David Holgate
University of Stellenbosch, South Africa

Enhancing Student Learning

Conversations about the teaching of undergraduate mathematics are easily dominated by the recurrent themes of student preparedness, large student enrollments and pressure to produce satisfactory pass rates. A lot of undergraduate lecturers' time and energy is consumed in finding coping mechanisms as we deal with these issues.

In this talk I want to ask instead what we can do to enhance the learning experience, both for the student and the teacher. Framed by some of my own experiences, in particular in the use of technology and in exploiting the freedom of an academic career, we will discuss what "enhancing student learning" might entail and what benefit it can bring.

Effective teaching is centered on relationships. This begins with the relationship between teacher and student but extends to relationships with our subject, with technology and with peers and colleagues. Fostering these relationships is at the heart of an enhanced learning experience.

John Mason

The Open University, UK

Plenary: Monday 28th November

Being Definitive with Definitions

It is well known that many students entering university struggle with the role, nature, purpose and use of definitions in mathematics. To those who are thoroughly enculturated into mathematics, it is hard to imagine there is an issue, while to those teaching students it is hard to work out where the difficulty lies. The classic distinction between *concept definition* and *concept image* (Tall & Vinner 1981, Vinner 1983), makes an important start, but there remains the issue of what definitions are for and how they are used. Following various linguists and philosophers (Edwards & Ward 2005) it is vital to distinguish between what have been called *extractive* definitions (usage is described and reported, as in a dictionary) and *stipulative* definitions (specifying required properties, as in mathematics). Students are culturally immersed in and familiar with the former, but in order to succeed in mathematics they have to become used to using the latter.

Victor Martinez-Luaces
Universidad de la Republica, Uruguay.

Mathematics and its connections with technical subjects, the real world and professional life

This paper will offer an analysis from a theoretical point of view of mathematical modelling and its applications. We will also analyse the inverse problems, of both causation and specification types. After that, experiences from courses taught over the past 15 years will be described and analysed. A separate section will briefly describe a particular experience carried out with former students, dealing with problems arising from the industrial sector. On the basis of this experience, the characteristics of real-world problems will be defined. Finally, several results will be presented and some conclusions proposed.

Chris Sangwin
University of Birmingham, UK

The Mathematics of Assessment

Online assessment of mathematics has developed in scope, sophistication and extent of use. Computer algebra systems have increasingly been used to support online assessment and publishers are providing exercises to accompany traditional books.

This talk will provide a survey of the interesting mathematics associated with online computer aided assessment (CAA). This includes randomly generating feasible problems, and establishing the properties of students' answers. The desire to automate a process throws into sharp detail the ambiguities and inconsistencies which traditional assessment might tolerate. For example, what does the word “simplify” mean, or what does it mean for two mathematical expressions to be “the same”? We will focus on assessing the answers to algebra story problems.

These issues concern teaching more generally, since they strike at the heart of *meaning* in mathematics. Ultimately students would gain valuable insights into our subject through an appreciation of these issues. This talk aims to raise awareness of, and appreciation for, the subtle issues associated with the mathematics of assessment.

Caroline Yoon
The University of Auckland, NZ

Moving forwards by walking backwards: Inverse problems in Te Ara Mokoroa

We often speak of learning as movement in a forward direction: we progress up a level, we journey along a trajectory. By contrast, the images we use to describe particularly deep kinds of knowledge often imply movement in the inverse direction. "*She knows her topic inside out*", "*He knows it back to front*". In mathematics, inverse problems are often more difficult than their direct counterparts: subtracting is harder than adding; dividing is harder than multiplying; factorising is harder than expanding. Yet, mastering a mathematical process in the inverse direction often leads to a deeper understanding of the process in the forwards direction, as well as a deeper appreciation of the generality of the process and its underlying mathematical structure.

Such was the case for eight undergraduate students who worked on inverse problems in calculus and ratios. Although the students were all adept at working in the forward direction they struggled when asked to solve the problem in the inverse direction The students adapted their knowledge of the problems in the forward direction to make the inverse problem easier, but did so in different ways that revealed the depth of their mathematical understanding in these topics