced teachers they become "novices" in the implementation of the pedagogical and assessment requirements of the new syllabus.

This paper reports on the challenges facing senior high school science students when faced with very different learning settings which emphasize investigation of research questions generated from real life contexts along with a very different balance of assessment instruments. These students formed part of the 2 year trial in years 2002 - 03 of new context-based learning syllabuses produced by the Queensland Syllabus Authority for senior high school chemistry and physics.

Using digital video in science teaching

Tony Brown & Terry Lyons
University of New England

Saturday 11.00 in Room 249
Chair: Leah Moore

Portable analogue video recorders have been available since the early 1980s, but editing the video was difficult and the process reduced the quality of the product. This situation has changed dramatically with the advent of digital video, which allows video to be edited on a computer without a reduction in quality. The video can be manipulated, reversed, slowed down or speeded up by a click of the mouse. Digital video can be used to analyse any time-based activity as it can be viewed frame by frame, and each frame represents $1/24^{th}$ of a second (on PAL systems).

This paper will consider some of the ways in which digital video can be used in science teaching.

The positioning of science in an environmental thematic curriculum

Coral Campbell
Deakin University

Thursday 11.00 in Room 249
Chair: Trine Hyllested

With a crowded curriculum, many primary schools attempt to integrate their key learning areas. One primary school in a large regional city has taken this a step further by providing a separate learning environment as well as a more flexible approach to the curriculum. Using the "environment" as the overarching theme, the key learning areas are interwoven into the teaching of the environment. This paper will discuss the manner in which science is taught in the "Enviro" year, taking into account the perspectives of teachers mainly, but also considering the views of parents, students and other staff.

The progress of primary school students' learning on the concepts related to temperature

Mei-Yu Chang
National Hsinchu Teachers College
Hsinchu, Taiwan

Thursday 11.00 in Room 204
Chair: Yong-Jae Jung

The purpose of this study is to understand the progress of primary school students learning on the concepts related to temperature using a qualitative method. Data were collected mainly by clinical interviews with students, supported by the analysis of video recordings of the instruction and learning worksheets. There are 120 third graders involved in this study. At the first stage, students were filtered through a pre test, 17 out of 120 students who had the alternative conception on body temperature, and another 18 students on water temperature, were selected. They were the targets for teaching and the one-to-one clinical interviews. The results are as follows: (i). Students have a variety of preconceptions about temperature that affect their learning (ii) Children's daily experiences are the base knowledge to learn the concepts related to temperature (iii) Similar preconceptions may not lead towards similar learning progress (iv) The inappropriate linking on preconceptions may possibly cause the difficulty of conceptual learning.

Diagnosing seventh graders' understanding of animal classification by an e-two-tier test

Wen-Hua Chang[1], MeiFang Ge[2] & Hsiao-Ching She[3]
[1]National Taiwan Normal University, [2]Chu-Jen Junior High School, [3]National Chao-Tung University

Friday 8.15 in Room 205
Chair: David Palmer

The Constructivist notion that learners actively construct knowledge on the base of their prior understandings arouses needs in exploring students' prior understandings. Concerning school teachers' difficulties on developing a two-tier test and scoring in real time to inform teaching, an open-ended survey (N=190) and interview with-instances (N=17) were conducted to develop a two-tier diagnostic test module. The first version was administered (N= 248) and revised to build a web-based version. The measures from the web-based test (N= 457) suggest that the seventh graders classify animal instances by their physical characteristics, behaviors, reasoning by names or biological principles, or combining multiple judgments to classify animal instances. In addition, the students demonstrated a mismatch of phylum and subordinate class. It is concluded that the web-based test can appropriately provide information of students' understanding of animal classification and introducing the hierarchical structure of classification taxonomy may help students learn the topic better.

Online pre-laboratory exercises for introductory chemistry students

Gail Chittleborough, David Treagust & Mauro Mocerino
Curtin University of Technology

Saturday 8.15 in Room 249
Chair: Kerry Earl

The introduction of online resources, including pre-laboratory exercises, to students in an introductory first year chemistry course and its impact will be presented.

In this project students were required to complete pre-laboratory exercises online using WebCT – a Web Course Tools learning management system. The aim of this project was to engage students so that they are better prepared to maximise the benefits of the introductory laboratory class. The exercises were designed to be straightforward and provide immediate feedback to the students on their responses – endeavouring to help the students understand the practical and theoretical aspects of the experiment. In addition the online facility allowed students and staff to communicate via e–mail and the bulletin board. The increased flexibility of doing pre-laboratory exercises online and the increased feedback to students were two important aspects of this project that helped students to improve their learning experiences.

Young adults' responses to the contested scientific knowledge of mobile phone health risks

Clare Christensen
Queensland University of Technology

Thursday 11.00 in Room 137
Chair: Dong-Hoon Shin

This paper reports preliminary analysis of a critical realist study of 29 young adults' accounts of scientific knowledge in the context of judging the potential health risks of mobile phones. Participants across a range of science education and socioeconomic backgrounds engaged in focus group discussions in response to the stimulus of a recent television news report in which scientists disagreed about findings and interpretations of evidence regarding possible health effects of mobile phone use. Semi-structured interviews were used to further explore individual perspectives on 'science-in-the-making' and links with school science. Discussion in this paper outlines these young people's responses to uncertain science in the context of mobile phone use and examines the views of the nature of science that three particular participants' responses suggest. Implications for school science are considered.

Values in science and mathematics education – similarities, differences and teacher views

Debbie Corrigan, Dick Gunstone, Alan Bishop & Barbara Clarke
Monash University

Saturday 9.00 in Room 249
Chair: Michael Michie

Values are a crucial component of both science and mathematics education, and a crucial influence on how students choose to engage (or not engage) with science and mathematics. The issue is further compounded by the extent of teachers' awareness of, respectively, values ascribed to the particular discipline, the values carried by their selection from the available pedagogical repertoire, and their consciousness or otherwise of imposing their own personal values. The similarities and differences between the values (both explicitly and implicitly taught) of science and mathematics lead to contrasts between the two that have real potential to inform each. This paper reports early data from a study of values in teaching and learning of both science and mathematics – comparative analyses of values in the two subject areas and views of teachers about these values.

International students learning to write science: "Don't judge what they can do by what we think they can't"

Gina Curró & Chi-Yan Tsui
James Cook University

Thursday 11.00 in Room 205
Chair: Mark Hackling

This paper reports a study on writing instruction for international postgraduate students in biological sciences. Instead of using a deficit model, where gaps in student ability and performance become the focus of instruction, we adopted a genre-based approach. The study is action research using qualitative methods. Observations, e-mails and interviews were used to gather feedback for teaching evaluation and reflective practice. Our discourse community met weekly to review and summarise journal articles to understand the research design, data analyses and results interpretations. Initially, the students wanted to develop the language of critical analysis to improve their science communication skills. Preliminary findings indicated that the students improved their confidence, power and promise when learning to read and write scientific English. It appeared that our genre-based approach in teaching writing not only helped students understand the context and linguistic conventions for scientific writing, but also deepened their understanding of scientific content.

Affording and constraining the manifestation of pedagogy in middle years mathematics and science teaching

Linda Darby
Deakin University

Thursday 4.15 in Room 205
Chair: Russell Tytler

Researching teacher pedagogy is a complex process due to the complex nature of the way pedagogical knowledge develops and is manifested in the classroom. This research is investigating the effect of subject culture on the pedagogy of mathematics and science teachers. Describing and comparing why teachers teach the way they do in these two subjects can help to understand the relationship between the knowledge that teachers have about how to teach and the subject area within which they operate. This paper explores initial ideas about factors affording and constraining the use of "effective" teaching practices in primary and secondary mathematics and science classrooms. What is considered to be "effective" has been encapsulated in nine components of effective teaching and learning. School co-ordinators facilitated teachers participating in the study to evaluate their practice against these components. In doing so they gained insight into how teachers are reflecting on their classroom practice in mathematics and science in response to these components, and what teachers are thinking about (a) the affordances, what in the social setting of the teachers provides opportunities for the components to be reflected, and (b) the constraints, factors limiting the manifestation of the components.

