Abstracts

School, Industry, University Partnerships: Impact of a University-STEM Industry Engagement on Secondary Students in Science

Carol Aldous, Flinders University

Lifting student engagement in STEM has been the aim of numerous government initiatives within recent decades (Ng & Fergusson, 2019). One of these Bridging the Gap: Connecting Science Education to the real world enabled 36 pre-service teachers to engage with industry through three visits. During the engagement, student teachers identified, translated and communicated a STEM industry problem to an authentic audience. Subsequently, student teachers undertook their final teaching practicum. Measures of the project’s impact were ascertained by focus group interview and questionnaire pre and post the industry visit as well as with secondary students’ pre and post the teaching practicum. The student teacher questionnaire was purpose designed. The questionnaire for secondary students comprised the PISA 2006/2015 science attitudes inventory. The percent agreement pre (n= 213) and post (n=305) the teaching practicum were compared alongside state (South Australian) and national (Australian) figures. In a matched sample (n= 108) five dimensions, science self-efficacy, science related activities, future-oriented science motivation, science teaching uses investigations and science self-concept were found to be significantly different pre to post. In the unmatched sample the mean percent agreement increased pre to post for all dimensions except science teaching uses hands on activities where it remained the same.

Reference:

Strengthening the rope: building primary students’ scientific literacy through participation in online citizen science

Dayle Anderson, Markus Luczak-Roesch, Cathal Doyle, Yevgeniya Li, Cameron Pierson, Brigitte Glasson - Victoria University of Wellington

Murcia (2009) describes the development of scientific literacy as a rope weaving together three strands: Nature of Science; Interaction of Science and Society; and Scientific Terms and Concepts. The nature of an individual’s rope reflects their varied experience, but scientific literacy requires weaving of strands from all three dimensions. Building primary students’ experience of the Nature of Science strand can be particularly challenging. Online citizen science [OCS] projects provide opportunities for such learning in a functional and participatory manner. OCS is a subset of citizen science that enables volunteers to contribute to scientific investigations using the Internet. This paper describes findings from a multiple qualitative case study investigating primary students’ perceptions of learning from an intervention where they participated in an OCS project as part of their teacher-planned classroom science programme. Students identified improved science skills, understanding about science, content-related learning, and many described possible actions to take in response to their learning. Integrating OCS into a well-planned unit appears to offer opportunities for students to weave all three strands, thus strengthening their rope of scientific literacy.
Examining the Relations of Teacher-Directed and Inquiry-Based Science Instruction to Adolescent Students’ Science Dispositions: A Multilevel Analysis Across 65 Countries

Shaljan Areepattamannil, Dean Cairns - Emirates College for Advanced Education

Teacher-directed and inquiry-based science instructional practices have been shown to influence students’ performance on science assessments (e.g., Cairns & Areepattamannil, 2017). However, only a small body of research has examined the associations of inquiry-based and teacher-directed science instructional practices with science-related dispositions among adolescent students using nationally representative samples drawn from countries across the globe. Hence, the present study, employing multilevel structural equation modelling (MSEM) as an analytic strategy, investigated the relations of teacher-directed and inquiry-based science instruction to students’ science-related dispositions, such as enjoyment of science, interest in broad science topics, instrumental motivation to learn science, science self-efficacy, and epistemological beliefs about science, among 375,756 adolescent students from 15,206 schools in 65 countries. Results of MSEM analyses, after controlling for student-, school-, and country-level demographic and socio-economic factors, revealed that teacher-directed science instruction was significantly positively related to adolescent students’ enjoyment of science, interest in broad science topics, instrumental motivation to learn science, science self-efficacy, and epistemological beliefs about science. Similarly, inquiry-based science instruction was also significantly positively linked to enjoyment of science, interest in broad science topics, instrumental motivation to learn science, and science self-efficacy. However, inquiry-based science instruction was not significantly associated with students’ epistemological beliefs about science.

Link to RISE paper:


If I had a magic wand: Engaging student voice in secondary school science

Zoe Arnold - Central Queensland University

The scientific literacy of Australian students is dependent on their sustained interest and engagement with science education. Despite research acknowledging that student voice is critical in “addressing the decline in students’ attitudes and interest in science” (Logan & Skamp, 2008, p. 501), there remains little research focused on hearing the student perspective. This study aimed to explore student perspectives about school science, and how it should be experienced. In this study, 46 secondary school students from three science classes completed a 31 item survey. Students reported substantial differences between their lived school science experiences and their perceptions of how school science
should be experienced. Results revealed two significant factors: the teacher pedagogy; and learning experiences students were exposed to during their science lessons. Students suggested ways of enhancing the school science experience through relevant and engaging learning experiences and pedagogies, as well as suggesting the types of experiences that detracted from their experiences of school science. Critical insights into the science classroom experience from the student perspective were provided. Cognizance of the student voice may well provide the impetus necessary to mitigate Australia’s declining engagement with science education.

**Link to RISE paper:**


https://doi.org/10.1007/s11165-007-9063-8

**Exploring the Disconnect Between Theory and Practice in Environmental Education**

Sally Birdsall - University of Auckland
Peta White - Deakin University
Fabian Sack - Sustainability Pty Ltd

In collaboration with three leading organisations across Australia and New Zealand representing approximately three thousand environmental education practitioners, three researchers are undertaking the development of a position paper about the practice of environmental and sustainability education (ESE). This paper will then be used to politically leverage continued and further action to raise the profile of ESE. The guiding research question is: “What are educators’ perceptions of the nature of environmental and sustainability education?” The first data collection strategy was an online survey that elicited 475 responses. This presentation presents these survey data to demonstrate a disconnect between how participants described their education practice and what literature suggests should constitute contemporary practice of ESE. Using Wals & Benavot’s (2017) people and planet typology characterising ESE, the survey results suggest current practice equates to the theoretical characterisations of the field from the 1960-1970s with some venturing into early 1990s characteristics. The nuanced aspects of more recent ESE practices were not evident in the survey responses. The implication of these findings are that different strategies are needed to establish shifts in discourse and practice (Aubusson, 1994) of environmental educators to bring about the types of thinking and practice needed in the Anthropocene.

**References:**


**Facilitating the learning of theoretical knowledge in Chemistry using hands-on investigations**
In high-stakes testing environments, practical work is often dismissed in favour of teacher centred dissemination of theoretical knowledge. This implies that practical work has a low value attributed to it, which is not uncommon according to Cairns and Areepattamannil (2019). This presentation will describe the story of two Year 11 Chemistry students who must ‘endure’ a 3-week Practical Investigation. Presented as two case studies, the presentation will depict the learning experienced by the two students. The study explores the research question “How does hands-on learning facilitates the learning of theoretical knowledge in chemistry classrooms? The Practical Investigation is the training ground for the Year 12 Outcome (3), which is 20% of the School Assessed Classwork (SAC). Both students obtained Semester exam results of over 90% and both were expecting similar results in this assessment task. One of the students, has no appreciation of ‘hands-on’ work such as Practical Investigations while the other believes that there is a benefit in ‘physically seeing’ the ‘hands-on’ work. This presentation will describe how these two different personal views impacted each learner and the implications for junior science ‘hands-on’ investigations for teachers and students alike.

Reference:


Excellent secondary science teachers – a comparative case study

Joanne Burke - Monash University

In 2001, Rennie, Goodrum and Hackling conducted a large-scale national survey examining the quality of science teaching and learning in Australian schools. Their findings showed that teacher quality is a key factor in a successful science education (Rennie, Goodrum, & Hackling, 2001). In my study, I examined the beliefs and practices of three excellent secondary science teachers. Teachers were interviewed about their background, experiences and their beliefs about teaching and learning science in the middle years (years 7-10). Observations of multiple lessons were conducted, and their students were interviewed to understand their perspective of their teacher’s practice. This paper discusses each teacher’s personal and professional attributes through examining their beliefs and teaching practice. Whilst a deep understanding of each case study teacher is presented, a comparison also allows for identification of patterns and themes that could be extrapolated to improve the quality of science teaching beyond just these cases.

Link to RISE paper:

The Role of Volunteers in Early Childhood STEM

Coral Campbell, Chris Speldewinde - Deakin University

In 2018, we developed materials and resources for a volunteer-aided STEM package of activities for 3-5 year old kindergarten children. The package of material included: Program General Guide booklet that provides an overview of the program, linking into current research around children’s developing understanding about STEM; Activities Guide for Volunteers with activities and strategies for getting started, engaging children, using children’s play experiences to highlight STEM, building on ‘everyday’ STEM explorations, and using appropriate and effective questions; and Facilitators’ Guide - Workshop for Volunteers for training the volunteers.

The research was evaluative in nature, using both quantitative and qualitative data to provide information on the effectiveness of the program. Specifically, the evaluation provides evidence of the impact of the Curious Young Minds STEM Literacy Program on educators/teachers, volunteers and children of the program in terms of effectiveness and sustainability. However, for the purpose of this presentation, the following question will be considered:

What impact has the delivery of the Program had on Volunteers’ understanding of STEM?

This presentation will discuss the research undertaken and its limitations. Evidence suggests that the volunteers’ STEM understandings and capacities to teach STEM to very young children improved across the life of the program.

Critiquing collaborative CoRe design as an effective professional development intervention for developing teachers’ PCK for teaching science

Jared Carpendale - Monash University
Anne Hume - The University of Waikato

Using empirical research, this presentation critiques collaborative Content Representation (CoRe) design as a professional development (PD) intervention for developing teachers’ pedagogical content knowledge (PCK) for teaching science. The research design evolved from previous research that explored how collaborative CoRe design could develop pre-service teachers’ PCK (see Hume & Berry, 2011, 2013) and the researcher’s own professional experiences. Data focused on the knowledge transformations and experiences of three case study teachers as they engaged in authentic professional discussions with six others teachers. These teachers’ PCK was examined before and after the workshop, using interviews and lesson observations.

To improve trustworthiness, two analytical methods were used to critique the effectiveness of the workshops: a deductive approach guided by key characteristics of effective PD from the literature (i.e., content focus, active learning, coherence, duration, and collective participation); and, a comparison of case study participants’ pre- and post-CoRe design PCK. The two sets of findings corroborated and revealed that collaborative CoRe design is an
effective PD intervention for developing teachers’ PCK for teaching science. For the case study teachers, the workshop embraced those key PD characteristics identified, and their PCK developed as a result of working collaboratively, although, each teacher’s development was unique.

References:

Teaching Practice for Enhancing Students’ Scientific Communication Skill Using STS approach

Kannika Chaithong, Sasithep Pitiporntapin, Pramote Chumnanpuen - Kasetsart University

The purpose was identifying the best practices for students’ scientific communication skill (SC skill) improvement, focusing on writing and speaking skill. Classroom action research was performed to investigate the effect of student relationship and their preferable group work through Science Technology Society (STS) approach. The data were obtained from 36 of tenth grade students using students/teacher reflective journal and semi-structured interview. Data were analyzed in three components according to Kulgemeyer and Schecker’s (2009) and Burns’s (2003) frameworks. Approximately 62 percent of students’ reflective journal commented activities which contribute sharing ideas are the most important part. The results point to teaching practices: 1) teacher should provide group discussion after topic implemented, 2) showing students’ worked with commenting help students improve using representation form, and 3) classroom presentation can be a pair/group work depends on students’ relationship. Students preferred to work with their close friends since they can freely share opinions and get feedbacks would make them improved. Furthermore, doing laboratory helps students learn systematically thinking which affect to the data management for creating proper representation form. Overall, the study sheds light on creating activities using STS approach for developing students’ SC skill and the effect of students’ relationship is discussed.

Reference:

Identifying ways that students construct and visualize explanations in scientific drawings: From the perspective of “Norms”

Jina Chang, Joonhyeong Park, Kok-Sing Tang, David Treagust, Mihye Won - Curtin University
When students make scientific drawings, they interact with the teacher, peers, phenomena as well as their own ideas. To analyse these interactions, this study focused on the perspective of “Norms”—shared behaviour patterns desirable in a community. We investigated which norms are formed and how they emerged when students make their drawings to explain phenomena. Data were collected by classroom observations, interviews and students’ artifacts from five physics lessons in a primary gifted and talented program. The data were analysed based on three essential features of norms (justifiability, sharing, and behaviours). Consequently, two main norms were identified. First, to show invisible mechanisms, the students made drawings in terms of ‘explaining why’ in their diagram. This norm was shared in group discussions and their drawings as students constructed their explanatory diagrams with key science concepts in terms of particle movements. Second, ‘telling a story visually’ was the other norm shared by the teacher and students. Students documented their ideas with their own symbols to represent their ideas visually and tried to make the diagrams easy to understand. These results indicate that the norms can guide the desirable directions for students to construct and visualise drawings.

Link to RISE paper:

Improving scientific argumentation skills of grade 10 students by using context based learning in stoichiometry

Tanabordee Chankhuntod - Pakchong School
Jiradawan Huntula - Khon Kaen University

The objective of this study was to use context-based learning for developing students’ scientific argumentation in grade 10 of the stoichiometry. The classroom action research was used to study two groups of students. The first group of students was twenty-four students and the second was fifteen students in a school in Thailand. The context based learning lesson was used with the first group of student then it was revised before used with the second group of students. The situation in real life were selected to be problems in context based learning consisting of mass, concentration and volume of gases. There are three steps of the of context- based learning following 1) setting the scene 2) problem solving, investigate and 3) socio-scientific decision making. The open-ended questions of scientific argumentation questions were used as pre-test and post-test. There were four element of scientific argumentation consisting of Claim, Evidence, Counter arguments and Supportive arguments. In each element the answer of student was categorize in to three level, 0-2 level.

The data shown that, the first group of students was significantly increased in every question except in the first question of mass concept and the second group of students was increased significantly in all concept.
Best Practices for Socio-Scientific Issue-Based Teaching Integrated with ICT Tools to Enhance Students’ Science Communication Skill

Kamonchanok Cheevakul, Sasithep Pitiporntapin, Teerasak E-Kobon - Kasetsart University

With the aim of exploring how students’ science communication skill is developed through socio-scientific issue (SSI)–based teaching integrated with ICT instruction, this classroom action research provided the best practices of SSI–based teaching integrated with ICT tools on nervous system unit of 42 grade–11 students in a girl school.

The students underwent SSI–based teaching in issues: 1) cooking while animals are still alive, 2) consumption of slim pill and energy drink, 3) artificial intelligence (AI) technology, and 4) morning vs evening workouts. Data sources included developing scores on science communication skills questionnaire, semi-structured interviews for students, and reflective journal entries of student and researcher.

There are four aspects of the science communication to assess the students’ science communication skills: presentation, context, language, and content. The findings showed that the best practices for SSI-based teaching integrated with ICT tools to enhance students’ science communication skill were: 1) engaging with the issues that can be imagined in many perspectives and can be used in their daily lives, 2) providing opportunities for students to express their work in a variety of ways, especially integrated with ICT tools, and 3) allowing students to exchange information between groups with different ideas before the presentation.

