Editorial – Welcome to Volume 23, Issue 3

Scientists are by nature inquisitive. Their curiosity stems from a powerful urge to understand the world around them and the universe beyond. That understanding can be enhanced through active and imaginative inquiry, invention or collaboration, or all these and more. Through these means, scientists grapple with the natural world, in the process building and enhancing their critical thinking and problem solving capacities, as well as their investigative and communication skills. Contrastingly, students' experiences of a science degree too often have little in common with those of scientists pursuing their science. Those experiences routinely include rote and passive learning, practice and repetition. Students are frequently denied opportunities to explore and investigate biological and physical phenomena at their own pace, on their own terms, or via their own designs (Weaver, Russell and Wink, 2008).

In recent years there have been initiatives at school and tertiary levels in the US, UK and Australia to deliver learning opportunities that encourage science students to progress beyond passive approaches to learning to actively engage in authentic activities that are much more inquiry-oriented (see, for example, Casotti, Rieser-Danner and Knabb, 2008). It is this emphasis that has led to this special issue of the International Journal of Innovation in Science and Mathematics Education. Contained in this issue are reports of evidence-based advances in learning of value to instructors working in all science disciplines. This edition was partly inspired by a national teaching fellowship awarded by the Australian Learning and Teaching Council to one of the editors (LK). The fellowship showed that many academics were either already actively involved and committed to enhancing engagement and learning through inquiry, or on the cusp of doing so. We determined there was a compelling case for bringing the work that had been done by these academics to a larger audience through a special edition of IJISME.

We have been delighted by the enthusiastic response to our call for expressions of interest to contribute to this special issue on inquiry-oriented learning (IOL). In this issue you will read about work that has been carried out in the physical, biological and chemical sciences as well as in the context of senior secondary school science. The thirteen papers in this issue fall broadly into two categories, the philosophy and methods of IOL, and laboratory-based IOL.

Examples from the philosophy and methods category include a paper by Ross on how inquiry and other research-based pedagogies can be systematically embedded within undergraduate curricula, recognising that past efforts to do so have been less than successful. Dickson and Stephens take up the issue of student engagement and explore the effectiveness of using elements of popular culture, such as commercial advertising campaigns, in enhancing student skills in critical review and experimental design. This issue of student engagement is also explored by Williamson, Huang, Bell and Metha, who report on the process and positive outcomes of the introduction of guided IOL into several foundation chemistry units. Francis reports on IOL tasks that use a model imaginary universe, quite different from our own, via which students learn to ask meaningful scientific questions, propose observations of the universe and develop and test hypotheses. Myatt and Jones neatly capture the academic sense of integrating elements of research and inquiry into their teaching programs - thereby highlighting the important nexus between asking questions and developing meaningful approaches to answer those questions. Gordon, Sharma, Georgiou and Hill describe the effects of an IOL activity on senior secondary students engaged in a

university outreach program, pointing to the greater mental effort required for IOL, with concomitant positive impacts on higher order skills, such as critical thinking and problem-solving.

Laboratory-based IOL manuscripts include a paper by Naiker and Wakeling on the use of guided-inquiry to devise an experimental protocol to accurately execute an assigned task. Wegener, Doyle-Pegg and McIntyre describe an inquiry-oriented activity based around heat transfer, utilising technology that allows students to remotely monitor, at a time that suits them, the status of an experiment they have devised. Julien and Lexis report on their redevelopment of a third year subject, through replacement of cook-book type experiments with a carefully scaffolded, student-centred project that promotes student research skills. Edwards frames the integration of IOL into a zoology unit via making the activity student- rather than teacher-centered, and reports on the range of innovative methods students' developed in order to resolve an open-ended question. Colthorpe, Zimbardi, Bugarcic and Smith report an examination of students' skills development over three years, involving increasingly complex assessment tasks that require students to draw on their developing content knowledge and expertise to propose and undertake experiments. Kirkup, Waite, Beames, Mears, Pizzica and Watkins report on a novel joint educational initiative between University of Technology Sydney and the CSIRO, in which an evaluation framework was applied within a large enrolment physics subject in order to assess its impacts on student learning, engagement and group discussions. Through their use of video-recordings of students undertaking IOL together with subsequent interviews with students, Zimbardi, Loyle-Langholz, Kibedi and Colthorpe shed light on the ways that students apply new information, and suggest methods that educators can use to enhance these processes.

The papers in this special edition contain more than simply good ideas for improving learning through inquiry. There are thoughtful and well evaluated examples of inquiry applied in real situations with large and often diverse classes that secondary and tertiary educators can adopt or adapt. We trust you will find something of value in this issue that you can apply, integrate or build upon to enhance the understanding and skills of your students. The workplaces of the 21st century will increasingly require graduates with the knowledge and skills to succeed: the use of proven inquiry approaches will be a crucial factor in their education.

Gerry Rayner, Chris Thompson and Les Kirkup, February 2016.

Casotti, G., Rieser-Danner, L., & Knabb, M.T. (2008). Successful implementation of inquiry-based physiology laboratories in undergraduate major and nonmajor courses. *Advances in Physiology Education, 32* 286–296.

Weaver, G. C., Russell, C. B., & Wink, D. J. (2008). Inquiry-based and research-based pedagogies in undergraduate science. *Nature Chemical Biology 4*(10), 577-580.