What makes undergraduate tutorials successful? The case of a second year chemistry class

Bette Davidowitz[1] & Marissa Rollnick[2]
[1]University of Cape Town, [2] University of Witwatersrand

Friday 3.30 in 204
Chair: Terry Lyons

Many university chemistry departments perceive that there is a gap between first and second year chemistry. Gauging a gap by simply looking at pass rates fails to provide information about the nature or extent of a gap. Research has shown that aspects of the gap can be attributed to both the interface between first and second year and progression through second year.

In order to reduce content for increased mastery, and ensure student engagement with these topics, tutorials were introduced for one of the second year chemistry courses in the place of one of the formal

lectures. The effect of this innovation was investigated using questionnaires, interviews and a study of opportunistic data, such as examination results. Analysis of the data showed that the overall pass rate increased noticeably, but further examination revealed that this was almost entirely due to an improvement in the organic chemistry sub-discipline where student performance had initially been a cause for concern. Possible reasons for this one-sided improvement are explored.

Development and application of a rubric for analysis of novice students' laboratory flow diagrams

Bette Davidowitz[1], Marissa Rollnick[2] & Cynthia Fakudze[1]
[1]University of Cape Town, [2] University of Witwatersrand

Friday 8.15 in Room 249
Chair: Glenda Leslie

The purpose of this study was to develop and apply a scheme for the analysis of flow diagrams. The flow diagrams in question are schematic representations of written instructions which require students to process the text of their practical manual. It was hoped that an analysis of the flow diagrams would provide insight into students' understanding of the manual. To this end, we describe the development of a rubric for the analysis of flow diagrams. The analysis showed that most students were able to draw flow diagrams which showed evidence of deep processing, many of which could be used in place of the practical manual. Most students had some concept of how the apparatus worked, providing evidence of their initiation into the social practice of laboratory work. The analysis also showed that flow diagrams could be used to gauge the students' level of understanding of the practical manual. Flow diagrams could be considered to be learning tools as well as part of the assessment for a practical session.

Evaluating preservice science teachers' ICT pedagogy skills

Vaille Dawson, Patricia Forster & Doug Reid
Edith Cowan University

Friday 11.00 in Room 205
Chair: Peter Aubusson

This paper outlines and evaluates a range of initiatives designed to integrate ICT in a compulsory science education unit for students enrolled in a Graduate Diploma in Secondary Education. An action research model developed from a constructivist perspective was used to evaluate the effectiveness of modeling, co-operative activities and authentic assessment in enabling students to enhance their skills, knowledge and pedagogical content knowledge related to the use of ICT in science education. A questionnaire was designed to elicit students' perceptions of their own competence to teach with ICT, and their pre-course and post-course responses were analysed using Rasch modeling. The findings of this research study suggest that some ICT skills warranted greater attention in the course, but students' pedagogical knowledge and knowledge of ICT resources reached more satisfactory levels over the duration of the course.

Push or pull: tertiary science students' computer use

Kerry Earl
The University of Waikato

Saturday 9.45 in Room 249
Chair: Alan Harrison

This presentation reports on research conducted by School of Science and Technology at The University of Waikato during 2003. Previous research had found there was little information collected on the nature of our tertiary student population in relation to computer access, attitudes and skills. This presentation will discuss the findings of this research in relation to levels of web use, pedagogy, and lecturer buy-in and outline our response in practice. The implications of this study will provide

information on the factors surrounding computer use that impact on tertiary science students and provide information on specific issues that will help inform decision-making.

Teacher-researcher: the benefits and pitfalls

Robyn Gregson
University of Western Sydney

Saturday 8.15 in Room 205
Chair: Janette Griffin

Teacher-research has been proposed as a productive method for teachers to gain professional development while exploring issues in their classroom. This example of teacher-research, using an action research framework, presents a self-reflective study of a teacher working with Year 8 science students to help them improve their ability to write about their understanding of science. While the students writing was the primary focus of the study, as part of a doctoral thesis, what became apparent were the changes in role that the teacher had throughout the study. There were shifts from being a classroom teacher to a teacher-researcher and back again with ramifications for all participants as a result of these changes.

The findings from this study confirm that teacher-research is often messy with the outcomes of the research not always immediately obvious due the nature of the projects, and that the data and responses to them must be collected, collated and reviewed on top of the teachers normal teaching duties. Overall the findings of this study demonstrate how complex and yet how powerful teacher-research is in the classroom and highlight the need for teachers to be aware of the potential that researching their own pedagogy has in influencing student learning and motivation, pedagogy and assessment practices.

Purpose, choice and ownership in teacher professional development: teachers learning to facilitate student learning on science excursions

Janette Griffin & Kimberley Pressick-Kilborn
University of Technology, Sydney

Saturday 11.00 in Room 205
Chair: Dick Gunstone

Excursions can create excellent opportunities for authentic science learning, although the teachers' approach can sometimes constrain the students' opportunities to learn in these environments. Our research has established that providing teachers with scaffolded opportunities to try new ways of facilitating learner-centred approaches to museum field trips can lead to enjoyable and valuable learning experiences for both teachers and students. This paper focuses on the responses of teachers to their learning about alternative approaches to planning, conducting and evaluating field trips by drawing upon data collected in a series of studies framed from a social constructivist perspective, which informed the professional development process, and the methodology through which it was studied.

The PhD in science education: getting on track, staying on track, and reaching the destination

Barbara Groombridge & Léonie Rennie
Curtin University of Technology

Thursday 1.30 in Room 204
Chair: Chi-Yan Tsui

As a doctoral student in the Science and Mathematics Education Centre at Curtin University of Technology, the first author's research has adopted a case study approach to a project exploring the experiences of 30 women, and a smaller number of their supervisors, about the journey to their doctorate. The research responded, in part, to an assertion by Moses (1990) that women are as likely as men to complete doctoral degrees, but they take longer due to interpersonal issues which impact upon

their doctoral experience. This paper focuses on data collected from four science educators using the analogy of a journey and "keeping on track" that pervaded the interview data. It was also mentioned by one of the supervisors as being an important determinant of timely completion. Strategies to avoid getting "off track", and keeping "on track" will be presented to assist women to complete their doctoral journey.

Improving assessment practice

Mark Hackling
Edith Cowan University

Friday 11.00 in Room 248
Chair: Wen Hua Chang

There is sufficient evidence to indicate that there is scope for improving many teachers' assessment practices (Black & Wiliam, 1998; Goodrum, Hackling & Rennie, 2001). Analyses of existing research (Black & William, 1998; Hattie, 2003) indicate that improving assessment practice is one of the most effective ways of improving students' learning. Projects conducted at the University of York, King's College London, Waikato University and in Australia at ACER and Edith Cowan University are trialling various approaches to improving diagnostic and formative assessment. This paper will present some models for improving assessment practice arising form these research endeavours.

The development of an analysis tool on emotion words for measuring of scientific emotion

Hye-young Han, Dong-Hoon Shin, Hye-jung Lee, & Yong-ju Kwon
Korea National University of Education
Poster presentation

Friday 3.30 in Room 137

Scientific emotion is a reaction that combines subjective, biological, functional, and expressive components in science activity. However, there has been little amount of research on measuring of scientific emotion. The purpose of this study is to develop an analysis tool on emotion words expressed in scientific thinking. To collect emotion words in scientific thinking, 12 tasks on scientific thinking of inductive, abductive and deductive process were developed and administered to 425 college students. Subjects were asked to write an emotional essay while performing each task of the scientific thinking, and check emotion intensity in an emotion check-list. One hundred one emotion words were sampled in student reports of essay. These words were classified into 17 categories according to Plutchik's theory by 3 researchers. Also, the emotion words were tested by administering to 111 college students. This study, finally, developed an analysis tool of scientific emotion words.