Reference:


The Impact of Images of Female Indigenous Scientists on Stimulating Learning Motivation among Female Indigenous Students

Ming-Hsiu Mia Chen - Tatung University

The present study investigated the relationship between the image of Taiwanese female indigenous scientists and learning motivation among male and female indigenous elementary students. Science curricula in Taiwan are generally taught from a Western perspective, making it difficult for indigenous students to relate science learning to their own culture and environment. Previous studies have found that the incorporation of indigenous knowledge into a mainstream (mainly Western) science curriculum helps to enhance motivation and learning effectiveness among indigenous students (Lee, Yen & Aikenhead, 2012; McKinley, 1996; Ritchie and Butler, 1990). In addition, a survey conducted by a task force appointed by the National Academy for Educational Research of Taiwan found that most elementary school textbooks in Taiwan lack images of female scientists, which results in a severe lack of science role models for female students during their elementary school years. In the present study, an experiment was conducted during lesson time among 74 fourth-, fifth- and sixth-grade students of five indigenous elementary schools
located in remote areas of Taiwan. An animation depicting the story of a female indigenous scientist was shown to students belonging to the experimental group, while an animation depicting the story of a female scientist of Han descent was shown to students of the control group. Before and after viewing the animation, all students filled out the Motivated Strategies for Learning Questionnaire (MSLQ). The results of the experiment indicated that the differences in self-efficacy before and after the experiment was highly significant in female students of the experimental group, while the differences between the female and male students in both the experimental and control groups were significant for two out of five of the dimensions of the questionnaire, namely self-efficacy and control beliefs for learning. Therefore, the present study demonstrated that images of female indigenous scientists had a profound impact on the self-efficacy of female indigenous elementary students.

Link to RISE paper:


Towards a ‘spectrum’ view of students’ understandings

Maurice Cheng - University of Waikato

Modelling students’ understandings is a key research activity among science education researchers (Taber, 2013). There have been different ways that students’ understandings were modelled. Take the ideas related to ‘chemical reactions’ as an example, students’ understandings were conceptualised as distinctive types (Andersson, 1990), stages (Stavridou & Solomonidou, 1998), levels (Ahtee & Varjola, 1998; Øyehaug & Holt, 2013), models (Cheng & Gilbert, 2017) and more recently, learning progression (Hadenfeldt, et al., 2016). This paper reports findings from a 3-year longitudinal study on students’ understanding of chemical structures and chemical reactions (Grades 10-12 chemistry) that sampled 18 students from three different academic-achieving schools in Hong Kong. Each student was interviewed eight times. This allowed the researcher to capture subtleties in students’ understandings. Instead of conceptualising their understandings into levels or categories with concrete boundaries, the data were modelled as a spectrum. The spectrum, compared with learning progressions, is of a finer grain size, meaning that it only modelled students’ understanding of a smaller number of concepts (of chemical reactions), and is made of bands (cf. levels). In this talk, I will discuss the limitations and affordances of spectrum/bands as compared with other ways of modelling students’ understandings.

Link to RISE paper:
Promoting elementary school students’ environment literacy through modelling-based teaching

Chiu-Lan Chuang, Silvia Wen-Yu Lee - National Changhua University of Education

Teacher-guided practices can help students participate more meaningfully in learning science through modelling (Sung & Oh, 2018). The study aims to facilitate students’ environmental literacy through modelling-based teaching with a focus on the wetland ecosystem. The study sample consisted of one fourth-grade class and one fifth-grade class in Taiwan. The curriculum includes six stages: anchoring phenomena and central questions, constructing an initial model, empirical investigations, scientific ideas and computer simulations, evaluating and revising the model, using the model to predict or explain related phenomena. Movies, lectures, games, computer simulations and a field trip to wetlands were used. Students’ understanding of a wider spectrum of models can be advantageous when constructing a model through drawing, writing, or using computer applications (Lee, Chang & Wu, 2017). Research instruments include Environmental Literacy Questionnaires and drawings of wetland ecosystem and environment. Paired sample t test and descriptive statistics were used for analysis. Results show that the modelling courses enhanced students’ environmental literacy. Comparing the students’ pre- and post-drawings, the results showed the increase of wetland creatures, reduced human activities and man-made objects and the location expanded to the ocean and mudflat. Suggestions for future environmental education are provide.

The Role of Students’ Representational Reasoning Processes during an Authentic Science Inquiry Task

Connie Cirkony - Monash University

Although a central activity in science classrooms, practical investigations customarily do not meet the expectations of engaging students in genuine inquiry or in making conceptual links. Research into authentic scientific practices suggest a more dynamic set of interactions and ongoing refinement of ideas than is normally represented in classroom practical investigations, challenging the traditional notion of an orderly scientific method.

This paper draws on findings from a study on how Year 9 science students responded to a guided-inquiry task to address a problem related to sustainable housing. The research design followed an ethnographic case study approach using multiple methods for data generation. Drawing on distributed cognition perspectives, this paper explores how students’ ideas were developed and resolved throughout their interactions with materials and material processes.

This paper argues that students’ complex pathways of formal and informal reasoning processes were reflective of Pickering’s (1993) mangle of practice. It proposes that processes of exploration and refinement through “accommodation” and “resistance” are legitimate experiences in classroom inquiry. Implications include the value of inquiry tasks that support students’ generative recruitment of their conceptual knowledge to authentically engage with scientific problems.

Reference:
Predictors of senior secondary participation in biology, physics, chemistry and earth/space sciences: Evidence from Australia

Grant Cooper - RMIT University
Amanda Berry - Monash University

Declining participation in senior science subjects present an ongoing concern in Australia and internationally. Particularly worrying, the profile of certain student groups decreases as year level increases. Research from a previous study by the authors (authors, 2018) indicated that indigenous status, SES and ancestry were significant predictors of student participation in science post-16 in Australia. However, this study did not allow differentiation between student participation in different science domains. Building on this work, the authors analysed data from the 2015 Longitudinal Surveys of Australian Youth (LSAY), to investigate whether, and to what extent, demographic factors predict participation in the specific domains of biology, physics, chemistry and earth/space sciences. Outcomes of the study indicate that SES predicts participation in post-16 science subjects in each science domain, indigenous status is a negative predictor of participation in biology, physics and chemistry, but not earth/space sciences, and gender is a significant predictor in biology and physics participation, but not chemistry or earth/space sciences. Drawing on Bourdieusian perspectives, the authors propose associations between participation and access to cultural, social and science capitals. Implications for the ways in which students’ capital may influence their subject choices and how capital may be enhanced, are explored.

References:

Authors (2018) Research in Science Education.

education, including impact on their thinking about science teaching and learning to teach, and their classroom practice. Data was collected from 4 co-teachers across one academic year, including an initial survey, a final interview, and documentation from planning meetings. Data was thematically analysed. Findings indicate that co-teachers’ learning occurred in two main ways: accumulating new activities and teaching procedures for use in their own classes or to share with colleagues, and reflecting on their own knowledge development and purposes for teaching science. Interestingly, a focus on co-teachers’ own learning emerged as strongly from the data as their learning about pre-service teachers.

Link to RISE paper:

Values in, for and of science and science education

Deb Corrigan, Cathy Buntting, Ange Fitzgerald, Richard Gunstone, Justin Dillon

Science educators recognise the important contribution science education can make towards active, responsible citizenship. However, research that explicitly links science education with values development is relatively limited (Kumarassamy & Koh, 2019). This presentation draws on our experiences editing two books: ‘The re-emergence of values in science education’ (Sense, 2007) and ‘The shifting sands of values in science education’ (Springer, 2019). We identify the themes to have emerged from these projects: Values in the intended, implemented and attained science curricula; and values in, for and of science. Both books resulted from writing workshops that all contributors attended, and they contain chapters authored by a number of ASERA members. Our aim for the presentation is to contribute to discussion about the ways in which values explicitly and implicitly interact with science education and the implications of this.

References:

Leveraging the meso level ecosystem to support the learning of engineering students

Bronwen Cowie, Elaine Khoo, Jonathan Scott, David McKie - University of Waikato

This paper draws on the work of Ralls, Bianchi and Choudry (2018) to present an adaption of a ‘meso networked level’ development of teaching and learning within a ‘learning ecosystem’ (OECD, 2015). We, researchers and lecturers in engineering, management and education from one New Zealand university, collaborated to support engineering students to develop project management competencies as part of problem-based coursework.
Problem-based learning (PBL) is a strategy that is being used to provide engineering students with experience of working in teams to solve complex problems, but the project management and teamwork professional competencies students need are rarely a direct pedagogical focus. Within the project, students in a fourth-year engineering problem-based course, regularly communicated their planning and project progress to a management tutor who provided business-informed feedback on their project management and teamwork. Pre- and post-course surveys, student focus groups, lecturer and tutor interviews and student formative and summative grades were collected as data. Findings show students gained an understanding of key aspects of project management and were generally supportive of the opportunity to interact with a management tutor. They illustrate how cross-disciplinary collaborations can promote critical reflection on teaching-learning and develop professional competencies important for engineering graduate work-readiness.

References:

“It’s not what you know: it’s who you work with” – a phenomenological enquiry into pre-service science teachers’ experience of collaboration

John Cripps Clark - Deakin University

In both science and teaching collaboration is a central practice and this collaboration is important to both the intellectual and social practice of both science and teaching (Patchen & Smithenry, 2015). During their education pre-service teachers experience a variety of forms of collaboration which sometimes mirror these practices, such as laboratory experiments, professional experience, team teaching, and group investigation and activities. Students collaborate with each other, with their tutors and lecturers, with classroom teachers and school students. These collaborative activities are important elements in student learning (Hume & Berry, 2013) yet there is still much to discover about our students’ experience of collaboration. In particular we need to be able to choose which collaborative activities (with whom) will best prepare our students to become effective teachers of science (in a limited time). This paper reports on of ongoing research into pre-service teachers’ understanding and experience becoming teachers of science, and in particular its theoretical underpinnings. It uses cultural-historical activity research (Cole, 1991), and in particular relational agency (Edwards, 2005, 2007) to analyse a longitudinal series of interviews and surveys of pre-service teachers’ experience and interpretation of the variety of experiences of collaboration in their becoming a teacher of science.

References:
How Teachers Encourage Scientific Inquiry in Children Projects

Chanyah Dahsah, Tepkanya Promkatkaew, Navara Seetee - Srinakharinwirot University

Young children are like scientists. They always construct their own knowledge based on curiosity. However, children need to practice to engage in scientific inquiry. This research collected data from three experienced early childhood teachers to explore how teachers encourage scientific inquiry in children projects. Several sources of data collection were used for triangulation including interviews, surveys, instructional plans, and children’s artefacts. The data were coded based on inquiry features suggested in literature which are, encourage children to build ideas from their prior knowledge, develop ideas based on their curiosity, engage in in-depth exploration, and reflect their ideas with others. The results indicated that the teachers still face several challenges of incorporating scientific inquiry in children’s projects. For example, teachers faced difficulty to identify children’s prior knowledge based on curiosity, to design a set of investigation questions that draw from children’s curiosity, and to design guide questions to help children to reflect their opinions related to the task. In addition, the teachers were in control of what children should explore and explain by making decisions instead of encouraging them to be in charge of their own investigation.

References:


A holistic perspective of emotive-cognitive engagement and the performance of concepts in Grade 10 science

James Davis - Queensland University of Technology

Student engagement in science education is often understood from psychological perspectives: Accepting emotion, cognition and behaviour as engagement’s constitutive
components that are influenced by context as an external source of variance. In contrast, the present study adopts a holistic, sociological view of engagement where emotion and social cognition are analysed as in-the-moment performances and experiences of students in classroom contexts. My aim is to analyse in-the-moment performances of students’ ideas and formal concepts in a Grade 10 science class, through small group interaction by analysing video and audio data. This study applies ethnomethodology to describe data and an interpretative framework based on interactional ritual theory and emotional energy. The significance of this study is its application of a novel conceptual framework of emotional energy emphasising the analysis of ideas within emotional experiences of social interaction. Findings from this study will illustrate how formal or abstract scientific concepts may unfold from particular or concrete embodied performances that are embedded within emotional experiences of science classroom interactions. An implication of this study is to indicate an alternative for understanding ideas such as conceptual change in science education, by shifting the site of emotive-cognitive experiences beyond the body to include collective, social spaces.

*Link to RISE paper:*


**Who and what influences middle school students to assume a science identity and value science?**

Katrina Elliott - University of South Australia

Whilst there is much research highlighting teachers’ reasons for valuing science and why it should be valued, there is less about what factors influence students valuing of science. In the middle school only 8.6% students consistently expressed science-related career aspirations at age 11 and again at age 14, and the majority of students (63.5%) expressed other career aspirations (Sheldrake, R., 2018)

The aim of this study is to find out why many students are disengaged in science learning in order to be able to suggest changes in pedagogical practices. The purpose of my research is to work in the space/intersection between parents, students and teachers and their impact on students valuing and identifying with science.

A mixed method research on three case studies of secondary schools focussing on Year 8 students will be used to determine how students’ values and identities are impacted on by their teachers’ pedagogical practices, parents’ value of learning science and social media.

The instruments used for data collection will be a semi structured interviews, focus groups, and South Australian Teaching for Effective Learning (TFEL) observation tool. In addition,
students will be asked to bring along an artefact that represents their value of science and how they identify with learning science.

In this presentation we will focus on the early stages of data collection and any preliminary findings.

Reference:

Exploring the Possibilities of STEM Integration in Secondary School Curriculum in Taiwan and Australia

Su-Chi Fang - National Taiwan Normal University
Lihua Xu - Deakin University

Integrated STEM is advocated as a promising curricular approach to attract students into STEM subjects and to develop their skills for tackling multidisciplinary problems in globalized societies. While numerous instructional resources have been developed for implementing STEM integration in classrooms, existing curriculum frameworks play an important role in either enabling or constraining such integration to occur. This study employs a comparative approach to explore the affordances of the current Victorian (Australian) and Taiwanese curriculum framework for developing integrated STEM in secondary schools. Firstly, we described and juxtaposed Victorian and Taiwanese Science, Mathematics and Technology curriculum structures to examine their similarities and differences. Secondly, we compared how the two curriculum structures can afford or constrain the development of an integrated curriculum through several frequently used approaches, including inquiry-based, problem-based, project-based, and design-based approaches.

The results show that both Victorian and Taiwanese curriculum frameworks allow for content integration through inquiry-based and problem-based learning approaches. Victorian Technology curriculum offers practical contexts for the application of project-based and designed-based learning approaches whereas the two-dimensional structure: content and performance, across disciplines in Taiwanese curricula could serve as a systematic framework for analysis and mapping the possibility of STEM curriculum integration.

Link to RISE paper:

Growth and Change

Peter Fensham, Richard Gunstone, Richard White - Monash University

In this session we shall describe the substantial changes that have occurred since ASERA’s first meeting in membership and in the topics and style of research presented at its
meetings. We shall feature conference papers that we see as agents of change, such as Ian Napper’s use of interviews within lessons (1976) and Colin Gauld’s discovery that memories are altered to fit enduring beliefs (1986). Our purpose then is to identify social and intellectual factors that stimulated and influenced the changes in style and membership. We shall note how factors may limit topics and style, and then discuss how researchers may transcend such limits and so advance scholarship.

A toolkit for STEM club development and implementation: Process and product

Angela Fitzgerald, Tania Leach, Kate Davis, Neil Martin, Stephanie Piper, Margaret Power - University of Southern Queensland
Rena Singh, Shelley Dunlop, Inspiring Australia Queensland

A significant approach to integrating STEM into students’ school experiences has been to offer extracurricular activities, a notion supported by the Queensland Advancing Education strategy (2017) and Chief Scientist STEM position paper (2013). In terms of supporting teachers and schools in such initiatives, numerous networking and professional learning opportunities are offered, although it is an emergent area. How these connections translate to the establishment and implementation of shared approaches to quality STEM education is unknown. <<De-identified>> is a nationally funded initiative that aims to foster public participation in STEM. In Queensland, a key focus is supporting the establishment and sustainability of STEM clubs. STEM clubs fill a niche by exposing students to STEM concepts and skills in an engaging environment without necessarily being linked to curriculum. <<Deidentified>> partnered with a team from a regional university to create a toolkit to support the enactment - from development to delivery - of quality STEM clubs. This presentation will share the process and the product. While shifting STEM education outside of the classroom is not necessarily the answer to increased participation, the toolkit approach does offer some insights into processes and practices that foster improved engagement in educators and students alike.

Giving the silent a voice: How rangatahi used Actor-Network Theory to unravel the complexity of a New Zealand native forest ecosystem.

Bev France, Sally Birdshall - University of Auckland

In New Zealand, the poison sodium fluoroacetate (1080) is used to control pest animals that kill native birds and cause damage to native forests. This socioscientific issue is of particular concern to Māori as they enact their role as guardians of the environment (kaitiakitanga) (McKinley, 1996). A Māori world view is expressed as them being within an ecological relationship rather than separate from an ecosystem. This interconnectedness of nature and humans is central to Traditional Ecological Knowledge where values and beliefs are an important part of the knowledge system. In this research, 28 rangatahi (young Māori) and their kinspeople (iwi) produced posters (Cartography of Controversy) to identify the participants (actants), their emotions and connections involved in a native forest ecosystem disruption when 1080 is applied to control predator pests. Actor-Network Theory (ANT) was
used to analyse these posters in order to reveal the complex biological interactions. It was
shown that it was possible for these rangatahi and their iwi to record both the biological
concepts and the emotions and values of all actants, which increased their perception of the
variety of viewpoints and components that needed consideration when critiquing the use of
this poison. This analysis showed the pedagogical potential for ANT to provide an
epistemological model for teaching that can capture the complex interaction of actors that
are involved in knowledge development.

Reference:

MCKINLEY, E. (1996). Towards an indigenous science curriculum, Research in Science Education,
26(2), 155–167.

Justifying a view of risk: Exploring communication mechanisms employed

Katherine Garthwaite - Tuakau College

Socioscientific issues (SSI) have potential to raise students’ interest in science. But as
Saunders and Rennie (2013) discuss, there is international concern that teachers avoid SSI
because of their controversial nature and difficulty managing the wide range of students’
opinions about possible solutions. An important outcome of SSIs is to develop an
appreciation of this range of viewpoints and Douglas’s grid/group typology proposing four
‘types’ of viewpoints can help to do this. This study explored forty 16-17 year old New
Zealand biology students’ perceptions of the SSI involving the risks associated with using the
poison sodium fluoroacetate (1080) to control mammalian pests in New Zealand’s forest
ecosystems. After analysing which of Douglas’s ‘type’ of viewpoint these students held
about this SSI, the ways in which they communicated their ideas were explored. Using
Kahan’s communication mechanisms, it was found that despite the ‘type’ of viewpoint held
by these students, they all used the same mechanisms to communicate their ideas.
Combining Douglas’s typology and Kahan’s mechanisms could provide a useful tool to assist
students develop an appreciation of the complex and inherent risks involved with, as well as
the differing perceptions held by people of, the many science-based issues currently
affecting society.

Reference:

Saunders, K.J., & Rennie, L. (2013). A pedagogical model for ethical inquiry into socioscientific issues
in science. Research in Science Education, 43(1), 253-274.

Teacher Explanation of Concepts in Science Education: Research Published in RISE since
1983

David Geelan - Griffith University

Explaining scientific concepts to students is an important part of teaching science. It has
been researched for some time, but quite sparsely. Seven papers published in RISE since
1983 have explored this issue, and their contributions are discussed. There is also a strong
tradition of philosophical work on explanation in science, some of which is relevant to explanation and explaining in science teaching. While there has been research on explanations given by students and teachers in classrooms, there is little or no research on the ways in which teacher educators can explicitly prepare beginning science teachers to explain concepts to students. This presentation reviews research work in this field and seeks to synthesise past science education research, philosophy of science and current science education research to lay the groundwork for further research and application in teaching and teacher education practice. It is also intended to lay the ground for further research on the ways in which teachers explain concepts to students in science education, and it is hoped that some of this research will be conducted by ASERA members.

Primary teachers’ perceptions and current understanding of STEM education: A cross-cultural analysis

Sindu George, Kathleen Smith, Jennifer Mansfield - Monash University

Increasing dependency on technology, positions readiness for Science, Technology, Engineering and Mathematics (STEM) careers as an investment in future economic growth. Successful STEM education depends not only on producing STEM graduates, but also on ensuring that education systems effectively develop the associated knowledge, skills and dispositions that align with and enhance STEM learning (Bybee, 2010). To date the primary teacher voice has been noticeably absent from the STEM education debate, yet it is the teachers’ insights about their lived classroom realities (Du Plessis, 2018) that is needed to better understand how teachers can better develop their competency teaching STEM. This study attempts to address this situation by examining STEM education through the eyes of Australian and Indian primary teachers.

Focus groups were conducted with 12 Australian (3 groups) and 32 Indian (5 groups) primary teachers. Thematic analysis identified that teachers from both contexts understood STEM as an integrated and more practical approach for learning, emphasising the importance of problem-solving skills and making connections with real life situations. There was consensus around valued outcomes for STEM education such as promoting collaboration and developing logical and creative thinking in students. Teachers articulated the internal and external constraints associated with STEM education.

References:


Closing the science and education divide in preservice science teacher education

Helen Georgiou, Wendy Nielsen, Glennys O’Brien, George Takacs - University of Wollongong
The University of Wollongong has offered a Bachelor of Science Education (BSciEd) degree since 2003. Based in Education, students take subjects across the university. Key issues compelled a program review; in particular, students felt disjointed by spending time in three (or more) faculties. The review noted that most BSciEd students selected biology as their main teaching area, which meant that they had limited exposure to the basic physics concepts that underpin the junior science curriculum. Program redesign in 2016 included a new subject to address this curricular weakness in the previous program, which is the focus of the current paper.

SCED101 is a first-year subject shared by academics in the Schools of Chemistry, Physics and Education. Pedagogy to teach collaboratively has been challenging, although there is some guidance for subject integration and teacher development in school settings (Wei, 2018). SCED101 has an explicit aim to develop students’ conceptual understandings and consolidate discipline-based study around three unifying concepts—energy, forces and matter. Data include student and instructor commentary. Thematic analysis considered successes and challenges. Results show that students developed integrated understandings, but those with weak backgrounds in the physical sciences still struggled. Overall, the cross-faculty collaboration shows promise, however, logistical challenges remain.

Link to RISE paper:


Science as a Human Endeavour

Denis Goodrum - University of Canberra

The Australian study into science teaching and learning at the beginning of the century (Rennie, Goodrum & Hackling, RISE, 2001) had a profound influence on the nature of the Australian Curriculum: Science. One of the significant developments for this curriculum was the prominence and importance of the strand ‘Science as a Human Endeavour’.

The presentation will examine the following questions.

- Why is the idea ‘Science as a Human Endeavour’ important?
- Why do some teachers struggle with this strand ‘Science as a Human Endeavour’?
- Why is ‘Science as a Human Endeavour’ important to STEM education?
- What is the relationship between ‘Science as a Human Endeavour’ and assessment?

Information and interactive items from the Science by Doing module “Science as a Human Endeavour” will illustrate the issues and research involved in answering these questions.

Reference:
But aren’t all kiwi the same? Exploring children’s understandings of variation within a species

Katie Gormley - University of Auckland

In 2017, a New Zealand Parliamentary Commissioner’s report painted a grim picture of the state of the country’s endemic bird population and urged the public to consider novel strategies to support these species. Discussing controversial approaches, such as promoting greater biodiversity through genetic engineering of small, often isolated, populations, requires an understanding of the need for genetic variation to support survival. Although there has been research into children’s understanding of biodiversity (Bermudez & Lindemann-Matthies, 2018), there has not been a focus on their understanding of within-species variation and the contribution such variations have on the survival of the individual animals and the wider population. This qualitative-interpretive study used paired guided discussions with 84 children participants from two central Auckland primary schools. Implementing thematic analysis, it was found that survival of the individual and means of identification were prominent explanations for variation. These children accepted within-species variation and were aware of the impact that such difference could have on both the individual and the wider population. Misconceptions such as variations being only for identification purposes or for the benefit of humans, were identified.

References:

Science wise with PeerWise

Rena Heap, Dawn Garbett - The University of Auckland

PeerWise is an online learning platform that leverages students’ familiarity with social-media and user-generated content (as exemplified by YouTube, Reddit, Facebook etc.) to create an online learning community. It has been proposed that employing Web 2.0 in educational activities promotes richer opportunities for making learning personally meaningful, collaborative, and socially relevant (Dohn, & Dohn, 2017). We have used PeerWise with each cohort of the science course in a Graduate Diploma Teaching (Primary), 2012-2018, and a BEd(Honours), 2017-2018. Using PeerWise, students create a communal repository of online science animations, interactives and visual resources, and questions—which they then answer, evaluate, provide feedback and discuss. The research aim of this mixed methods study was to determine if PeerWise is efficacious in supporting an online community for pre-service science education. Quantitative data shows that in each iteration, 94-100% of students exceed the minimum requirements for maximum marks in the assessed PeerWise task. Qualitative analysis of students’ evaluative comments shows affirmation for the community, skills, knowledge and an appreciation of science resources. However, the students do not continue to use the repository beyond the course. We are continuing to research how we could better facilitate the utility of the resources amassed in the repository.
Learning to teach science out-of-field

Linda Hobbs - Deakin University

In Australia, out-of-field teaching is a common occurrence in all states and territories. Marginson, Marginson, Tytler, Freeman and Roberts, (2013) have signalled that Australia has one of the highest incidences of out-of-field teaching in comparison to other OECD countries. This presentation focuses on teachers who are learning to be out-of-field science teachers and draws on case examples from research studies examining teacher experiences of learning to teach science out-of-field and the supports they draw on. These are rich qualitative longitudinal interview studies that identify various dimensions to the change processes that these teachers must undergo beyond simply learning the content and how to teach it. This paper provides insight into teaching out-of-field as a temporal experience. Two research questions are examined: (RQ1) What does it mean to be out-of-field in the sciences? (RQ2) What is needed for teachers to learn to teach science out-of-field? Five categories of learning were identified in the data, including learning related to: content, teaching strategies, students and their learning, the school landscape and the professional self. A number of key learnings for future research and practice can be identified. Firstly, teaching science out-of-field should be examined in the context of a teacher’s full teaching load at any one time, but also in the context of their career trajectory. Secondly, teacher’ learning to teach science out-of-field should consider the teacher in context, and in relation to teacher learning generally.

Reference:

Examining the ways in which science teachers mediate between students’ language use and scientific language

Lay Hoon Seah - Nanyang Technological University

When constructing scientific explanations, students do not just encounter conceptual challenges. They also experience language demands arising from the differences between everyday language and scientific language as well as the distinctive grammatical and discourse features that characterise the representation of the various genres found in science. However, previous studies have found that teachers do not necessarily attend to these language demands during their instruction. This study examines episodes of whole class discourse in which the teachers were able to mediate skilfully between the students’ language use and the scientific language. The data for this study came from a project that sought to raise teacher language awareness through several iterative cycles of researcher-
teacher inquiry using student writing as the target of inquiry. Discourse analysis was conducted on the selected episodes to identify the various discursive means by which the teachers attempted to address the language demands of constructing scientific explanations. The use of metalanguage was found to play an important role in the various discursive strategies adopted by the teachers. The analysis also suggests that the inquiry process was able to equip teachers with both the knowledge of their students and knowledge about language that provided the basis for their mediation.

Link to RISE paper:

What happens when you place young children with an augmented reality sandbox? STEM learning experiences

Christine Howitt, Grace Oakley - The University of Western Australia
Rhys George - Bold Park Community School

Augmented reality (AR) technology is being introduced in educational settings for its ability to overlay virtual information into physical environments. The AR Sandbox is a conventional sandbox with contour lines and colour mapped elevations projected onto the sand’s surface in real time. This presentation describes how 4 and 5-year-old children created STEM learning experiences through their play with the AR Sandbox. Based on a single case study of a Reggio-inspired classroom, a mosaic approach to data collection was used that included observation, child conferencing, and children’s photography. The children used the AR Sandbox for games, exploration, representation and small worlds. The findings are presented as a series of vignettes that storied the children’s use of the AR Sandbox and highlight the STEM in their play. To enhance STEM possibilities, the AR Sandbox should be used as an open-ended tool for children’s play that encourages observation, questioning, problem solving, cooperation and creativity. Educators should be mindful of the wide range of STEM learning experiences that are possible when using new technologies.

Link to RISE paper:

Facilitate non-science major students’ understanding of astronomy and epistemic beliefs about science through epistemology and history embedded online astronomy learning content

Li-Yu Huang, Meng-Jun Chen, Shen-Wei Tsao, Hsiao-Ching She - National Chiao-Tung University

This study aims to explore whether explicit prologue can better enhance students’ understanding of astronomy and epistemic beliefs about science through epistemology and history embedded online astronomy learning content. A total of 120 non-science major
students were recruited and equally assigned to two groups either with vs. without prologue based upon their pre-test of understanding of astronomy concepts. Students’ responses to the questions of online astronomy learning content and eye movement behaviours were collected throughout online learning process. Results showed that All students made significant progress, regardless of understanding of astronomy concepts and epistemic beliefs about science. For understanding of astronomy concepts, the explicit group significantly outperformed the implicit group, and the high epistemic beliefs group significantly outperformed the low epistemic beliefs group. For the epistemic beliefs about science, differences were not observed, regardless groups of explicit/implicit prologue, and high/low epistemic beliefs about science. Eye movement measures indicated that students in the explicit group allocated significant longer mean regression duration in the main text area than those in the implicit group. Students in the low epistemic beliefs group allocated significant longer mean fixation duration and mean regression duration in the question area than those in the high epistemic beliefs group.