Social justice, science, and critical pedagogies: how much have socially critical perspectives influenced science education?

Mary Hanrahan
Queensland University of Technology

Thursday 4.15 in Room 249
Chair: Leonie Rennie

"Critical scientific literacy" is now a term used in the science education literature (e.g., Hodson, 1998). But what does it mean? What is the theoretical basis of being "critical" in science education? What does the research literature have to say about critical approaches? What implications does being "critical" have for pedagogy for science literacy and what implications does it have for research methodology? This cross-disciplinary paper explores these issues by reviewing both the science education literature and research literature in related disciplines that have impacted on teaching practice and research in science education (including language and literacy teaching, psychology, and social science).

Primary science teachers' knowledge and inquiry skills for teaching floating and sinking

Allan Harrison, Teresa Moore & Jan Bulman
Central Queensland University

Saturday 9.00 in Room 205
Chair: Terry Lyons

In 2003, we taught floating and sinking to a cohort of primary science pre-service teachers. Guided inquiry was used to understand floating as a pair of balanced forces. The unit comprised 10 sequential activities that culminated in students making a working Cartesian Diver. Most students believed that small or light objects floated and 'floaters' have air in them (somewhere). The sequenced activities enabled students to differentiate the concepts involved in floating and sinking and density, Archimedes' Principle and buoyancy were banned in favour of operational definitions. Students proposed explanations like "the carrot sinks … if you make it into a canoe, *you keep the space and reduce the weight* … it floats" and plasticine floats when "you keep the weight but increase the space". Students concluded the unit by making a Cartesian Diver and explaining why the Diver floats and sinks. A striking outcome was the change from reluctance to keenness to teach primary science as inquiry.

Student perceptions of computer-assisted learning in mathematics and physical science classes in South Africa

Shaheed Hartley[1] & David Treagust[2]
[1]Cape Technikon, [2]Curtin University of Technology

Friday 2.15 in Room 248
Chair: John Hunt

This paper examines the perceptions of computer-assisted learning held by students in their mathematics and physical science classrooms, and also describes the development and application of the *Computer-Assisted Learning Environment Questionnaire*. The perceptions of Grade 12 students in two disadvantaged schools in South Africa were examined by an actual and preferred version of the *Computer-Assisted Learning Environment Questionnaire (CALEQ)* and by interviews conducted with both individual students and groups. At Centre A, the students preferred more involvement, more open-endedness, more organisation and more learning assessment opportunities but also less integration of computers in their every day classes whilst desiring investigation procedures in their classes to remain the same. At Centre B, students preferred to be more involved, to have more open-ended activities in their classes, have more learning assessment opportunities and a greater level of integration of computers but a reduction in investigative activities. Findings from student interviews reflected three viewpoints with regard to the inclusion of computer-assistance in classes.

Shifting balances: a study of the impact of assessment for qualifications on classroom teaching

Rosemary Hipkins
New Zealand Council for Educational Research

Friday 9.45 in Room 248
Chair: Unaeza Alvi

Assessment is often said to be the "tail that wags the curriculum dog" when examinations prescriptions are used to determine the *content* of senior secondary courses. Less seems to be known about interrelationships between assessment-for-qualifications and actual classroom teaching. This small-scale study explored relationships between the change to a standards-based qualifications regime and associated changes in year 11 science and mathematics teaching. Working with eighteen teachers from very different schools, we devised a self-reflection sheet that captured pre and post-NCEA practice related to 19 descriptors drawn from the Victorian Science-in-Schools (SIS) report. We found a web of shifting balances. Some changes seemed to cancel each other out

while others interacted to provide an impetus for further change. We identified a need for richer professional knowledge of formative assessment possibilities, so that some potentially positive changes could be further enhanced, and workload obstacles could more easily be overcome.

The impacts of a History and Philosophy of Science course on students' understanding of NOS

Lorna Holtman
University of the Western Cape

Poster Presentation
Friday 3.30 in Room 137

This descriptive study details the impact of a 6 week course on history and philosophy of science (biology) offered to novice postgraduate students at a South African University. The approach used in teaching this course (integrating HPS with the content of the discipline) is advocated by Matthews (1994) and others. The approach helps students to identify their own misconceptions about science and assists them in understanding epistemological aspects of science.

The Nature of Science (NOS), including scientific habits of mind, is an important goal of scientific literacy (American Association for the Advancement of Science [AAAS], 1993; [National Research Council], 1996). There is no one "nature of science", but for this study I looked at aspects of the NOS that are generally agreed on by science educators, historians and philosophers. Examples of these aspects are: scientific knowledge is tentative, scientific knowledge has a basis in empirical evidence; and, scientific knowledge is the product of human imagination and creativity.

Participants for the study were postgraduate students in the biological sciences during 2001 to 2004. A pretest survey was used at the start of the course in order to gauge students' prior knowledge of NOS issues and their content knowledge. Other data sources included the final objective examination, quizzes, student reports, course evaluations, interviews and observations conducted during the discussion sessions. Quantitative data (close-ended responses on the surveys) were anlayzed through simple descriptive analyses. Open-ended responses were analyzed qualitatively through content analysis and provided information for categorizing participants' profiles.

Findings of this study indicate that participants had misconceptions about the nature of science and evolutionary theory at the start of the course, and that these views are similar to those reported in the research literature. Student evaluations done at the end of the course indicated that they felt that the course learning outcomes were met, they offered constructive suggestions on how the course could be improved for the future and they were generally happy with their own participation in the course.

Promoting students' critical thinking through using a science writing heuristic in 5th grader science classroom

Jinmeei Kuo Hsieh
National Chiayi University

Thursday 11.45 in Room 204
Chair: JongSeok Park

The purpose of this study was to examine the effectiveness of promoting students' critical thinking through teaching with a Science Writing Heuristic (SWH) in 5th grader classroom in Taiwan. Eighty 5th graders in two classes participated in this study. The elementary school is a city school with a population about 2000 students in grades 1-6. Two researchers observed the classroom during the two-semester experiment with the SWH instructional mode executed by one teacher who has 20 years of teaching experience. Five science units in each semester were designed according to the WHS instruction with 5 main phases: focusing topic and question, eliciting students' ideas, exploring the answers, group and class discussions, and reflective writings. There were 2 – 3 writings in each unit and 25 writings were

finished during this one-year study. Cornell Critical Thinking Test (CCTT) including 41 items was revised and translated according to the culture for the instrument to examine students' critical thinking before and after the teaching experiment. The result of a t-test ($t=5.68$; $p< .001$) showed that teaching with SWH instructional mode was significantly effective for promoting 5th graders' critical thinking ability.

Year 12 students' understandings of models within the context of learning optics

Peter Hubber
Deakin University

Friday 11.00 in Room 249
Chair: Wonkun Oh

This presentation will report on the third year of a three-year longitudinal study into six Year 10 students' understanding of optics at a secondary school level. During the first two years of the study the students' understandings of geometrical optics were explored with the adoption of constructivist teaching and learning strategies. The researcher acted in the dual roles of teacher and researcher. In the final year of the study the students' mental models of the nature of light were explored in addition to their understanding of the nature and function of scientific models. During Year 12 the students studied physical optics and quantum ideas. This presentation will outline the findings of the study with respect to the students' understandings of models and link that to their mental models of light.

KLA technology implementation: a study of a Queensland School District

John Hunt, Ken Appleton & Alan Harrison
Central Queensland University

Friday 11.45 in Room 205
Chair: Alister Jones

The Key Learning Area (KLA) Technology Syllabus for Years 1-10 was made available to Queensland schools in 2003. The support materials for schools comprise the new syllabus, sourcebook modules, and a CD ROM of case studies and presentations. The Technology KLA is a new subject to primary schools, and requires a re-conceptualisation of traditional junior secondary school subjects such as Manual Arts, Business Studies, Information Technology, Agricultural Science, and Home Economics.

Simply supplying support materials to teachers is insufficient to ensure that the Technology syllabus will be effectively implemented. The new syllabus presents many challenges including teachers' ability to conceptualise, plan, resource and assess Technology curricula derived from the syllabus.

This project sought to research, develop and evaluate Technology curriculum professional development strategies that will meet those challenges.

What is the influence of "out-of-school settings" on learning?

Trine Hyllested
Danish University of Education

Thursday 1.30 in Room 248
Chair: Clare Christensen

This study explores how teaching in 'out-of-school' settings supports more conventional 'in-school' science. Three field studies on 'out-of-school-settings' were done over a period of one and a half years. The first study was at a nature centre with a professional nature centre leader. The second was a 14-day study at an experimental school. The children incorporated 'out-of-school' settings as a part of their chosen science projects. The third was a study of a biology teacher group at a public school using "out-of-school" settings among other teaching strategies. A preliminary finding of this paper is that changes of teaching settings can be used to stimulate children in learning science. The teacher mediated efforts where the children made reflections, dialogues, writings and participation, built bridges between experiences with the senses and the

conscious recognition of them. To accomplish this, the teacher is a key person in the use of "out-of-school" settings.

Developing a model of pedagogical content knowledge: examples from science and technology primary classrooms

Alister Jones & Judy Moreland
University of Waikato

Friday 9.45 in Room 249
Chair: Vaille Dawson

When thinking about teaching, the pedagogical content knowledge of teachers cannot be ignored. We argue that pedagogical content knowledge is a major determiner of teaching practice and is central to teachers' curriculum decision making at the classroom level. This paper takes a sociocultural perspective on the importance of developing teachers' pedagogical content knowledge. From our classroom-based research in science and technology education and the past research on pedagogical content knowledge, we propose a model of pedagogical content knowledge with seven characteristics that we believe are important for effective teaching in science and technology. This model will be illustrated with examples from our research in primary school classrooms over the last six years.

Typically-perceived-situation (TPS): its meanings and examples in conceptual learning of physics

Yong-Jae Jung and Jinwoong Song
Seoul National University

Thursday 1.30 in Room 205
Chair: Shiho Miyake

In cognitive science and cognitive psychology, the last two decades have witnessed a remarkable growth of the study on brain-style computation, i.e. connectionism. In a connectionist view, a concept is represented as a pattern of activity distributed over many connected units. On the base of this view, it was suggested that Typically-Perceived-Situation (TPS) should be highlighted. This study discusses the meaning and illustrates the examples of TPS in conceptual learning of physics. TPS is a kind of mental representation rising spontaneously in an individual's mind when someone is thinking about or in relation to any object such as physical object, feeling, concept, situation, etc. According to this definition, TPS has two features: (a) event-like features including scenes, backgrounds, causes & effects, stories, and (b) integrated features composed of sub-level objects. This study investigated four 6th grade students' TPSs related to 'force and motion', especially 'the situation where force is being acted, and the situation where force is not being acted', with a drawing-and-explanation type questionnaire. Their TPSs were then compared with their concepts checked by a selection-and-explanation type questionnaire and by interview. The results showed that the students' TPSs represented not only their concepts about/related-to 'force and motion' but also their related idea, and that the TPSs were also affected by their past experiences. Finally effective ways of how to apply the ideas of TPS to the conceptual learning of physics are discussed.

The power of the concept map: authentic learning for graduate students

Gillian Kidman
Queensland University of Technology

Thursday 11.45 in Room 248
Chair: Judy Moreland

The usefulness of the concept map as an ideal strategy for representing knowledge structures has been well documented in the research literature over the past 20 years. Since the early work of Novak, concept maps have been used in a variety of applications, including the identification of misconceptions, the evaluation of learning, the design of instructional materials, and in the facilitation of meaningful learning (Novak, 1996). This paper extends these latter two applications in that it describes how the concept map was used with pre-service biology teachers as a tool for

curriculum development. The paper then discusses the changes in the pre-service biology teacher's views in relation to meaningful learning. It was found that graduate students had a greater metacognitive awareness to their learning than their undergraduate peers. As a result, the graduate students learnt what it meant "to really learn something – I felt it!" and the benefits of group work. Suggestions for further research are made.

A comparative study on the secondary school science curricula of Korea, Japan, and Britain

Young-Min Kim & Won-suk Kim
Pusan National University

Friday 1.30 in Room 249
Chair: Rick O'Connor

In this study the latest science curricula of Korea, Japan, and Britain were analyzed and compared. Science is required for all middle school students (3-4 hours a week), and is optional for the high school students in all sampled countries. The format of curriculum document of Korea is similar to that of Japan, but much different from that of Britain. Besides scientific knowledge and understanding, scientific inquiry, and scientific attitudes, STS (in Korea and Britain) and scientific thinking method (in Japan) are emphasized in addition. All the sampled science curricula describe instructional planning, usages of instructional materials, teaching methods, and teaching of inquiry activities, in addition to those, the curricula of Japan and Britain describe 'contents treatment'. Finally, the description about evaluation is different from each other curriculum.

Characteristics of brain activities on processing scientific hypothesis generation by the EEG analysis

Suk-Won Kwon[1], Yong-Ju Kwon[1], Kyoung-Tae Ko[1], Jin-Su Jeong[2]
[1]Korea National University of Education,
[2]Songchon High school

Poster Presentation
Friday 3.30 in Room 137

The purpose of this study was to propose the characteristics of brain activities between resting state and scientific hypothesis generation by electroencephalogram (EEG) analysis. We recorded the EEGs from 19 electrodes in 25 subjects of the 5th grade students on resting state and scientific hypothesis generation. We performed linear analysis in the delta (1~4 Hz), theta (4~8 Hz), alpha (8~13 Hz), beta (13~30 Hz) frequency bands and correlation patterns by using Matlab (Matlab v5.31). These analysis results were mapped. The results of the EEG analysis, delta and beta wave was increased, theta and alpha wave was decreased to resting states rather than scientific hypothesis generation. Also, our results showed the decreased correlation between frontal areas of several areas (O1, T4, Pz, and F7) and the increased correlation between central areas and posterior areas. This result suggests different brain activities in anterior and posterior areas during hypothesis-generating. This study suggests a possibility that student's scientific thinking ability and the difficulty of scientific hypothesis generating may be measured by the analysis of subject's EEG frequency bands and correlation patterns.

Types of Scientific Emotions in The Generation of Abductive Science-Knowledge

Yong-Ju Kwon, Kuk-Tae Park & Hea-Jung Lee
Korea National University of Education

Poster Presentation
Friday 3.30 in Room 137

The generation of abductive science-knowledge that is applied in this study consists of knowledge in generating scientific questions and knowledge in generating hypotheses. The purpose of this study was to identify the types of scientific emotions in the generation of abductive science-knowledge by college students. In the study, 4 tasks that were suitable for generating scientific question and hypothesis were administered to 116 fourth college students. In each task, subjects were asked to report their scientific emotions through a self-report questionnaire, and to

check the strength of them through the emoticon checklists. As a result, the principle of emotion was curiosity (55.6%) in scientific question generation, whereas disgust (56.6%) in the hypothesis generation. Their strength was also very strong. These results suggest that particular types of scientific emotions exist for each scientific activity, and therefore systematic information on scientific emotion should be provided for effective science education.

Lowering the activation energy barrier: How to encourage biotechnology teaching in schools?