Reference:


Feedback on Student-Generated Diagrams to Enhance Thinking Skills as Components of Scientific Creativity

Richard Jugar, Mihye Won, David Treagust, Felicity McLure, Jennie Tan - Curtin University

This study investigated how feedback may be effectively used to support the development of students’ scientific creativity through their diagrams in science classes. Adopting Sternberg’s (2006) Investment Theory of Creativity, through their diagrams, the study documented the development of students’ scientific creativity particularly in terms of their thinking skills (synthetic, analytical, and practical-contextual skills). Using Hattie and Timperley’s (2007) model of feedback, different types of feedback on students’ diagrams were analysed to see how they supported the development of students’ scientific creativity. A representation-oriented teaching strategy, called the Thinking Frames Approach (Newberry & Gilbert, 2007), was adopted to engage students in constructing explanatory diagrams and written explanations to enhance their creative scientific thinking skills.
Students’ thinking skills were assessed in terms of complexity (synthetic), coherence (analytical), and consistency (practical-contextual) in their drawings and written explanations. Initial findings from four Year-8 science classes showed that feedback on task, feedback on processing of the task, and feedback about self-regulation improved their diagrams and explanations. In terms of feedback sources and feedback modality, students expressed preference for the teacher as the primary feedback source and questioning as primary feedback mode. Implications for teaching creativity in science and possible future directions are discussed.

References:


RISE Literature Links:


Chemical literacy: What does this mean to Indonesian teachers?

Nural Kasyfita - University of Auckland

Since 2013, scientific literacy has become an essential ongoing reform within Indonesia’s science curriculum. This focus has intensified when Indonesia’s PISA 2015 result was ranked 66/74 of OECD countries. Therefore, teaching chemistry to support scientific/chemical literacy is urgently needed. While research about Indonesian teachers’ chemical literacy has been conducted quantitatively, there is a lack of qualitative research that examines teachers’ views.

This qualitative study asked 43 Indonesian teachers to describe their chemical literacy’s understandings through a questionnaire. Fifteen of them were then interviewed individually to clarify their responses. These responses and interview transcripts were analysed and interpreted using the PISA scientific literacy framework (2013) that identifies four components: knowledge; competency; attitude and context.

Most of the teachers described chemical literacy as content knowledge gained predominantly from texts. “Observation” was mostly mentioned by teachers in relation to procedural knowledge, and there was a lack of awareness of epistemic knowledge. The main competency was identified as ‘to explain phenomena.’ Respondents thought the most important attitude was for students to have an awareness of environmental issues which was viewed from a global context rather than from a personal or local perspective. It is
suggested that these findings could contribute to a refocus of professional development (Archer-Bradshaw, 2017).

Link to RISE paper:

The impact of argumentation on conceptual change in Neutralization Reaction

Suparat Kayadee, Pattamaporn Pimthong, Apisit Songsasen, Tassaneewon Lertcharoenrit - Kasetsart University

The purpose of this study was to investigate the impact of argumentation on conceptual change in neutralization reaction. The participants were 30 Grade 11 students in one large school in Bangkok, Thailand. The argumentation learning unit was implemented in the topic of acid and base. The students were promoted to make claim, use data to support or rationale for the claim, give warrant to show the relationship between claims and data, use backing and qualifier to support students’ reasoning. Moreover, in the topic of neutralization reaction, the paper models were used to promote students’ backing. The data were collected from students’ pre-post surveys, students’ works, students’ interviews, teacher logs and classroom observations. The inductive analysis method was used to analyze the data. The result of this research showed that most students gave quality arguments and improve their understanding in neutralization reaction. The results suggest that the implications of argumentation should be promote conceptual change in other scientific concepts.

Reference:

Design and Evaluation of STEM Tasks Related to Chemistry: An Integrated Approach

Yi-Juan Kee, Tan Aik Ling - National Institute of Education

With the growing pertinence for students in the 21st century to master problem-solving techniques and tackle issues beyond their own disciplines, it is crucial for the education system to move the teaching of science, technology, engineering and mathematics to a more integrated and contextualized manner. In addition, teachers need to ensure that the content taught is located within persistent, complex and extended real-world problems. As such, lessons would no longer only focus on helping students to solve textbook-based questions, but also develop necessary interdisciplinary problem-solving skills and creativity in every student.

The aim of this research is to design and evaluate the effectiveness of three integrated STEM activities that require the application of knowledge in Chemistry. Through engagement in the activities, students could develop knowledge on how Chemistry can be connected to engineering, mathematics and technology. The STEM activities that are
designed will be trialled with a group of 40 grade 9 students in Singapore. The students will undergo pre-, post- assessments and interviews to determine the level of learning after each STEM activity. Discussions related to the benefits of the integrated STEM activities in schools and how they can be implemented will be included in this research.

Link to RISE paper:

https://doi.org/10.1007/s11165-014-9437-7

Science Teachers Design Thinking in STEM Contexts

Gillian Kidman - Monash University

The thinking, planning, and decision making of science teachers comprise a large part of the psychological context of classroom teaching. Curriculum is interpreted and acted upon within this context. Science teachers’ behaviours are substantially influenced and even determined by the teachers’ thought processes. This research explores how and why the observable activities of science teachers’ professional conduct, as they collaboratively plan and investigate STEM problems, takes on the forms and functions that it does. As groups of people solve most problems, my methodology reflected this reality. Thus, following the work of Park & Song (2018), I used group settings to explore how thinking was expressed by science teachers, shared, and elaborated among peers during STEM activities. My aim for this presentation is to comment upon a number of science teachers in terms of their curiosity, inquiry, and collaboration and STEM practice values, and to make comparisons of these factors with mathematics and technology teachers.

Reference:


Developing students’ agency of reasoning in teacher-led classroom talk

Mijung Kim - University of Alberta

To develop students’ reasoning and problem-solving abilities, teachers encourage students to critically and constructively discuss ideas, reasons, and alternatives in problem solving contexts. Exploratory talk has been recognized as cognitive and social tool to create a co-joint space of learning where teachers go beyond the ground rules of teacher-dominant IRE (Initiate-Response-Evaluate) approach. This study examines what teacher scaffolding strategies are used in exploratory talk and how those strategies develop a co-constructive learning community for students to enhance knowledge, reasoning and problem-solving skills. The study employed a descriptive and explanatory case study to understand the dynamics of teacher-students’ interactions during whole classroom talk. 23 students and a teacher in a Grade 5-6 class participated in this study. All science classes were video taped and transcribed to analyze the discourse of classroom talk, teacher scaffolding strategies,
and students’ learning. Research findings suggest that the teacher 1) continuously shifted and expanded individual students’ challenges to the whole class and 2) participated in classroom inquiry process as a member of problem solving community rather than evaluating students’ ideas in order to achieve curriculum goals. This process developed students’ agency of reasoning and problem solving as inquirer and knowledge builder in a collective learning community.

Link to RISE paper:

One Science Programme for All – Diversity within Cultures

Rekha Koul, Rachel Sheffield - Curtin University

Many studies report on the challenges faced by educators engaging with students from diverse backgrounds and with diverse academic needs. There is, however, limited evidence identifying the specific needs of diverse groups of teachers and the strategies to assist them with these needs. A purpose built digital Professional Learning Program was trailed with 94 primary school teachers (42 rural and 52 urban) in India with a view to develop their pedagogical content knowledge in STEM education. This presentation elucidates the differences between rural and urban Indian science teachers’ technological competency and its relationship with the associated attitudinal measures. Data was collected on scales of Teaching - Efficacy, Outcome Expectancy & Practice; 21st Century learning Attitudes, Teacher leadership and STEM Career Awareness. Urban teachers demonstrated higher level of confidence and competence in their use of technology, while as rural teachers were low in technological competence but despite displayed positive attitudes and high resilience towards developing their technology skills.

Using a PCK lens to capture pre-service science teachers’ internalized knowledge of Nature of Science

Louise Lehane - St Angela’s College

This study is situated within an initial teacher education provider in Ireland. The aim was to use a pedagogical content knowledge (PCK) tool to capture pre-service science teachers’ knowledge of Nature of Science. Nature of Science is now an explicit focus in the post-primary curriculum in Ireland and it is therefore critical that our pre-service teachers can recognize Nature of Science within their own and their students’ practice. The tool, known as content representation (CoRe), was developed initially to capture teacher PCK (Hume and Berry, 2011). It has since been used to serve different needs of researchers (Lehane, 2016). This study analyses CoRes that were developed by pre-service teachers (n=12), working within a professional learning community, using the Family Resemblance Approach to Nature of Science (Erduran & Dagher, 2015) as its framework. The main findings from the content analysis show that these pre-service teachers, while they held particular surface
understandings of science as a social-institutional system, they did demonstrate understanding of science as a cognitive system moving beyond the scientific method to science as inquiry. This study contributes to the field as it discusses Nature of Science as part of a teacher’s PCK and uses a PCK tool to capture such understandings.

Reference:


The infusion and effect of critique-oriented argument-driven-inquiry (CADI) in university bio-lab

Yu-Fan Lin, Shu-Mey Yu, Yan-Jie Li, Ko-Jou Chang - National Taichung University of Education
Yu-Zhu Wu - National Taiwan University of Science and Technology

Although argumentation is an essential learning goal for K-12 classrooms (NRC, 2012; Osborne, 2010) one challenge is need to promote ways to support teachers and students in critiquing arguments (Henderson, McNeill, González-Howard, Close, & Evans, 2018; Jang & Hand, 2017). The purpose of this research was to investigate the infusion and effect of critique-oriented argument-driven-inquiry (CADI) on students’ critique arguments in university bio-lab. Quasi-experimental design action research was used. Subjects were forty-three university students taking biology laboratory course from a national university in middle Taiwan. Critique-oriented argument-driven-inquiry (CADI) and critique-oriented argumentation instrument were developed by research team and validated by biology science educator. Subjects went through three rounds CADI under support from research team during biology laboratory course. Critique-oriented argumentation instrument was conducted before and after three rounds CADI. Qualitative data collected of critique-oriented argumentation were analyzed based on Osborne et al., (2016). Inter-rater reliability was 89%. Pairwise t-test was used to compare pre- post-test of subjects’ critique-oriented argumentation. Results showed that significance difference (P<.01) on pre- post-test of subjects’ critique-oriented argumentation after three rounds CADI. Detailed examples of subjects’ three rounds CADI will present in this conference. Implication of further research and teaching practice will present in this conference.

Link to RISE paper:

Exploring Taiwanese university students’ mental models of the greenhouse effect: A factor analysis study of drawings

Shu-Chiu Liu - National Sun Yat-sen University

Using students’ visual representations such as drawings to convey student alternative conceptions and underlying mental models have become increasingly common in environmental science education. The learner-generated drawing provides particular insight into important features and the relationships of these features perceived by the student when thinking about the studied topic. In this paper, we report on a study that used a factor analysis approach to examine Taiwanese university students’ drawings (n = 130) of the greenhouse effect in the context of a general climate studies course. A total of 15 codes were generated by two researchers together in the process of identifying salient features of the drawings. Using exploratory factor analysis to investigate these codes, we discovered four models of the greenhouse effect, and further examined these models in relation to other climate perception variables. Libarkin et al. (2015) have analysed greenhouse effect drawings by US college students using a similar approach, providing an opportunity for us to compare and interpret our findings in a larger context.

Link to RISE paper:
DOI: 10.1007/s11165-018-9703-1

Designing Science Historical Essays in Communication Books to Improve 8th grade Students’ Understandings of Nature of Science

Shiang-Yao Liu - National Taiwan Normal University
Cyong-Huei Chen - Jingxing Junior High School

The role of History of Science (HoS) in science curriculum has been considered as a prominent material for teaching Nature of Science (NOS), while NOS is an important component of scientific literacy. Taiwan’s new science curriculum guidelines also make greater emphasis on “the history of scientific development” as one of the sub-themes in the content framework and learning outcomes. However, historical information in science textbooks, in the current situation, could not help students understand the dynamic process of scientific development, and may even distort NOS by misusing historical stories. In attempt to mitigate the constraints of textbooks and teaching time, this study aims to integrate HoS essays into the home-school communication book as a supplementary reading material for 8th graders’ daily homework. We will describe the framework and writing technique in composing 100 essays and the page layout normally used in Taiwan’s secondary schools. The communication book has been field-tested with 61 students from two junior high schools. According to the analysis on the pre- and post-test scores of the “Understanding of the Nature of Science Scale,” a validated instrument, the way in which reading and responding HoS essays throughout a semester indeed enhance students’ NOS understandings significantly.

Link to RISE paper:
https://link.springer.com/article/10.1007/BF02620497
Contribution to Teaching and Learning Science, Interest to ASERA. The child-framed research surrounds a science program where secondary students as teachers and facilitators present activities with primary students to bring about awareness of their local critically endangered ecosystem

Marianne Logan - Southern Cross University

Research reveals science lessons that are relevant to the students’ everyday lives increase their interest in, engagement with, and positive attitudes towards, school science (Logan & Skamp, 2008; Kang & Keinonen 2018). Furthermore, when young people engaged with their local critically endangered ecosystem in their science lessons their knowledge about the forest increased and they cared about the future of the forest in their local area (Logan, 2018). This paper outlines the methods and early findings of a child/youth-framed project where young people from secondary school as educators and co-researchers work with young people from primary school to engage with their local rainforest and its rich cultural, geological, and biological history. The project, where young people teach young people, aims to promote awareness of, and engagement with, the local critically endangered ecological community. Fifteen young A/r/tographic co-researchers from three secondary schools in regional Australia, will develop skills as artists, researchers, educators and leaders and document their experiences employing arts-based methods during the science program. The project builds on the findings of an earlier child framed research project: Young People Inspiring Awareness of, and Action towards, their Local Natural Ecosystem (Logan, 2018) to develop a framework for young people as A/r/tographers and co-researchers.

References:


The nature of education and biomedical science students’ views about observations and inferences

Jennifer Mansfield, Yvonne Hodgson, Pavneet Heer, Hanh Ho, Fiona Wightman, Binhui Tu - Monash University
Developing mature views about the nature of science (NOS) is necessary for developing scientific literacy. Mature NOS views are important for science teachers (many of whom enter the profession after a career or degree in science), as their beliefs and values about NOS influence their teaching (Deniz & Adibelli, 2015). Understanding where and how NOS views develop can influence tertiary education and science degree teaching curriculum.

This research reports on education and biomedical science students’ views about the nature of observations and inferences (OI), important aspects of NOS. The SUSSI survey instrument (Liang et al., 2008) was used to measure OI views of education degree (n=185) and biomedical science degree (n=71) students. Views were categorised as naïve, semi-naïve, semi-informed and informed. Thematic analysis of qualitative survey data identified key characteristics of each category. Further analysis of characteristics across categories led to development of three board themes about the nature of OI: nature and processes of science (such as accuracy, complexity and certainty); individuality (such as prior knowledge and experience), and; generalised statements about science/scientific knowledge (e.g. change over time). Views about the nature of observation and inference increased in complexity and specificity as views became more informed.

References:


Science news stories in the media – old issues, new challenges and new opportunities for science preservice teacher education!

Karen Marangio, Richard Gunstone - Monash University

Social media channels today are major (sometimes sole) sources of information for people. The escalating amount and access of science news stories is clearly significant for science education, as is the numbers of “fake science” reports. This creates challenges for school science, but also opens new opportunities. This paper offers starting points for future development of science preservice teacher education.

Media distortions of science have a long-term problem for science education, for example we briefly consider 1980s secondary school students’ views of fake science prominent at that time. Our prime focus is on contemporary secondary science preservice teachers’ views about/ experiences with sourcing and using science news stories during school placements. In 2018, 47 preservice teachers completed an online survey. Almost half had observed or taught with science news stories on placement, but only 3 observed critiquing of a science news story. They were interested in why we are all susceptible to making quick decisions about news headlines. Preservice teachers strongly advocated the use of science news stories in teaching but also wanted to be more up to date about the issues, especially if they are controversial, and ways to help both them and their students to critique the stories.
Recent Evidence of New Zealand Students’ Engagement with Science

Kaitlyn Martin, Lloyd Davis, Susan Sandretto - University of Otago

Students’ engagement with science encompasses their motivations, interests, and attitudes toward science and is a predictor of choosing to pursue science in their future. While large-scale assessments of engagement frequently suggest strategies to promote science, many provide narrow bands of insight for determining when and why students lose engagement. We review studies in this area from Aotearoa New Zealand – a nation concerned with a large spread in science achievement. We draw on peer-reviewed research, longitudinal studies, and national and international assessments to give a comprehensive report on student engagement with science. The comparison shows that while engagement levels are frequently reported as positive, there are three consistent issues which go unresolved. Our analysis found contradictions in results between studies, a lack of research from non-governmental bodies, and a failure to capture engagement changes across the middle year-levels where, internationally, students have been found to make decisions about staying in science. Understanding how students lose their engagement in the national context can help target successful strategies to improve student engagement with science in the future. We discourage sole reliance on large-scale assessments, and call for empirical research into student engagement with science, especially across the primary and secondary transition.

Building creativity: Communicating scientific understanding of chemistry through student-generated conceptual drawings in a gifted primary program

Felicity McLure, Mihye Won - Curtin University

An essential part of creativity is the ability to communicate ideas persuasively to an
audience (Sternberg, 2006). This study focuses on the development of creative skills to communicate scientific understanding through production of student-generated conceptual drawings. Grade 5 and 6 students attending a chemistry program for gifted students generated and evaluated explanations of phenomena presented as discrepant events. Students then developed strategies to communicate their understanding of these phenomena through conceptual drawings. This study is an illustrative case study, documenting different approaches that students took to persuasively communicate their explanations pictorially. Data was collected from videos, student drawings and student interviews. The cases of two students, who enthusiastically embraced drawing as a medium of scientific communication, are presented. Results illustrate a number of creative strategies these students adopted to communicate their conceptual understanding through drawing: use of a variety of symbols to represent movement, collisions, attractions; zooming in; use of a series of drawings illustrating different aspects of the argument and a combination of macroscopic and sub-microscopic views. The importance of feedback through questioning by teachers to support students in critically evaluating and further developing these communication strategies is highlighted.

References:


Enhancing Students’ Constructing Ability of Scientific Explanation in a high school electrochemistry classroom: An action research

Chontawat Meedee - Khon Kaen University and Office of Basic Education Commission

This study aims to enhance senior high school students’ scientific explanation. Four cycles of action research were conducted in an electrochemistry classroom by author as a high school chemistry teacher. A theoretical framework to elicit participants’ explaining ability was developed from deductive-nomological (DN) explanation model (Hempel and Oppenheim, 1948), pattern of an argument (Toulmin, 1958), and concept of chemical representation (Johnstone, 1982) that consists of macroscopic, sub-microscopic and symbolic. Data were collected from 1) participants’ paper-based writing and drawing explanation, and 2) verbal explanation. The findings showed their progress of explaining ability, and uncovered students’ process of learning to link abstract and concrete electrochemical phenomena as various directions.

Link to RISE paper:
https://link.springer.com/article/10.1007/s11165-017-9614-6
https://link.springer.com/article/10.1007/s11165-017-9648-9
The role of community in a university run science outreach astronomy program

Victoria Millar, Maurizio Toscano, Jan van Driel, Emma Stevenson, Chloe Nelson - The University of Melbourne

Concern with participation in science has been an ongoing feature of discussions amongst science educators, policy makers and industry groups for a number of decades in many countries. Outreach programs have been proposed and implemented in an effort to both increase and retain students’ participation in science. Universities in particular are increasingly expected to engage with communities and as a result a large number of university run science outreach programs have arisen. Previous studies of outreach programs have tended to take into account the perspectives of just a few stakeholders in the program. Although this approach has led to some understanding of outreach programs it underplays the level of complexity in running outreach programs and leaves a gap in understanding how student identity and aspirations toward science are supported in science outreach. This research has investigated the perspectives of students, teachers, parents and university educators in one university run astronomy outreach program with the aim of better understanding the role of community in engaging students in science. The study confirms the importance of sustained support rather than single interventions (Fitzgerald et al., 2015) and highlights how different stakeholders contribute to shared affective experiences of astronomical phenomena and practices.

Link to RISE paper:

Equipping Primary Preservice Teachers with a Specialisation in Science: A Summary of Our Research Program

Reece Mills, Theresa Bourke, Erin Siostrom - Queensland University of Technology

In response to perceived deficits in primary science and mathematics education, there is an increasing interest in discipline area expert teachers by researchers and policymakers alike (e.g., Marco-Bujosa, Levy, & McNiell, 2018). Recent reforms in Initial Teacher Education (ITE) in Australia have called for primary preservice teachers to graduate with a specialisation in a priority learning area that may include science or mathematics. In developing a program of research about this policy reform we: (A) use document analysis and Carol Bacchi’s what’s the problem represented to be (WPR) approach to analyse the discourses present in four policy documents that led to the introduction of primary specialisations in Australian education; (B) systematically review current research to find out what is known and what is not known about science and mathematics expert teachers’ preparation, daily work, and impact in schools and classrooms; and (C) conduct a case study of science specialisation policy enactment at one Australian university. Our findings demonstrate that the introduction of primary specialisations has a weak foundation and there is contradictory
evidence that science and mathematics expert teachers have a positive influence on instructional quality and student learning. We document our approach to equipping primary preservice teachers with a specialisation in science through a series of online modules linked to critical events in their ITE course. Implications for scholarship, policy, and practice are discussed.

Reference:


Effective socio-scientific communication: Observing audience reaction to a picture-story show at a Japanese zoo

Shiho Miyake - Kobe College, Japan

Abstract: Recent reports have predicted that zoos’ educational function of fostering biodiversity awareness and environmental values (e.g. Britton & Tippins, 2015) is expected to create global citizens who are interested and involved in socio-scientific issues (Tytler, 2012). This study explored a way of promoting how a socio-scientific issue of biodiversity awareness for citizens would be developed by the effectiveness of a picture-story show about a specific Japanese stork at a zoo. The show was developed for this study and comprised three parts: an audience pre-quiz, Rico’s story, and an audience post-quiz. The author and students delivered the picture-story show in front of the Japanese stork house at the Osaka Tennoji Zoo. Based on the chronological record of the number of audience members during the shows, the number of spectators seemed to gradually increase from start to finish. Therefore, it can be understood that the show content attracted visitors’ attention. From the free description soliciting audience impressions of the show, it is evident that they were interested in both the quizzes and story. Additionally, the audience had a favourable impression of the show’s visual features. This research can be used as a case study of an effective communication exhibition at a zoo.

Reference:


Making difficult choices, creating a space for science in a Māori medium school

Azra Moeed, Craig Rofe - Victoria University of Wellington

In New Zealand most students attend English medium state schools; however, approximately 15% of Māori students attend Māori medium schools (wharekura). These schools are underpinned with Kura Kaupapa Māori philosophy which is culturally specific to Māori and aims to revitalise the Māori language, Māori knowledge and culture. Māori
students’ engagement and achievement continues to be a challenge for both mainstream and Māori medium schools, teachers and students. The challenge is access to teachers who had a background in science and could teach it in Te Reo Māori. School leadership and whanau believed that by year 9 their students had developed their identity as Māori, and were proficient in Te Reo Māori. They wanted their students to have the option to learn science. This paper presents the findings of a case study conducted in one Māori medium school where a space was created for Pūtaiao (Western science) teaching and learning from year 1 to 13. Pūtaiao is being taught in Te Reo Māori in kura (years 1 to 8) and in English in wharekura (Year 9-13). Evidence suggests students are engaging and learning science, learning to investigate, and achieving in science. We will be sharing the resulting model.

Link to RISE paper:


Young science explorers: Guiding play through inquiry questioning

Karen Murcia, Karen Nicholls, Leigh Mitchell - Curtin University

Early childhood is the perfect time to cultivate positive attitudes and develop fundamental skills in science as children are naturally questioning and open to exploring (Gomes & Fleet, 2018; Sliogeris & Almeida, 2017). Intentionally planned environments rich with engaging resources provoke science learning as children explore what’s around them. Learning opportunities are enhanced when Educators’ guide, question, and assist children with new ideas (DEEWR, 2009). Educators encourage children’s curiosity, noticing and doing by asking open inquiry questions and actively listening. Intentional learning design, resource selection and timely questions can focus children’s thinking as they play, explore and learn. This paper reports action research conducted in a University Early Years Learning Centre where the Centre Educators were positioned as practitioner researchers and collaborators.  We illustrate with a learning example titled ‘Shadows’, how planning scaffolds supported the design, monitoring and documenting of children’s science thinking.  We questioned and investigated how teaching and learning practices which included inquiry questioning impacted on an Educator’s self-efficacy and children’s engagement with science.

Link to RISE paper:


Collaborative Philosophical Inquiry promotes improved STEM competencies in the primary science classroom
Embedding Collaborative Philosophical Inquiry (CPI) into Year 6 inquiry science units has significant effects on students’ questioning skills and other inquiry behaviours. In this study, the development of STEM competencies from the Australian Curriculum for Science, Mathematics and Design Technology are explored across 159 Year 6 students in two groups; those that participated in a design thinking (DT) inquiry task to construct a generator at the end of an inquiry unit on electricity and energy, and those that also participated in CPI across the same unit. Eleven Year 6 teachers attended two days of professional development around science curriculum that included DT, inquiry tasks and CPI. Five of the 11 teachers embedded CPI in the inquiry unit. Student data sources included pre/post-tests, focus group interviews and video recordings of a DT inquiry task at the end of the unit. Paired and unpaired t-tests were used to compare the groups’ pre-post test results and a Mann-Whitney U test was utilised to analyse recorded discourse analysis for competencies. The findings show the CPI group achieved significantly higher learning gains, deeper epistemological knowledge and understanding and a wider range of STEM subject competencies in Science, Mathematics and Design Technology than their non-CPI peers.

Reference:

Building digital and scientific literacies through generating multiple representations in a digital explanation

Wendy Nielsen, Helen Georgiou, Pauline Jones, Annette Turney - University of Wollongong

Digital literacies feature in contemporary curriculum documents as desired practices during learning activity. ‘Digital literacy’ is defined as “the ability to use information and communication technology to find, evaluate, create, and communicate information” (Johnson et al., 2014, p. 22). Scientific literacies include the specialized terminology of concepts and processes, disciplinary conventions and canonical forms of representation for meaning making and communications. ‘Digital explanation’ is a task for university science learners (Nielsen et al., 2018) that provides opportunity to develop digital and scientific literacies because in developing the artefact, learners choose ideas to represent, select representational forms to illustrate the ideas, produce them in digital form and then curate them into a coherent sequence that communicates science content to a non-expert audience.

In this paper, we demonstrate how the process of generating a digital explanation supports students to develop digital and scientific literacies. Data include digital explanations and interviews with the university science students who created them. Analyses are grounded in theories of multimodality and semiotics and illustrate the complex relationships between student-generated digital media, digital literacies and scientific literacies. Effective engagement with these complexities is key to generating a successful digital explanation, which has implications for science learners’ ability to communicate their science knowledge.
References:


Year 7 and 8 STEM Collaborative Inquiry Research Findings

Lisa O’Keeffe, Bruce White - University of South Australia
Katrina Elliott, Alex Semmens - Department for Education, South Australia

The role of science, technology, engineering and mathematics (STEM) cannot be underestimated in preparing global citizens for the challenges of the future (Chubb, 2015). Federal education authorities initiated a range of policy changes culminating in the National STEM School Education Strategy (Education Council 2015), with South Australia’s Department for Education developing and implementing a State STEM Education Strategy for 2017 to 2020.

The South Australian Department for Education in partnership with University of South Australia initiated a Year 7 and 8 STEM collaborative inquiry project which brought together five school networks with industry and academic partners to work collaboratively to design, trial and evaluate innovative and evidence-informed approaches to improve learner engagement, disposition and achievement in STEM across Years 7 and 8. The five networks consisted of at least one secondary school and a minimum of four primary schools, in total thirty nine schools across metropolitan and regional settings in South Australia were evaluated.

Longitudinal quantitative and qualitative mixed methods, multiple data sources were analysed including students’ and teachers’ focus groups, interviews, engagement and disposition surveys and classroom observations. Some of the findings were that schools which partnered with industry and community added a sense of authenticity and depth of learning that was not evident in the projects without this type of connection. There was also a small but significant increase in student’s confidence in science in the course of the project.

STEM Education: how new?

Ann Osman, Jan Van Driel, David Clarke - University of Melbourne

Context:
To investigate STEM Education from an Australian perspective, a curriculum conceptual framework (using the eras identified by DeBoer, 2014) was used to examine factors that lead to the development of curriculum for STEM Education.

Significance:
This research draws on the work of Fensham (The Future Curriculum for School Science:
What can be learnt from the past? 2016) to identify which aspects (e.g. the use of contexts relevant to students to build understanding) of past curriculum reform (e.g. Science for All) remain relevant to STEM Education.

Research aim:
To determine if stakeholders’ conceptualisations of STEM Education can be used to establish a preferred vision for curriculum for STEM Education in Australia.

Methodology:
Data was collected from the analysis of a selection of published STEM Education documents a Delphi study and semi-structured interviews with sixteen key stakeholders.

Findings:
Three visions for STEM Education and its implementation in the Australian context emerged. Each vision reflected at least one aspect (as identified by Fensham, 2016) of past curriculum reforms that are applicable to STEM Education.

This presentation will discuss the three visions developed and suggest how each of these visions could lead to effective and sustainable STEM Education.

References:


Transdisciplinary STEM: An eco-justice orientation

Kathryn Paige, David Lloyd, Richard Smith - University of South Australia

An eco-justice orientation is a necessary one for educators who intend to assist their students towards the kinds of ‘whole-Earth’ knowing, wanting and acting that just might enable them to work toward an increasingly whole — and just — Earth community (Herman, Zeidler & Newton, 2018). A set of eco-justice educational practices and principles have been developed over the past two decades and used as the basis of primary/middle science teacher education courses. They are positive/ proactive and enable a more hopeful forward looking story and include 1) identify and challenge current worldview values and behaviours 2) develop a community of learners with a disposition to value with compassion natural and human systems 3) engage in working collaboratively towards socially, culturally and ecologically just sustainable communities 4) develop as role models who value the
commons 5) promote acquisition of eco-social wisdom-ways they think feel and act 6) develop a respect for the long term 7) critically reflect on actions and 8) employ culturally responsive pedagogy and indigenous perspectives. This paper will draw on examples of practice and activism from both primary classrooms and teacher education science and mathematics curriculum courses where transdisciplinary approaches to STEM are explored.