Glenda Leslie & Renato Schibeci
Murdoch University

Friday 11.45 in Room 249
Chair: Rosemary Hipkins

In a recent survey in Western Australia, science teachers identified a number of factors that encouraged or hindered them in teaching biotechnology. The most nominated factor was low level of personal content knowledge of biotechnology. The level of understanding of biotechnology influences the development of teachers' pedagogical content knowledge (PCK) and determines the selection of instructional strategies for the classroom. It will also impact on the use of appropriate knowledge representations and the awareness of student misconceptions; all of which are important in promoting scientifically acceptable conceptual development in students. The 'barriers' and 'encouragement' factors selected by teachers can be explained in general terms of increasing levels of understanding and teacher confidence in teaching biotechnology. We followed up this written survey with interviews with teachers to probe behind some of the stated reasons. We report the results of the interviews.

Developing a model of writing to learn science

Ya-Hui Lin[1], Wen-Hua Chang[2] & Huey-Por Chang[1]
[1]University of Education, [2]National Taiwan Normal University

Friday 11.00 in Room 204
Chair: Gillian Kidman

Language plays a critical role in enculturation of learners into scientific communities. Learners can use written language as a tool in doing science and constructing understandings. Through writing to represent understandings, learners should examine, elaborate and transform their knowledge. The first author designed writing tasks to facilitate students in constructing understandings and coordinating evidence and theory. The authors designed and sequenced tasks in each science unit followed by content analysis by concept mapping strategy, then they explored the characteristics of thirty-five 4th graders' writing representations and generated the influencing factors in the writing sessions. Since around 85% of the fourth graders tended to incorporate observable phenomena and manipulating experiences instead of applying definitions and terminologies from previous units, the authors propose a model of situated science writing. In the model, students' concrete learning experiences in previous units are applied as anchors to induce learners' reflection and transforming of understandings.

Students' attitudes to science in late primary school and junior secondary school

Marianne Logan & Keith Scamp
Southern Cross University

Friday 1.30 in Room 205
Chair: Bette Davidowitz

Research studies from a number of countries show that positive attitudes towards school science decline over the secondary schooling years. This paper describes a snapshot questionnaire study (n~500) investigating whether this trend is supported in students' attitudes towards science in years five through to ten in a semi-rural area in NSW, Australia. It will inform a longitudinal study which is looking at changes in the attitudes to, and interest in, science of approximately 20 students as they progress from late primary to early secondary school. The students' attitudes towards science were determined using the 'Pupils' attitudes to science'

questionnaire (Dr A.W. Pell, University of Leicester England). Initial trends and interpretations will refer to attitudes to school in general, 'participating in school science' and 'science and its place in the world'.

Practices at different nodes in an urban science class and their impact on teaching and learning

Linda Loman
Curtin University

Friday 3.30 in Room 249
Chair: Mark Hackling

Urban schools are often overcrowded, lack resources, and live under the threat of a state takeover. However, there are urban schools that compete with suburban districts. Research often focuses on what is wrong in the education system, I will look at a school where it is the norm to succeed. In this study, I examine my classroom practices that enable me to teach diverse learners at an urban academic magnet school. This study uses video analysis, transcripts, and cogenerative dialogue to identify specific practices from my classroom and their impact on the learning of science. The implications of this study focus on my own teaching practices and the use of cogenerative dialogue and evaluation of specific events in a classroom. This type of research could be used by any teacher wanting to improve their practices and allow students to achieve their goals of learning science.

Deciding for or against science: investigating the enrolment decisions of high achieving year 10 students in NSW

Terry Lyons
University of New England

Friday 2.15 in Room 205
Chair: Linda Loman

This paper reports the findings from research on high achieving students' decisions about enrolling in senior high school science courses. Motivated by national and international declines in science enrolments, the research compared the perceptions of NSW students deciding for, or against, further science study, and the influences on their decisions.

In particular, the paper focuses on the influence of attitudes and values within students' families, and the important roles of family social and cultural capital. The paper also discusses the school science experiences of high achieving students, and how these experiences colour their perceptions of science and science careers.

Student voices in developing and communicating their science understanding: formative assessment in action

Bill MacIntyre & Brian Coles
Massey University College of Education

Friday 9.00 in Room 248
Chair: Ya-Hui Lin

This work-in-progress paper looks at students' use of 'specific assessment indicators' from the developing and communicating science understanding strand in the science exemplar matrix to help with their understanding of heat energy. The students involved in this action research project were age 11 and 12 (Year 7 & 8). The three teachers involved in this action research project developed a unit on heat energy, using the *Building Science Concepts* booklet, which allowed students to communicate, monitor, assess and provide feedback for their developing understanding of heat energy through a range of activities. Evidence collected from pre and post assessment activities, student interviews, student end of the year personal CVs and teacher interviews demonstrated the usefulness and formativeness of the 'specific assessment indicators' when assisting students with communicating their understanding of heat energy.

"You ain't feelin' me!": student identity and achievement in urban science classrooms

Sonya Martin
Curtin University

Thursday 1.30 in Room 249
Chair: Rod Fawns

Numerous studies suggest that teacher expectations about student ability can have a powerful affect on student performance and achievement. Because expectations are informed by personal beliefs and experiences, I began to critically examine my classroom practices and interactions with students in an effort to identify how my beliefs affected student achievement. Using critical ethnography, I investigated how perceptions of student identity by teachers, peers, and self affected student learning and achievement in science. With the use of video analysis of classroom interactions, student created video ethnographies, and a variety of other data resources, I identified practices that both prohibited and encouraged students to develop positive associations and identities with science. This study has implications for the development of classroom learning environments and indicates the need for teachers to be aware of their beliefs in the structuring of their classroom and while dealing with students of varying cultural backgrounds and identities.

The pendulum, primary schools and professional development

Michael Matthews & Rick Connor
University of New South Wales

Friday 9.45 in Room 205
Chair: Chih-Chung Tsai

This paper will report on the initial findings from a professional development project conducted in ten primary schools in the eastern suburbs of Sydney. The project involves 60 primary school teachers observing and conducting a series of science lessons using the pendulum as the context. The lessons have been developed by the investigators to increase the pedagogical content knowledge of the participating teachers, firstly through their observation and practice of pedagogical approaches to the explicit teaching of the tenets of the Nature of Science and secondly through increased awareness of contextualised teaching in science. It is anticipated that changes in teachers' knowledge and understanding of NOS tenets and self-efficacy for science teaching will occur as a result of participation in the project. Teachers have maintained a learning log throughout the course of the project and have been pre- and post-tested using the SETAKIST self-efficacy instrument and a modified VNOS(D) form.

Fitting in or opting out: deconstructing the marginalization of women in academic science

Sherie McClam
The University of Melbourne

Thursday 2.15 in Room 204
Chair: Mary Hanrahan

This narrative ethnography addresses the problem of under-representation and marginalization of women in academic science. It is an illumination of ways in which junior faculty and senior doctoral candidates in natural science departments shape and are shaped by their interactions with representational artifacts (inscriptions) associated with working as an academic scientist. Using interpretive lenses from Michel Foucault and actor-network theory my analyses indicate that these inscriptions play a critical role in doctoral student and assistant professor's construction of knowledge about academic science and their relation to it. These constructions can make the difference between someone who believes they can and want to be an academic scientist and someone who believes they can't or chooses not to be.

"Teacher as culture broker" in indigenous science education: work in progress

Michael Michie
University of Waikato

Saturday 11.00 in Room 204
Chair: David Treagust

In this presentation I will be taking a look at three aspects of the progress I have made in examining the role of "teacher as culture broker". These will include:

- the variety of roles suggested in the literature for teachers in cross-cultural education
- the results of an investigation of enactivism as an alternative theory for teaching indigenous students
- some indications from the data collection through interviews with practitioners and autobiographical assessment.

Roles of student talk and teacher behaviours in promoting quality learning in science

Ian Mitchell
Monash University

Friday 11.45 in Room 204
Chair: Bill MacIntyre

This session distils 24 years of classroom research into promoting quality learning in science classrooms to develop an overall framework for better understanding and describing both the learning and teaching approaches that stimulate and support it. For me, quality learning is characterised by adjectives such as informed, purposeful, reflective, intellectually active, metacognitive and independent. Central to such learning are the ways that students talk in the classroom and the ways that teachers promote, react to and use student talk.

I focus on four, overlapping aspects of student talk. These variously involve students existing ideas and explanations, the purpose, design and significance of practical activities, constructively challenges to the teacher (or text's) ideas and lateral, reflective 'thinking' questions. Achieving these sorts of student behaviours requires consistent and persistent use of a number of strategic principles of teaching. Each of these principles requires a mix of appropriate teacher behaviours and teaching procedures.

The historical development of the Field Studies Council (FSC) in the UK to promote environmental education: a case study of its early period

Shiho Miyake
Kobe University

Thursday 11.45 in Room 249
Chair: Yong-Ju Kwon

The FSC is a charity organisation which has provided field study programmes in the UK over 60 years. While several researches to report scientific and systematic approaches of studying the local environment of the FSC have been published, an investigation to explore how the FSC has been offered such prominent programmes has not written in detail to date. In this paper, I will explore why the FSC was established and how it developed focusing on its early history in terms of services and funds. First, the background of its establishment will be briefly outlined. Second, some undertakings, which the FSC carried out in their early days, will be explained. Third, the alternation of funds from the Ministry of Education and a course fee towards candidates of the field centres will be described. Finally, some factors which contributed to the development of the FSC in this period will be considered.

Use of student interview techniques to enable strategic learning activity design: a new take on an established procedure

Leah Moore, Jim Woolnough & John Rayner
University of Canberra

Saturday 9.45 in Room 205
Chair: Peter Aubusson

We all link new learning to our existing knowledge, so gaining some knowledge of students' conceptual frameworks allows design of learning activities that specifically address the needs of a cohort. Typically an analysis of existing student knowledge in a discipline area identifies three things: correct understanding of concepts, key misconceptions and areas where there is a lack of understanding. Student interview techniques have been modelled in primary science teacher training programs for some time. One of the rationales behind this is to allow preservice teachers to identify the value of strategic rather than generic learning activity design. It appears that the techniques have been championed less energetically with senior teacher trainees. This study reviews the use of student interview techniques as part of strategic learning activity design for senior physics students.

The picture this project

Judy Moreland and Bronwen Cowie
University of Waikato

Thursday 3.30 in Room 249
Chair: Sherie McClam

A pilot study (The Picture This: Children 'seeing' science and technology project) to explore children's perceptions of science and technology has just begun in a rural two-teacher primary school (years 1-8). Using an interpretive methodology, the innovative techniques of auto-photography and photo-interviews are being used to gain an understanding of children's perceptions of science and technology and how science and technology fit into their lives. Photographs are emerging as a means for studying social phenomena; yet children rarely use this method. In this study children were loaned cameras to photograph examples/instances of science and technology at home, at school and in the community and were interviewed about their photographs. The children will exhibit a selection of their photographs for the local community with the aim to increase community involvement in the study and at the same time contextualise our understandings and analysis. The innovative methods and some preliminary findings used will be discussed.

Korean secondary students' map of misconceptions about wave, light, and color

Wonkun Oh[1], Jaewoo Kim[2], Ikgyun Kim[1], and Jinwoong Song[3]
[1]Chungbuk National University, [2]Munchang Junior high school, [3]Seoul National University

Friday 9.00 in Room 205
Chair: Terry Lyons

This paper reports the partial result of the recent study to construct the map of Korean secondary students' physics misconceptions; on the area of wave, light, and color. The subjects were 7th, 9th, 11th, and science high school students. The samples were from the four biggest cities including capital city, and from several minor cities and rural areas of five major provinces of Korea. About 500 male and as many female secondary students in each grade, and hence 4399 in total were tested in the research. The research instruments consists of 4 sets of test inventory, each of them has 9 or 10 questions. Every student was asked to answer only 2 sets of them. It required 20 to 30 minutes for each student to finish the job. Every question has 2 to 5 choices. The questions were made by the researchers, where recent worldwide results about students' misconceptions about wave and optics were considered as much as possible. Our purpose was to find comprehensive distribution of Korean secondary students' physics misconceptions, which is necessary for improving the science education of Korea. Couples of notable map of misconceptions, and the influence of the related variables such as grade, gender, living area, achievement, change of National Curriculum, etc. will be discussed in detail.

Exploring the link between conceptual change and motivation

David Palmer
University of New Castle

Friday 11.45 in Room 248
Chair: Marianne Logan

This paper concerns an example of conceptual change and possible sources of motivation that may have helped to facilitate the learning process. Individual interviews were used to pretest a stratified sample of 87 grade 9 students. Forty-four percent of them were found to have a misconception about the concept of ecological role – they believed that some living things do not have a role in nature. During a short intervention the majority of these students experienced conceptual change, as measured by immediate and delayed posttests. Students were also asked a series of questions about their motivation at various stages of the process. It was found that student motivation was very high in the experimental situation, and this may have facilitated the conceptual change.

Suggesting a model of scientific creativity and developing scientific creative activities

Jongwon Park
Chonnam National University

Friday 2.15 in Room 249
Chair: Peter Hubber

Creativity is domain-specific, that is, scientific creativity may be different from creativity in art or literature. In this study, a scientific creativity model consisting of three components is suggested: thinking for creativity, scientific inquiry skills, and scientific knowledge contents. Recently, many researchers have empathised that divergent thinking, as thinking for creativity, alone cannot lead to scientific creativity. Therefore, convergent and associational thinking are added to this model. Based on this model, various types of activities for improving students' scientific creativity are developed. In this study, some can be applied to science education in normal classrooms as well as gifted education in science, because I feel sure that scientific creativity will be one of the main purposes of ordinary science education in the near future.

How do the science teacher and pre-service science teacher appreciate the goals of science education?

JongSeok Park[1] & Okkyung Kim[2]
[1]Kyungpook National University, [2]Daegu Middle School

Thursday 2.15 in Room 249
Chair: Mei-Yu Chang

One of the traditional goals of science education has been the acquisition of knowledge or to get students to understand physical phenomena, theories and laws, methods, and even science itself. Those goals have been changed step by step. In recent years, the goals for school science are to educate students who are able to 1) experience the richness and excitement of knowing about and understanding the natural world, 2) use appropriate scientific processes and principles in making personal decisions. These goals define a scientifically literate society. Scientific literacy is the knowledge and understanding of scientific concepts and processes required for personal decision making, participation in civic and cultural affairs, and economic productivity.

How do science teachers and pre-service science teachers appreciate the goals of science education? According to their appreciation, direction of science education could be changed. We devised a questionnaire to examine the awareness of science teachers and pre-service science teachers to the goals of science education. Their responses were 1) the most important goal is to educate the thinking process and to take an objective and theoretical view, 2) the unpractical goal is to appreciate the science in listening to music and to educate the ability to solve social problems by inquiry.

Using a theoretical framework to guide assessment decisions in secondary school science

Debra Panizzon & John Pegg
University of New England

Friday 3.30 in Room 205
Chair: Debra Panizzon

This paper describes the experiences of secondary science teachers in four rural schools as they explore the changing assessment requirements relating to the 'Assessment for learning' emphasis of the Board of Studies of NSW. Teachers were introduced to a cognitive structural model to inform their assessment practices. Two important findings emerged from their involvement and experiences. First, teachers reported that using a theoretical framework to guide decisions acted as a catalyst to their rethinking of 'how' and 'what' to assess. Second, teachers used assessment information as a trigger for improving their teaching practices to enhance student learning.

Tracking changes in students' perceptions and cognition

Christine Redman and Rod Fawns
University of Melbourne

Thursday 11.45 in Room 137
Chair: Hsiao-Lin Tuan

Peirce (1867) understood the cognitive process as one of hypothetical inference (Eco, 1997, p 97). Humans interpret and respond to sensations, making perceptual judgments as they interpret these perceptions against their background of experiences. But what first draws the eye and what anomaly arrests attention? Once noted what responses and processes occur? This research reports on the semiotic exploration and interpretation of the processes primary students used to make sense of anomalies. Examining students' questions, comments and observations better enables us to explore the relation between perception, cognition and language.

Twenty years of primary science: have teachers changed their minds about why they teach it?

Léonie Rennie
Curtin University of Technology

Friday 2.15 in Room 204
Chair: Ian Mitchell

In 1983, as part of a larger project, 60 teachers in one metropolitan region of Western Australia were surveyed about their teaching of science to their Year 5 class. Questions included how much time was devoted to science, resources used, teachers' confidence and perceived competence in the major curriculum areas, and what they thought were the reasons for teaching science. In 2003, twenty years on, as part of a baseline data collection for a new project, 61 teachers of Years 4 or 5 classes from randomly selected schools in two metropolitan and two country regions, were asked very similar questions. The results show a little progress (science now averages 70 minutes a week compared to 60 minutes), but in other areas, patterns are somewhat similar. There are interesting comparisons on the reasons given in response to the question "Why teach science?", especially given the recent focus on scientific literacy.

Individual|collective leadership in school science departments

Stephen Ritchie, Gail Mackay, & Donna Rigano
James Cook University

Friday 1.30 in Room 204
Chair: Mark Hackling

Given that the subject department is recognized by subject specialist teachers as the central and immediate unit of organization in secondary schools it is surprising that so little attention has been paid by researchers to the leadership dynamics within science departments. The leadership dynamics within the science departments of two contrasting school contexts were explored dialectically in this

study. The structure | agency and individual |collective dialectics guided our interpretation of data from lesson observations, interviews and questionnaire responses, especially as they related to teachers' preparation of units of work (i.e., planned curriculum). As well as recognizing thin coherence in teachers' responses we identify contradictions in teachers' perceptions of leadership roles, influences on curriculum planning, and teaming within the two science departments. Through the paper we hope to disrupt traditional individualistic leadership discourses and challenge deterministic blueprints for action for designated leaders.

Evolution education and its effects on student science related attitudes

Michael Schulteis & Darrell Fisher
Concordia University/Curtin University of Technology

Thursday 11.00 in Room 248
Chair: David Treagust

The purpose of this research is to determine the condition of evolution education in American parochial schools and the effect of evolution education on students' attitudes toward science. Data were gathered using Fraser's Test of Science Related Attitudes (1981) and Bilica's Teaching Evolutionary Topics survey (2001). The research participants consisted of all biology teachers currently teaching in Lutheran high schools in the United States, and 580 Lutheran high school biology students in Grades 9-12 in California, Nevada, and Arizona. This quantitative data were enhanced with a free response comments section for participants. The students exhibited varied attitudes toward evolution science. Initial survey results show a positive change in attitudes amongst students toward science. Results have also shown that all the biology teachers teach some aspects of evolutionary theory to varying degrees. The impact of evolution education has been addressed only in the public sector, making the findings of this study groundbreaking.

Mapping changes in teachers' practice during a professional learning program

Rachel Sheffield[1], Mark W Hackling[1] & Denis Goodrum[2]
[1]Edith Cowan University, [2]University of Canberra

Friday 9.00 in Room 204
Chair: Jongwon Park

The DEST funded ($0.55M) Collaborative Australian Secondary Science Program (CASSP) trialled an innovative professional learning model with 120 lower secondary teachers from 28 schools across six states of Australia. Data were collected from the teachers using questionnaires before, during and after implementation of the program. In addition, in-depth case studies were compiled based on the experiences of four WA teachers. Analysis of questionnaire and case study data enabled the researchers to map the changes in teachers' practice. Mapping involved consideration of teachers' beliefs and concerns about practice (Hall & Hord, 1987), and their understanding and implementation of new strategies (Dlamini et al., 2001).

Identification of types of scientific emotion in the generation of inductive science-knowledge

Dong-Hoon Shin & Yong-Ju Kwon
Korea National University of Education

Thursday 2.15 in Room 248
Chair: Jinmeei Kuo Hsieh

The purpose of this study is to analyze types of scientific emotion in the generation of inductive science-knowledge of students. For the purpose, the scientific emotion was identified through reviewing literatures, and, to analyze the types of scientific emotion, four tasks were developed that are suitable for the generation of inductive science-knowledge. The generation of inductive science-knowledge that is applied in this study consists of generated knowledge in observing and generated knowledge in discovering rules. The subjects recorded their generated science-knowledge and emotion through self-report

questionnaire, performing each task of the generation of science-knowledge. The strength of their scientific emotion was also measured using emoticon check lists. As the results, for the generated knowledge in observing, acceptance was 34.8% in Plutchik's basic emotion, which was the biggest part, and 56.9% of interests and 19.5% of love in complex-order dyads were shown. As for the generated knowledge in discovering rules, each disgust and acceptance forms 51.7% and 17.1% respectively in basic emotion, and interests established 51.7% in complex-order dyads. More disgust and less interests were showed in the activity of generated knowledge in discovering rules rather than that of generated knowledge in observing. These results show particular types of emotion exist for each scientific activity, and thus, provide more systematic information for effective science education.

Recent outcomes from the programme for international student assessment

David Treagust[1] & John Cresswell[2]
[1]Curtin University of Technology,
[2]Australian Council for Educational Research

Thursday 3.30 in Room 248
Chair: Michael Schulteis

The Programme for International Student Assessment conducted by the Organisation for Economic Cooperation and Development is a regular survey of 15-year-olds that assesses aspects of their preparedness for adult life in terms of reading literacy, scientific literacy and mathematical literacy. The first survey took place in 2000 with a second survey in 2003. This paper will describe the goals of the PISA surveys, the types of questions used and describe some recent findings.

The effects of inquiry-based teaching on 8th grade students' motivation in physical science

Chih-Chung Tsai & Hsiao-Lin Tuan
National Changhua University of Education

Friday 1.30 in Room 248
Chair: Jim Woolnough

The purpose of this study was to investigate the effectiveness of inquiry-based teaching on 8th grade students' motivation toward physical science. Students' Motivation toward Science Learning (SMTSL) (Tuan, et al., 2002) questionnaire was implemented to six classes of experimental and six classes of control groups in the beginning and at the end of two units of inquiry lessons. All the data were analyzed by MANOVA and multiple-regression. Findings of the study indicated that students in experimental group showed significant difference in all scales before and after tests. Scales such as "self-efficacy", "active learning strategies", "science learning value", and "learning environment stimulation" showed experimental group were significant higher than control group in the post test. Scales that dominated students' motivation toward science most are "self-efficacy", "active learning strategies" and "science learning value". Implication for science teaching will be discussed in the paper.

The difference between science and mathematics teachers' attitudes and beliefs towards science and mathematics

Shu-Chun Tsai & Hsiao-Lin Tuan
National Changhua University of Education

Thursday 4.15 in Room 204
Chair: Sonya Martin

Due to the importance of teachers' beliefs and attitudes in relation to their professional development, and of integrating science and math, this study reported a group of experienced science and math teachers enrolled in the in-service professional development program, their attitudes and beliefs toward the content and pedagogy of science and math. Sixty-five teachers including half math and science conducted questionnaire and interview. The questionnaire "Attitudes and Beliefs about the Nature of and the Teaching of Mathematics and Science" (McGinnis, et al, 2002) consisted of five scales: beliefs about mathematics and science, attitudes toward mathematics and science, beliefs about the teaching mathematics and

science, attitudes toward learning to teach mathematics and science, and attitudes toward teaching mathematics and science. Results showed a significant difference in science and math teachers' attitudes toward science and math, and their desires for taking further math courses in the professional development program. Suggestions for this study will be provided in the paper.

Science, maths, and the whole damn thing: describing effective teaching and learning

Russell Tytler
Deakin University

Thursday 3.30 in Room 205
Chair: Linda Darby

A number of Australian states are developing generic pedagogical principles. This has been accompanied by critiques of the operation of discipline based 'silos' in constraining learning and teaching. The ARC funded project 'Improving Middle Years Mathematics and Science' aims to examine different aspects of mathematics and science in schools, to explore the role of subject cultures in framing school and classroom practice. This paper will describe the development of a framework to describe effective teaching and learning in Science and Mathematics. The framework was developed from interviews with effective teachers of Mathematics, to extend and refine work previously carried out in Science. Preliminary findings concerning teacher practice in mathematics and science, and experience with the development of Technology Components and of generic components for the early, middle and later years will be used to support a discussion of generic and subject specific aspects of teaching and learning.

Charting futures for science education

Russell Tytler
Deakin University

Saturday 9.00 in Room 204
Chair: Robyn Gregson

In May 2004 the Deakin University Mathematics, Science and Environmental Education group hosted a forum aimed at charting new directions for Australian Science and Mathematics education. The aim of the forum was to give voice to a wider set of voices that is usually represented in determining curriculum and pedagogy, and to gather together key players from around the country with the potential to influence future directions. The forum considered four themes: Schooling for Australia's futures; Schools and the wider community; Teaching and life long learning; and Organisational change. For each theme, community and professional leaders presented a perspective, and exemplary school stories were used to illustrate possible directions. Out of this, participants generated a set of principles and blue prints for ways forward. This paper will present these blue prints arising from the forum, as stimulus for discussion of an appropriate national agenda for science education.

The nature of anxiety in pre-service secondary science students: initial school experiences

Liisa Uusimaki & Gillian Kidman
Queensland University of Technology

Friday 3.30 in Room 248
Chair: Ken Appleton

Many pre-service teachers experience anxiety in relation to their school practicum experiences. This article investigates the nature of this anxiety in 25 pre-service secondary science teachers'. These pre-service teachers spoke of their fears and anxieties in relation to their first school placement experiences during three group forums. The outcomes of the analysis of forums showed that most of the participants' science teaching anxiety stems from their own experiences in classrooms, as students giving student teachers a hard time. In addition, the prospects of not knowing "enough science", "how to speak to teachers", and "what to wear to school" causes considerable stress. The paper concludes with a brief discussion about the implications of these findings for the

ensuing phases of a longitudinal study into secondary science teacher education.

Out of the mouths of experts: what geneticists think children should know about genes and DNA

Grady Venville and Jenny Donovan
Curtin University

Thursday 2.15 in Room 205
Chair: Gillian Kidman

Our first study looked at the understandings that children aged 11 – 16 have about genes and DNA and raised some issues about their conception that genes and DNA are entirely separate in structure and function. The second phase involved interviewing some experts in the field of genetics to gauge their response to the understandings demonstrated by the children. So far, 8 geneticists from different branches of the discipline have been interviewed and some of the emerging trends in their responses will be discussed. These include some disparity in working concepts of genes and the relative emphasis that should be given to genotype versus phenotype. However, there is general agreement that genetics is best taught in context and that the role of the environment should be emphasised more than is currently the case in the curriculum. This phase of the study is ongoing.

Utilising multi-modal representations to enhance primary science learning

Bruce Waldrip[1] & Vaughan Prain[2]
[1]University of Southern Queensland, [2]La Trobe University

Thursday 3.30 in Room 204
Chair: Coral Campbell

As part of a long-term research project to enhance science learning, this paper reports on a study aimed at identifying initial beliefs and practices of a group of teachers and students (years 5-8) when the students engaged with multiple representations of the same science concepts. There is growing recognition in science education research that students need to understand and integrate different representational modes in learning to think and act scientifically. They need to be able to recognize different representations and processes, translate these into one another, and understand their co-ordinated use in representing scientific knowledge. The study used a multi-site case study approach employing qualitative and quantitative methods. The study found that students who recognized relationships between modes demonstrated better conceptual understandings than students who lacked this knowledge. The paper also considers practical and theoretical issues of these findings, including implications for assessment.

The folklore of the sky

Fred Watson
Astronomer-in-charge, Anglo-Australian Observatory

Thursday 9.30 Room 111

The night sky has had a profound influence on human thought across all the cultures of the world. It has inspired a rich and varied folklore that attempts to sum up our attitude to the sky and life on Earth. Even though humankind is now detached from the sky by urbanisation and light pollution, science provides us with an inspiring new picture of our surroundings in space. What does this modern "folklore" tell us about the origin and destiny of the Universe? Join Fred Watson of the Anglo-Australian Observatory as he explores these topics with stunning celestial images and inside information on our growing understanding of the Cosmos.

Teacher professional learning and pre-service teacher education: building a sustainable community

Kevin Watson
University of Western Sydney

Saturday 9.45 in Room 204
Chair: Russell Tytler

Australia implements a model of 'competency-based pre-service teacher education' where the desired outcome is to maximise the transfer of teaching and

learning theory into classroom practice. Theory is obtained from teacher education institutions (universities) while practice occurs in schools. Although there are exceptions, research suggests there is doubt about the ability of this 'teacher training' model to effectively facilitate transfer, yet it dominates teacher education programs. This paper describes an attempt to develop an alternative model of pre-service science teacher education, which also incorporates science teacher professional learning by building a sustainable community of teacher educators. The effectiveness of the model being assessed in terms of changed attitudes to teaching and learning by teachers and teacher education students and by increased school student motivation and interest in learning science as well as achievement in external assessment. Preliminary findings indicate that teachers welcome professional learning opportunities and student teachers are better prepared for classroom teaching.

The development of science pedagogical content knowledge (PCK) through Bachelor of Education and Graduate Diploma teacher training courses

Jim Woolnough, Leah Moore, Carole Kayrooz, & Mah-I-Laqa Rafiq
University of Canberra

Friday 9.00 in Room 249
Chair: Stephen Richie

The concept of PCK has been quite well established over the last two decades, but how it is manifested in practicing teachers and how it develops in training teachers is not well understood. What skills do expert teachers possess in terms of the teaching of science? How are these skills developed in teachers during their training years and early years of teaching? As trainers of teachers do we understand what skills we need to impart? This study examines the development of some aspects of PCK, including knowledge base, conceptual understanding, and attitudes to the teaching of science, in students training in both undergraduate degrees and in a Graduate Diploma of Education. Problems encountered in measuring PCK and a case study of a training teacher tracking her own development of PCK during an internship in her final year will also be discussed.

Chinese students' perceptions of learning science in English in New Zealand

Liyun Zhang & Bronwen Cowie
University of Waikato

Thursday 11.45 in Room 205
Chair: Bruce Waldrip

With the increasing popularizing of English in China, a number of primary and secondary schools, universities and even some kindergartens have begun using English as a medium of instruction. At the same time, large numbers of Chinese are going to English speaking countries to study. This paper reports on a small research project that investigated six Chinese-speaking students' perceptions of what helps and what hinders their learning of physics in English in New Zealand secondary schools. The students were interviewed individually or in pairs. The students were divided as to whether learning English or learning physics was the more important for them during physics lessons. They suggested a number of strategies that teachers could use to help them with their learning but their main suggestion was that teachers provide more opportunities for students to work together and discuss ideas. Although they considered their listening skills had improved the most since they had been in New Zealand and writing was the most difficult skill they considered speaking the most important skill.

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