Reference:
https://doi.org/10.1007/s11165-018-9764-1

Primary Connections Professional Learning: What do teachers really want?

Tracey-Ann Palmer, Paul Burke, Peter Aubusson, Kimberley Pressick-Kilborn - University of Technology Sydney

Professional learning provided by the Australian Academy of Science for its Primary Connections education program aims to help primary teachers to develop confidence and competence in teaching science. This paper reports on the final phase of a study investigating the features of primary science professional learning that are relatively attractive or relatively unattractive to primary school teachers. Data gathered from pre-service teachers and in-service teachers in focus groups and a survey were used to construct a list of features of professional learning in Primary Connections. These features were used to construct a discrete choice experiment (DCE). This paper presents the results from a sample of 270 in-service (70%) and pre-service teachers (30%) who completed the DCE survey. The DCE offered teachers alternative primary science professional learning scenarios described in terms of different features. Teachers were invited to choose between scenarios. Analysis of their choices revealed the trade-offs that teachers were making between specific features of the professional learning offered. The findings have implications for teacher participation in primary science professional learning.

A Stroll Amongst Historical Chemical Misconceptions

William Palmer - Curtin University

My past and current research1,2. involves ideas of chemical change and school textbooks. More recently, this research has been broadened; historical student alternative conceptions (misconceptions) have been investigated using my collection of 366 American laboratory manuals, all more than seventy years old, which were used by school and college students. The clear result of examining these manuals for misconceptions was that the area that consistently caused most student misconceptions was the writing of chemical equations. It was also noticeable that some of the authors of the manuals which the students were using, also had misconceptions about equations. So, as science advances, concepts from past eras may become misconceptions. Examples of his may be seen by looking at old school textbooks and manuals.
This study is to follow the development of the chemical equation over the past two and a half centuries illustrating changes in practice, using examples from school textbooks and student manuals. What chemical misconceptions are present in today’s teaching and school textbooks that will be obvious to future generations?

Reference:


An analysis on the patterns of interplay among different levels of representations shown in students’ drawings to construct scientific explanations

Joonhyeong Park, Jina Chang, Kok-Sing Tang, David Treagust, Mihye Won - Curtin University

In the construction of scientific explanations, visual representations are indispensable and have a complementary relationship with verbal representations. However, most studies have focussed on the role of verbal rather than visual representations in students’ explanations. In particular, we are interested in the interplay among different levels of visual representations to examine the relationships between them in constructing explanations. Therefore, we investigated how students construct scientific explanations while drawing explanatory diagrams. Years five and six students in a gifted and talented class drew explanatory diagrams as they studied the physics concept of mechanics. The researchers observed and analysed the diagram drawing process in relation to three representational levels: sensory (e.g., observed materials), unseen substance (e.g., molecules), and unseen non-substance (e.g., forces). The analysis showed five patterns of interplay among different levels. For an instance of one pattern, students drew diagrams on particles (unseen substance) in relation to what they observed (sensory), they then included physics concepts of forces (unseen non-substance) and returned to the other representational levels to consolidate their explanations. Based on the findings, we discuss building scientific explanations through drawing in light of the functions of the interplay among the different levels of representations in learning physics.

Link to RISE paper:

We were asked to identify similar “Preston, C. (2016). Effect of a science diagram on primary students’ understanding about magnets. Research in Science Education, 46(6), 857-877.” papers in RISE

The role of dialogic argumentation in science education for decision-making

Charlotte Pezaro - The University of Queensland and CSIRO

There is scant evidence to support the claim that learning science improves students’ decision-making. In this research, a mixed-methods, quasi-experimental design was used to
compare students’ knowledge, skills, and dispositions for decision-making, including open-minded thinking and valuing of science, before and after a first-year university course in science for education. All participants engaged in scientific inquiry; a small sub-set engaged in dialogic argumentation regarding socioscientific issues on a regular basis. The findings demonstrate that as a pedagogical approach, scientific inquiry is insufficient for developing students’ capacities for decision-making. However, dialogic argumentation regarding socioscientific issues may be more successful.

*Link to RISE paper:


**Teachers infusing representational inquiry in teaching chemistry**

Lam Pham, Peter Hubber, Russell Tytler - Deakin University

Chemistry usually deals with abstract concepts that are often explained through thinking about what happens in the sub-microscopic domain. In learning chemistry concepts, Johnstone argues that the learner needs to be able to flexibly move between representations at the macro-, sub-micro and symbolic level (Devetak, Vogrinc, & Glažar, 2009). It is also argued that learning in chemistry is enhanced through inquiry-based approaches.

This presentation will outline an ethnographic study that adopted a directed inquiry pedagogy based on students constructing and coordinating representations within a teaching sequence that explored students’ capabilities to flexibly move across Johnston’ levels when learning chemistry concepts.

The study involved Year 10 and 11 chemistry teachers across four schools in teaching the topics of dilution and concentration. Classroom videos, teachers’ pedagogical strategies and students’ artefacts were analysed to build a picture of representational practices including: 1- how the representation sequence was constructed, 2- how the teachers’ pedagogical strategies worked to enrich students’ conceptual understanding and problem solving skills and 3- proposing design principles for teaching sequences in chemistry based on carefully constructed representation challenges. The presentation will report on the strategies and student responses to representational challenges.

*Reference:


**Enhancing Students’ Creativity and Critical-Thinking Skills in the Direct-Circuit Unit by Integrated STEM with Project-Based Learning**

Tharuesean Prasoplarb, Chatree Faikhamta, Surasak Chiangga, Somsak Techakosit - Kasetsart University
Twenty-first century skills play a crucial role in teaching and learning science. This classroom-action research investigated the best practices for teaching physics to promote 11th grade students’ creativity and critical-thinking skills (2Cs) through integrated science, technology, engineering and mathematics (STEM) with project-based learning. The four steps of the teaching method – define, iceberg, modelling and plenty (the D.I.M.PLE model) – were synthesized from the key features of STEM and project-based learning and were used to create two challenges related to direct-circuit, focusing on improvement in the 2Cs. The 33 participants were 11th grade students. The students’ tasks were used to track individual performance for each component of the 2Cs, and overall score was analysed by mean and standard deviation. Reflective journals were used as a data source, then analysed by inductive analysis. The findings indicate that the students met both challenges and exhibited the 2Cs while working. The key features that enhanced students’ 2C skills were (1) engaging students in critical interpretation by training them to consider the same situation from diverse points of view and (2) having students creatively elaborate on their design process by encouraging them to be aware of the constraints during the process that improved their solution.

Reference:

Engaging children in citizen science and sustainability education through digital technologies: Bridges or barriers?

Kimberley Pressick-Kilborn, John Buchanan, Damian Maher - University of Technology Sydney

In conserving, protecting and managing the environment, digital technologies have an important contribution in enhancing youth interest and engagement in sustainability initiatives. Data sharing towards improved environmental and biodiversity activism can be promoted. Virtual encounters with the environment, however, are arguably an inferior substitute for real-time and real-place encounters. In this paper, we consider how digital technologies (dis)connect young people to or from their environments. There are two aims: to (1) investigate environmental education practices that incorporate digital technologies in children’s learning, and (2) examine how digital technologies can support such practices. To achieve research aim 1, a literature review identified affordances and limitations of a variety of digital learning tools, such as games and augmented reality, used in citizen science and other sustainability education initiatives. To achieve research aim 2, we constructed five illustrative vignettes that draw on research undertaken as well as our personal engagement and professional work in environmental, science and technology education in community, school and tertiary settings. Three vignettes are based on current practice, while two envisage practice likely to be realised in the near future. Authenticity and personalisation are identified as key pedagogical features across the five vignettes, with reference to the literature reviewed.

Link to RISE paper:
Thinking tools - modality analysis, how primary students represent Scientific and Mathematics concepts of dynamic phenomena

Christine Preston - The University of Sydney

This study explored how primary children use drawings to represent scientific and mathematical concepts of a dynamic physical experiment. The significance lies in identifying links between children’s developing representational resources and their use in formulating and expressing cross-curricula understanding. Representations in science and mathematics are integral to visualization and reasoning processes. The research integrates representational theories from both disciplines to interpret children’s ideas about inter-related concepts. The research aimed to identify the frequency of representation modes and affordances for communicating science and mathematics concepts. In individual task-based interviews, six children aged 7-12 observed an experiment and created drawings of the physical phenomenon. Digital data-gathering devices captured children’s drawing and talking about observations involving change, movement and relationships. Video analysis software was used to identify and quantify the representation modalities in children’s descriptions and explanations of the dynamic experiment. Analysis comprised tracking time spent: drawing, talking and gesturing and combinations of representation modalities. The findings revealed individual students approached the drawing task in a variety of ways using multiple modalities. Verbal and embodied representations were favoured by children to communicate concepts they found hard to draw. In conclusion, meta-representational competence impacts how primary students’ externalise scientific and mathematical concepts.

Link to RISE paper:

Taxonomy-in-Context: How Did Context-based Learning Help My Students Search for Meaning and Values in Biology?

Worakan Promsawat, Pongprapan Pongsophon, Ekkaphan Kraichak - Kasetsart University

This research aims to examine the effect of context-based learning approach (CBL) on high school students’ attitude toward biology in one of the most boring topic in Biology, Biological Taxonomy and synthesize some good teaching practices through cycles of critical self-reflection and reflective practice in my action research. Attitude toward biology test modified from The Attitudes Toward Science Inventory (ATSI) and reflective journal were utilized to gather the data. The views were collected before and after the intervention and compared using dependent paired t-test. The results show that three components of attitude toward biology namely, anxiety toward biology, enjoyment of biology, and
motivation toward biology, significantly increased after the intervention (p < 0.05) while the components of perception of the science teacher, value of biology, and self-esteem at biology did not change. The CBL had positive impact on some dimensions of the attitude because it encouraged the students to actively and collaboratively engage in hands-on/minds-on activity to discover scientific explanation and apply it in daily-life situations meaningfully.

Link to RISE paper:


Teachers’ understandings and use of socio-scientific issues in science classrooms: Chinese science education community’s perspective

Yujiao Qiao - University of Auckland

STS(E) is the main approach to develop scientific literacy in China. Socio-scientific issues (SSI) provide potential to realise broader scientific literacy goals (Sadler, Barab & Scott, 2007). However, no evidence supports its use in the Chinese curriculum context. This study explored a Chinese science education community’s perspectives of dealing with SSI and their use in science classrooms. Eleven in-service teachers, ten student teachers and five teacher educators participated individually in newspaper article reviewing activities and interviews regarding a local issue of smog and haze. A thematic analysis employed Ratcliffe and Grace’s (2003) SSI framework to analyse data inductively and deductively. Eight categories were identified: personal convictions; conceptual understanding; sustainable development; evaluation of evidence; decision-making process; risk analysis; as well as morality and ethics. The results showed that most of participants were open to utilise SSI in science classrooms, but they reported constraints hindering their realisation of SSI goals. Participants also expressed a wide range of perspectives in the conceptual understanding, sustainable development and evaluation of evidence categories but narrow understandings of other categories. These findings indicate that SSI has the potential to satisfy the scientific literacy goals identified in the Chinese science curriculum and identify areas for further professional development.

Reference:

Developing Critical Thinking in Integrated STEM Education Outside of School
Effective integrated STEM curricula have an out-of-school component that provides students with opportunities to experience the transdisciplinary nature of real-world science. It is argued that providing students with learning opportunities that require interaction with local or community issues can benefit their critical thinking. First, applying disciplinary knowledge in real life demonstrates the complexity of the real world, helping students to understand that such knowledge is rarely directly transferable because other variables are at play. Good understanding requires that disciplinary knowledge be balanced with integrated knowledge (Venville et al. 2004, provide examples). Second, connecting with community issues contextualises students’ learning, showing them how what they have learned can contribute to STEM-related issues beyond school. Third, working on issues important to the local community provides opportunities for students to develop their sense of social responsibility, as they face matters relating to social values and diversity. These arguments are illustrated using research-based examples, including high school students undertaking a biotechnology project and upper primary students exploring the disposal of intractable waste.

*Reference:*


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**A Practical Guide to Implement Learner-Generated Digital Media (LGDM) Assignments in Undergraduate Science Education**

Jorge Reyna - University of Technology Sydney

Learner-Generated Digital Media (LGDM) assignments empower students to become co-creator of knowledge instead of passive consumers of content. The affordability of digital technologies and devices such as a smartphone and tablets created the opportunity to use digital media in the classroom. Research in LGDM assignments focused on the content and neglected the importance of effective communication in the digital space. Part of the issue is because of educators’ lack of understanding of digital media production workflow. This paper aimed to present an evidence-based guide to help science educators to design, implement and evaluate LGDM assignments in the classroom. Five theoretical models were developed, refined and trialled in Autumn 2017 using a mixed-methods approach in undergraduate science students (n=1,687). These models helped to identify student training in digital media, the development of useful marking rubrics, and the design, implementation and evaluation of the LGDM assignments. Students reported enjoying learning with LGDM assignments and believe that the digital media assignment helped them to work as a part of the team, including the development of conflict resolution and communication skills. This presentation discusses the results of the successful implementation of LGDM at a Faculty level.

*Link to RISE paper:*
“Making Progress” in primary science

Sandy Robbins - New Zealand Council for Educational Research

1990’s science curriculum developments spanning the years of compulsory schooling created an illusory sense that it would be possible to meaningfully capture overall “progress” in learning (Fensham, 1994). The challenges which Fensham identified are exacerbated when the focus is on progression in the Nature of Science component of a curriculum. Leden & Hansson (2017) suggest broad progress categories for NOS as declarative knowledge. But what could progress look like if NOS is treated as supporting a more functional understanding of science?

The “science capabilities” initiative in New Zealand takes the latter approach (Hipkins & Bull, 2015). The National Monitoring Study of Student Achievement (NMSSA) provided an opportunity to explore students’ demonstrations of science capabilities at year 4 and year 8, and to infer “progress” between those two time points. The 2017 assessment round used pencil-and-paper assessment as well as “in-depth” tasks which students completed in the presence of a teacher-assessor. This session will illustrate how students’ science capabilities were assessed in each format and present evidence of the progress students can (but may not) make between the assessed year levels. Rasch-modelled indicators of progress will be used to illustrate the findings. (190 words)

References:


https://doi.org/10.1007/s11165-017-9628-0

Science is more than big experiments: Modelling everyday science in the early years’ setting

Pauline Roberts, Elaine Blake - Edith Cowan University

This presentation reports the implementation of a modelled approach to incidental science found in everyday activities. Prior research has identified that providing science in early years’ education is limited in terms of dedicated time and teacher confidence. This research aimed to work with educators to identify and respond to incidental science opportunities within the early years’ context. Through visits to three early learning settings in Western Australia, modelled science learning and teaching was utilised to demonstrate everyday science opportunities present within play experiences (Fleer, 2009; Gomes and Fleer, 2018). Data were collected through observations and pre- and post- interviews with educators.
about their perception of science. Results across the three participating settings were diverse. While one setting took on more science-based initiatives another made no change at all. Identified, however, was a multitude of factors that impact the uptake of science in an early years’ setting. For many educators, in this context, modelling needed to include explicit connections before the facilitation of everyday science increased.

References:

The STEM Approach for Promoting Critical Thinking Skill in Thailand Science Classroom

Supawadee Sarawan, Chokcha Yuenyong - Khon Kaen University
Chris Eames - The University of Waikato

To design and develop the model for promoting students think critically using a STEM approach based on the theories of social constructivism and metacognitive thinking are the aim of this research. Therefore, in this study we focus on the theory of thinking connected with teaching and learning design to supported students’ thinking. Also, we used CT-STEM model to be the STEM intervention to science classroom in Thailand science classroom. For promoting students’ critical thinking skill, we used threes processes which construct them to think: 1) ask questions, 2) write and converts students to identify issue, claims and arguments that reasons, and 3) group collaboration to promoted critical thinking skill such as discussions, case study, task-related group work, peer review or debates. In this study, the researcher used an intervention as follow these theoretical framework to supported students as a critical thinkers. For the early implementation, we found that learning process base of think critically in science classroom can enhance the learners to think with learning to argue. Finally, the learners will find the truth or believable of that things, the learners discovered an appropriate approach though their seasoned argument and finally they create their decision to solve that problem from their reason argumentation.

The Difficulties for Pre-Service Science Teachers’ to Cross the Cultural Boundary in Ethnoscience Course

Beni Setiawan, Chia-Ling Chiang - National Dong Hwa University

This article discusses the concept of pedagogical content knowledge (PCK) within the culturally sensitive (CS) of indigenous science context of pre-service science teaching. First, an attempt is made to define this concept CS which connecting with PCK pre-service teacher, the last is the implication on ethno science course. From this point of view, the concept of CS-PCK in Indonesia, PCK in pre-service teacher education, and culturally sensitive science teachers. Second, to identify the teaching and learning of pre-service science teachers toward ethno science course. The methodology is to use qualitative research with data collection are a questionnaire and in-depth interview toward pre-service
science teachers. The data from ethno science course shows that several pre-service difficulties to learn science in the cultural context, such as a) the traditional perspective towards culture is the old version and not appropriate with current period, b) learning culture context on ethno science course making the students was boring, c) the students was less understanding about science learning when they spend a lot of time doing observation in the remote area, d) less understanding about the culture even though they are trying to understand, e) the lack of literature and the laboratory to provide the tools that related with the problem as the result of observation. It is concluded that research on PCK may complement research on culture sensitive of students and pre-service science teacher.

**PISA 2015 Scientific Literacy Performance of Students in Australia and Taiwan: An International Comparison Study**

Hsiao-Ching She, Li-Yu Huang - National Chiao-Tung University
Huann-Shyang Lin - National Sun Yat-sen University

The purpose of this study is to conduct a secondary analysis of the PISA 2015 Australia dataset of 14,530 students from 758 schools and Taiwan dataset of 7,973 students from 214 schools to make comparisons between two countries regarding to their students’ PISA 2015 scientific literacy performance and a set of focus variables selected from student questionnaire. Results of cluster analysis indicated that four clusters of high, medium, low, and inferior scientific literacy/ epistemology/ affective disposition emerged for both Australia and Taiwan. In general, the higher the scientific literacy scores of students, the more positive epistemic beliefs about science, achievement motivation, enjoyment of science, interest in broad science, science self-efficacy, ICT autonomy; and the more frequent teacher support and teacher-directed instruction. Regression results indicated that the most robust predictor of students’ scientific literacy performance is epistemic beliefs about science for both countries. Results of the decision tree model for both countries showed that the descending orders of variable importance to differentiate students as resilient versus non-resilient were epistemic beliefs about science, self-efficacy and interest in broad science, respectively. A similar pattern of epistemic beliefs about science ranked at the top priority to determine students as high versus low performing.

References:


Evaluating the impact of a Distributed Approach on Teachers Professional Learning

Rachel Sheffield, Rekha Koul - Curtin University

The Deeply Reflective Engagement and Mastery (DREAM) project, sought to incorporate the key components of highly effective teacher professional learning within a reflective model to generate transformational change in teacher practice. The focus was on the Australian Curriculum: Technologies across the two strands of Digital Technologies and Design & Technologies. The Identification and training of Digital Edge Teachers who trained teachers in diverse geographic clusters in Western Australia was carried out. This enabled the creation and support of communities of practice, using face-to-face and online spaces to support a collaborative and reflective approach to teacher learning. Data were collected pre-program and post-program to investigate the effectiveness of the model in developing teacher confidence, self-efficacy and competence in implementing the curriculum and the use of digital technologies, and to examine the effectiveness of the wide-scale dispersion framework in addressing the needs the teachers. The results indicated that the Distributed Cluster Approach was an effective method of creating a large-scale dispersion of and access to teachers’ professional learning. The key factor that determined the program’s success was the engagement and dedication of the Digital Edge Teachers and their energy in supporting their Clusters.

Children's scientific and engineering experiences are viewed in supportive cultural affordances

Shukla Sikder - Charles Sturt University

In early childhood education, more attention has been directed to research in science education over the past three decades. However, integrated STEM Education is still not in focus. In cultural-historical research, children’s conceptual learning and development is viewed as a dynamic process (Vygotsky, 1987). In understanding children’s conceptual learning, it is important to focus on the dynamic process of affect and intellect (Vygotsky, 1993) in the established cultural context. This study examines how early childhood teachers can engage children and mediate science and engineering concepts, in regular cultural contexts. A total of 50 hours of video data, representing 64 children aged from 10 months to 5 years were collected through digital video observation over a period of seven weeks in an early childhood centre in Australia. This paper presents an analysis of one-hour video data on children’s water play using the analytical framework of Sikder and Fleer’s (2015) dialectical relations between small sciences and everyday activities. Early findings suggest that a teacher’s intention to link discipline knowledge in children’s play as play partner could enhance children’s science and engineering learning. It is argued children’s play motive and teachers’ learning motive can create Intellectual play motive where cultural affordances are supported.

References:

A link to a paper published in RISE:


Keith Skamp - Southern Cross University

To celebrate the fiftieth anniversary of the Australasian Science Education Research Association’ annual conference this paper reviews the last 25 years of the Association’s journal Research in Science Education (RISE). A sample of papers was selected for analysis by reviewing all the RISE articles at four year intervals (1994-2018; seven volumes): a total of 262/970 (27%) original papers. Abstracts, together with the methodology/methods sections of papers were the main source of data, although theoretical/conceptual frameworks were also identified. Using a range of research indicators (e.g., area/topic and domain focus; paradigm and research design/methodology choice; methods used; sample characteristics; authors’ nationality) various trends emerged across the 25-year period. Accessing ‘Special issue’ editorials and citation statistics added to the RISE research story. Comparisons are made with similar reviews of the world’s leading science education journals (e.g., JRST, Science Education, IJSE), as well as White’s review for the first 25 years of ASERA (RISE, 27(2), 215-221). Findings indicate the increasing diversity of areas and topics investigated, a mix of research approaches, with authors from all continents but some countries predominating. The most cited papers suggest areas of special interest. Some levels of education and science domains are underrepresented, as are particular research topics and approaches.

Australian Preparatory students’ representation of their knowledge of the Nature of Science
Jennifer Ann Smyth - Gumdale State School, Queensland University of Technology

Recent research suggests it is important for young children to develop an early understanding of the nature of science (NOS). The significance of developing their understanding is to enable them to view science as more than just conceptual knowledge; they see science as relevant to life and as a construct informed by their sociocultural experiences. This qualitative case study using interpretive methodology investigated the knowledge of NOS that Preparatory children bring to their learning and how they represent their knowledge. Data were supplied by a purposeful and convenience sample group of Preparatory children with an age range 4½-5½ years attending a government-run school located in Queensland, Australia. Data collected through ethnographic techniques and work
samples were analysed by applying an iterative process to thematic analysis. The key findings of the study indicate that Preparatory children bring a variety of views of NOS aspects to their science learning and can apply this knowledge to their science investigations. In addition, the type of activity is important in affording children the opportunity to express their views of NOS. These findings potentially add to the limited body of early years NOS research and improve teaching and learning of NOS in early years education.

Link to RISE paper:


Learning Progressions of Scientific Reasoning within Biology Learning Context

Chayakarn Suanboon, Jeerawan Ketsing, Weerasak Fungfuang - Kasetsart University

Scientific reasoning (SR) has long been recognized as a fundamental ability for preparing a scientifically literate person. However, a number of studies report contemporary education fails to promote future workforce with this ability (Ding, Wei, & Liu, 2016: OECD, 2018). Fortunately, recent literature reveals learning progressions (LPs) could be a solution for helping children to develop cognitive abilities necessary for scientific literacy. By understanding how children learn SR, teachers could create learning experiences suitable for SR development. Therefore, the study aimed to investigate 38 eleventh graders’ LPs of SR within a context of Biology course. Data obtained from the SR test, classroom artefacts, and video records were analysed using Rash analysis and content analysis. Results indicate the students were familiar with deductive reasoning skills. The main learning pathway began with a skill to identify variables. It follows by an ability to propose possible hypotheses, and to draw conclusions, respectively. Subsequently, the children employed eliminative causal reasoning and probabilistic thinking simultaneously, without consciousness. Besides, an enumerative generalization ability seemed to be separated from other SR’s components. Results of this study suggest an appropriate sequencing pattern of learning SR that could be used in biology course and/or curriculum design.

Reference:


The value or not of working in an expert scientist identity in dramatic inquiry

Carolyn Swanson - Auckland University of Technology

Students without productive science identities are less likely to pursue science careers or hold positive attitudes towards science. The dramatic inquiry approach Mantle of the Expert
has been found to support curricular learning and identity exploration but research involving drama usage in science is rare (Burke, Wessels, & McAvella, 2018). This mixed methods study explored whether Mantle of the Expert supported or constrained science learning at Years 7/8 and the possibility of future science career. 29 students aged 11-13 years used an expert scientist identity to reinvestigate the science behind the sinking of the Wahine in Wellington harbour in 1968. Data from pre and post-unit assessments, 22 classroom observations, student and teacher interviews and teaching artefacts were analysed statistically and thematically. Working as expert scientists enabled students to mirror how scientists construct and verify knowledge as they investigated the Wahine’s sinking. The findings showed the students significantly increased their knowledge of the scientific concepts taught. However, working in an expert scientist identity did not enhance the students’ career trajectory to include becoming scientists but they gained a greater awareness of the variety of science-based careers and the role of science in society.

Reference:

Four primary science teachers’ enactment of formative assessment during hand-on activities

Poh Hiang Tan - Ministry of Education
Aik Ling Tan - National Institute of Education

Though much has been said about its potential to improve quality of learning, formative assessment is not well understood especially when carried out during science activities. In Singapore, even when earlier studies reveal that primary science teachers tend to follow a certain pattern of instructional moves during such activities, there is very few mentions about how formative assessment is carried out.

This multiple-case study attempts to characterize how four teachers enact formative assessment in the social milieu of the classroom to shape students’ learning of science. Through stimulated recall, their ideas about how formative assessment supports science learning are also elicited.

Analysis of the findings shows that teachers may be (a) learner-focused; (b) outcome-focused; (c) teaching sequence-focused; and/or (d) activity-focused during formative assessment. Besides, though formative assessment was carried out frequently to help students connect the domain of objects and observable to the domain of science concept during science activities, the bridging of the two domains was mainly carried out by the teacher.

Finally, a Formative Assessment in Science Activities (FASA) heuristics is developed as a guide to offer science teachers a visual representation of how formative assessment could be situated within the learning environment of science hands-on activities.
A thematic review of early childhood research published in RISE, 1971-2019

Christine Tippett, Roxana Yanez Gonzalez - University of Ottawa
Todd Milford - University of Victoria

To celebrate ASERA's 50th anniversary, this presentation describes our thematic analysis of its flagship journal RISE, using the delimiter early childhood (EC) to reflect our current research interest. We used SpringerLink to search the RISE database (1843 articles from 1971-2019) and initially located 155 possible articles; ultimately we determined that 69 articles (<4% of the total) related to EC. We created a spreadsheet that included author, publication date, country of corresponding author, up to 3 research topics, methodology and methods, participants (e.g., children, educators, parents), educational setting, and country of research. Most categories were straightforward and did not require coding by multiple authors. For research topic, we independently labeled each article; our analysis is ongoing, but together we will compile labels and develop codes. Finally, each article will be independently coded and then IRR will be calculated by comparing our codes for 5 randomly selected articles. This presentation will describe our inclusion criteria and selection process. We will also present findings such as geographic source of articles, numbers of articles published per year, and common methods/methodology and topics. Results will have implications for RISE and for prospective authors as trends and gaps in published research will be revealed.

A teacher’s trajectory of learning in adapting tinkering for the science classroom

Frederick Toralballa Talaue, Sen Kee Peter Seow, Chew Lee Teo, Chin Fen Ho, Kei Xian Tan, Wei Loong David Hung - Nanyang Technological University

Tinkering is an educational practice that has recently begun to find purchase among formal science educators even as it continues to be debated how tinkering actually deepens students’ conceptual understanding and engagement in scientific practices. Moreover, teachers experience challenges in shifting pedagogical strategies to support collaborative investigations and scientific sensemaking through tinkering activities. This study aimed at exploring the tensions in integrating tinkering into the science curriculum and understanding how these shape teacher’s shifting instructional materials and practices. Employing the notion of identities-in-practice (Wenger, 1998), we examined a teacher’s identity construction at the intersection of two communities of practice - the teachers’ own science classroom community and the Tinkering in Science community wherein researchers, informal science educators and youth counsellors interacted regularly to design tinkering activities that promote science and well-being among lower track secondary school students. Findings show that the teacher’s identity construction involved actively negotiating competing discourses, such as (1) free exploration and fair allocation; (2) crosspollination of student ideas and copying; (3) “failure is ok” and “getting it right”; (4) varied tinkering goals and single tinkering goal; and (5) experience of tinkering process and task completion.

Link to RISE paper:
Perseverance in Science Education: A Longitudinal Study on the Academic Journeys of Eight Female Students

David Treagust, Isabel Blades - Curtin University

This longitudinal study over six years closely followed the progress of eight female students from secondary school to the end of their first degree, and in some cases the start of their careers. The research was designed to identify those factors which are responsible for the students’ perseverance in science education. Data were collected from established science attitude and learning environment questionnaires and Year 10 School Certificate results and Year 12 Higher Secondary School Certificate results were used to provide additional initial data. Questionnaires were given to the students, their teachers and parents. Interviews were conducted at different stages both in person, by telephone and online, to collect data at various stages of each student’s academic journey. The individual academic journey of each participant was written as a case study. When the eight case studies were compared, similarities were indeed more common than differences. Similarities included a positive attitude towards science education at an early age, consistent results with both school external examinations, and strong personal characteristics of each individual student as determining factors for their success. For some students, teachers or friends also played leading roles whereas for others, the home or career motivations were more important.

Link to RISE paper:

One teacher’s enactment of PCK in a secondary chemistry classroom

Imran Tufail, Chris Eames, Cathy Buntting, Maurice M.W. Cheng - The University of Waikato

Pedagogical Content Knowledge (PCK) makes teachers expert teachers rather than content experts (Park, Suh, & Seo, 2018). Recent consensus models of PCK (Carlson & Daehler, 2019; Gess-Newsome, 2015) have emphasised the importance of classroom practices in understanding PCK. This study investigates one secondary teacher’s enactment of PCK during a chemistry unit. A case study approach was used and data were collected using questionnaires, documents analysis, interviews, classroom observation and video recordings of the teaching. The initial findings indicate that student knowledge and assessment knowledge were more prominent than content knowledge, curricular knowledge and pedagogical knowledge, and these knowledges were interwoven in enacted PCK. The teacher demonstrated aspects of PCK differently when conducting laboratory work. The educational context and experiences, beliefs and prior knowledge also appeared to influence the enacted PCK.
Enriching Maths and Science Learning Through an Interdisciplinary Approach

Russell Tytler, Peta White, Lihua Xu - Deakin University
Vaughan Prain, Joanne Mulligan, Richard Lehrer, Leona Schauble, Chris Nielsen, Melinda Kirk, Chris Speldewinde

There has been increasing interest in interdisciplinary as an approach to more deeply engage students, especially as part of advocacy of integrated STEM approaches. However, there are concerns that this integration can do violence to the distinctive ways of knowing and practising represented by the disciplines. The Interdisciplinary Mathematics and Science (IMS) project (https://imslearning.org/) is developing and investigating an approach to primary school mathematics and science that consists of classroom activity sequences in which students’ invention and transformation of representational systems (see Hubber et al., 2010) in the two subjects can support deeper learning in each. In this way the guided inquiry pedagogy involves students in epistemic practices that approximate those in the discipline, such that concepts that sit at the intersection of the two disciplines (variation, sampling, symmetry, spatial reasoning) are approached from the distinct perspectives of each. The project is tracking students longitudinally over 3 years to investigate the development of representational competence. Sequences thus far have included motion, ecology and astronomy, and data modeling, graphing, variability, and geometric reasoning. The presentation will include examples of the interdisciplinary approach, its affordances, and evidence of enhanced student learning. We will also demonstrate the data management system we have generated as a methodological innovation.

Reference:
Effects of Supportive Argument-Driven Inquiry Teaching on Primary and Secondary School Students' Self-efficacy of and Engagement in Learning Science

Hsin-Hui Wang, Zuway-R Hong, Huann-Shyang Lin - National Sun Yat-sen University and Australian Catholic University

Existing literature reveal that the more years of young students are involved in learning science, the less actively they engage in formal science learning (e.g., Tytler, Symington, & Smith, 2011). This study was to explore the effects of Supportive Argument-Driven Inquiry (SADI) teaching on primary and secondary school students' self-efficacy of and engagement in learning science. 20 fifth graders and 25 seventh graders in Taiwan were randomly selected to the experimental group (EG) that comprised of a 2-semester SADI teaching. Another 24 fifth graders and 49 seventh graders were recruited as the comparison group (CG). The comparisons of pre- and post-test for the two groups revealed that both of the EG students’ self-efficacy of and engagement in learning science were not significantly promoted until the end of the second semester’s SADI teaching. On the other hand, CG students showed a significant decline in self-efficacy of and engagement in learning science over time.

Reference:

Primary Science Teachers' Self-Efficacy: A Case Study

Gillian Ward, Helen Dixon, Helen Withy - University of Auckland

Research highlights teachers’ lack of confidence and competence to teach primary science (Appleton, 2003). Though, self-efficacious teachers of primary science are critical in the development of positive student attitudes towards science. Whilst a plethora of research has been conducted in relation to self-efficacy (SE) (Bandura, 1997) little attention has been given to studies in SE of experienced teachers of primary science.

Utilising an interpretive, qualitative, case study methodology, the aim of this study was to explore how two experienced teachers of primary science, built their SE beliefs. Semi-structured interviews, field notes, and classroom observations comprised the dataset. Use of Bandura’s (1997) self-efficacy framework, including the four sources of influence, provided the conceptual lens to understand participants’ experiences and beliefs.

Findings suggest that teachers’ SE beliefs had developed over time with each of the four sources of influences making a significant contribution. As a result of these experiences the value of science was brought to the fore. As such teachers had a strong expectancy outcome.

Further evidence from this study indicated that the teachers’ long-standing science-related experiences, positively influenced their science teaching practice as they endeavoured to provide learning experiences with the intent of building student SE and interest in science.
Design and Evaluation of STEM Tasks related to Biology

Kai Wen, Darren Kung, Aik-Ling Tan - Nanyang Technological University

STEM (Science, Technology, Engineering and Mathematics) has been acknowledged to play a vital role in the advancement of nations worldwide (Lee, 2015; National Research Council, 2011) and as a useful platform to develop critical skills such as creativity, effective communication and self-management (Hathcock, Dickerson, Eckhoff & Katsioloudis, 2014; Bybee, 2010). STEM also promotes a multi-pronged approach towards many real-world problems we face today. Hence, it is vital for STEM education to be integrated into everyday lessons. Despite its importance, the implementation of meaningful STEM tasks is limited. This research aims to design and evaluate three Biology-based STEM tasks that combine knowledge from different disciplines of STEM to approach real-world problems. The tasks will guide students through a sense-making framework to systematically approach the problems. They are designed with regard to selected learning outcomes within the O-Level Biology syllabus to facilitate their integration into existing work plans of teachers. The tasks were then evaluated based on the level of learning that took place via pre- and post-assessment questions. The findings from this research will validate the usefulness of the STEM tasks as a means of effective inter-disciplinary education, and their potential role in science education of the future.

References:


The development, implementation and assessment of a science inquiry and practices curriculum

Meichun Lydia Wen, Pei-Shan Chang - National Changhua University of Education
Sheng-Han Lee - National Taiwan University

Reform efforts such as the NGSS and the New Curriculum Guidelines in Taiwan emphasize engaging students in the practices of science. The purpose of this study was to develop a science inquiry and practices curriculum of enzyme concepts via the Backward Design and to explore learners’ changes in inquiry and argumentation abilities, learning achievement and nature of science (NOS). We employed the Science Writing Heuristics, an argument-based inquiry approach, to help students integrate inquiry, argumentation, and writing practice in laboratory contexts (Choi, Hand, & Greenbowe, 2013; Yaman, 2018). Data were collected by implementing an inquiry-ability assessment, an enzyme achievement test, and a NOS questionnaire, in addition to students’ writings in the science concept journal. A total of 17 high-school students participated for one year. The results showed that students’ overall inquiry abilities were significantly improved, especially in planning and carrying out investigations. Their learning achievement scores improved significantly, and their argumentation abilities also increased, especially in the questions-claims relationship and reflection performances. In term of nature of science, the students’ views on “subjectivity” issue were significantly changed. This study also provides suggestions for in-service teachers to quickly assess students’ argumentation based on their writing.

References:


100 Jobs of the Future

Peta White, Russell Tytler, Dineli Mather - Deakin University
Ruth Bridgestock - Griffith University

The challenge of STEM for science education is the need to shift focus to the development of STEM skills that will prepare students for future lives and work. The world of work is changing dramatically and so too must our education strategies (Gilbert, 2017). This research has interrogated work futures through the predictive construction of ‘100 jobs of the future’, that go beyond generalities of trends and skills, and offer a grounded, but complex and imaginative projection of future work. After a comprehensive review of the literature we identified key domains, such as agriculture, health and games and used these to identify 11 experts familiar with cutting edge developments in their fields of expertise. We interviewed each expert, asking them to identify trends and areas of growth, specific jobs that may be created, and the skills that such jobs would demand. We then synthesised the information to scope and develop 100 future jobs that captured the breadth of trends, skills and work patterns. Unsurprisingly, we found that jobs across all these categories are
influenced by the major drivers of change: technological advances, climate change, data democratisation, globalization, population pressures and changed demographic profiles, and most also require a multidisciplinary skill set. In the presentation we will discuss the implications for school science.

Reference:

Engaging Diverse Youth with STEM

Kimberley Wilson - Australian Catholic University

There currently exists significant disparity in education outcomes for diverse groups of students in Australia. International testing results indicate that Australian students who fall into certain ‘domains of disadvantage’ (such as being from low SES backgrounds, remote locations and/or identifying as Indigenous Australians) have educational outcomes that are significantly below their mainstream peers (OECD, 2016). This inequitable situation has remained unchanged over a considerable period of time, and in the current educational policy context, encourages inquiry into how the recent STEM innovation agenda in Australian schools is being conceptualised to ensure that diverse students are not being left further behind. Previous research in the Australian context has shown that while there are challenges in implementing STEM initiatives in low SES communities (Lowrie et al., 2017), disadvantaged students show great capacity to work scientifically and innovatively if provided with the right opportunities (Dawson & Carson, 2018; Wilson & Stemp, 2011; Wilson & Alloway, 2012; Wilson & Boldeman, 2013). The findings of this study are intended to contribute towards developing a better understanding of the role of STEM in engaging diverse students, with a focus on identifying enablers and barriers to generating learning experiences where creative thinking thrives (Mishra, Koehler & Henriksen, 2011).

Link to RISE paper:

Teaching creative thinking in science class: a missing link for science learning?

Mihye Won - Curtin University

Creativity is not often associated with learning and teaching of science. Despite being part of the national curriculum in many countries, science educators tend to overlook teaching of creative thinking as a soft skill without any substance or benefit to the core business of science teaching and learning. As an advocate of STEM education, Dr Alan Finkel, Australian Chief Scientist, for example, has been emphasising teaching disciplinary content knowledge as a primary concern rather than teaching creative thinking or problem-solving skills. So questions arise: Does teaching of creative thinking have a place in supporting students’
learning of science? Would creativity develop naturally once students have enough knowledge and commitment in science? How can we ever teach creative thinking in science? In this presentation, I will first explore the role of imagination and creative thinking in scientific practice, and then examine components of creative thinking skills in relation to the construction of scientific knowledge and skills. With data from multiple projects, I will argue that engaging students in generating conceptual explanatory diagrams has a strong potential to enhance students’ creative thinking in science by challenging and expanding their understanding of scientific phenomena and improving their attitudes towards science learning.

Reference:

The viewpoints of parents, teachers and career advisors regarding enablers and barriers in STEM for female students

Amanda Woods-McConney - Murdoch University

While Year 11 female students studying physics were “most likely [to] possess high motivation and engagement for physics that is on par with their male counterparts” (Abraham & Barker 2015a, p. 67), female students’ continued participation in senior secondary school and university STEM enrolment is not the same. Abraham and Barker (2015b) reported that perceptions of females’ own ability predicted future secondary school physics enrolment. This study shifts the emphasis from female students and their perceptions, to what parents/guardians, teachers, and career advisors identify as barriers and enablers regarding female students’ continued participation in STEM-related subjects in senior secondary school and university. Participants were invited to interact in Two-Way Information Workshops. The two-way communication approach meant that participants responded individually and in focus groups, providing data for the study. While discussing their experiences with others in their groups participants also received information about the latest research on females in STEM. The opportunity for participants to reflect on their own experiences helped establish the relevance of current research. The findings reported here can inform science education researchers, educators and practitioners about parent/guardian, teacher, and career advisor perceptions and ways to support female students to pursue STEM subjects, degrees and careers.

References:

Examining the Effect of Explicit-Reflective Approach and Authentic Scientific Research Experience on Learning Progression of Grade 12 Students' Understanding of Nature of Science in Unit of Evolution

Palita Yaboonwan, Pongprapan Pongsophon, Koraon Wongkamhaeng - Kasetsart University

This research aimed to study the learning progression of grade 12 students' understanding of nature of science taught by authentic scientific research experience and the explicit approach in unit of evolution. The participants were 54 students. Data were collected through the view of nature of science form C developed by Abd-El-Khalick and Lederman. Learning progression were assessed by BEAR framework (Wilson 2009) using rash analysis and Wright’s racking and stacking for learning gain. The findings indicated the intervention could develop students’ understanding in all aspects of nature of science, especially in the myth of scientific method and the social and cultural embeddedness of scientific knowledge. The item invariance is evident and the relationship between rank difficulty of the items in pre-test and post-test was a strong positive correlation (rs(8)= 0.85, p= 0.014). From the wright map and the dependent t-test showed that the average student's ability is higher while the difficulty of VNOS-C is lower. There was a significant difference in the pre and post student ability (M= -0.08, SD= 0.62) and (M= 1.75, SD= 1.77); t = 12.33, p < 0.01.

Reference:

Critical Abilities of Problem Solving in STEM Education

Yi-Fen Yeh, Ying-Shao Hsu, Hsin-Kai Wu, Kai-Lin Yang, Kuen-Yi Lin - National Taiwan Normal University

Solving complex problem has been deemed an important ability for 21st century citizens. Considering that problems vary in nature, solutions and the cognitive skills required to produce them are various and often task-driven. Problem solving is a frequently-used pedagogy in many subjects, as it is in Science, Technology, Engineering, and Mathematics (STEM) education. Therefore, identifying abilities essential for students to acquire, from both the discipline-based and integrative perspectives, will help educators better conceptualize how learning tasks should be designed within and outside of their respective areas of focus. In this study, we reviewed the critical literature and proposed a framework entitled Problem Solving in STEM Education. Problem solving phases and the related critical abilities were identified. From these, we determined transitional abilities shared among disciplines, and rendered connections to STEM-based problems. These higher-order crossover abilities include analogical reasoning, contextualization, quantitative thinking, predictive ability, and reflective ability. The idea of play or playfulness deserves to be embedded in students’ STEM learning and problem-solving process, in order to facilitate ability enrichment. This framework will offer insights to STEM instructors and those of
related disciplines, as well as teachers emphasizing problem solving and designing learning-facilitation activities.

Risky business: Teaching for creativity in secondary school science

Reyna Zipf, Bobby Harreveld - Central Queensland University

Science education literature is laden with expectations that teachers will develop the creativity considered to be fundamental to the nature of science (Murphy et al., 2019). However, nurturing creativity remains a risky business for science teachers and students alike. Research suggests students are turned off science by transmissive teaching and focus on canonical abstract content (Lyons, 2006). This paper reports on a study that aimed to investigate how to teach for creativity-centred science. A qualitative methodological approach was deployed. Data were collected from ten teachers using semi-structured interviews, observations of science classroom teaching and lesson planning notes. Inductive thematic analysis across all data sets was used. The study found that there were risks associated with enacting creativity-focused science lessons. There were physical and emotional risks for students; and professional risks for teachers. These risks included teacher concern about safety issues and liability, and students' fear of experiments not working. Teaching for creativity necessitated the teacher and student becoming a risk-taker. The risky business of creative thinking was characterised by spontaneity, difference, fun, failure, questioning, student interest, ownership, and dialogue. The study also found there were multiple ways to nurture creativity in school science.

Link to RISE paper:
