

Guest Editorial

KNOWLEDGE BUILDING IN MATERIALS SCIENCE

I am delighted to present this collection of very varied and fascinating papers on the topic of student learning in Materials Science and Engineering. The papers range in content from a consideration of curriculum and teaching process as well as a focus on attracting students to enter into a career in materials, and making sure they don't get blocked in their progress along the way. In this introduction I am going to borrow the metaphor of building a house, as presented by David Brandon in his paper 'Educating Materials Engineers'. Brandon starts his work by demonstrating the 'Greek temple' model of a successful career, whereby the personality provides a firm foundation for the pillars of ability leading to 'goals' in the attic. He also uses a different house to look at the scope of a materials science profession. This house has 'rooms' of specializations and is similar in principle to previously discussed models linking structure, property, processing, application, life cycle and characterization (Baillie and Vanasupa, Navigating the Materials World, 2003). Brandon points out that the traditional curriculum is missing many professional skills and we can see that the Greek temple model pillars of 'leadership and creativity, together with 'communications and cultural awareness' are very much needed alongside the 'professional competence' to make a balanced structure.

We see many features of the desired house structure in other papers within this volume. Richard Savage considers the role of design in materials science – building up that pillar of creativity and leadership. Bradley Diak introduces us to a pillar made of chocolate in his special case of a design module in a first year class which involves the making and testing (but sadly not eating) of chocolate. Jonathan Stolk and Robert Martello in their paper, give us some understanding of the mortar or 'pedagogical fusion' that is required between the bricks of the pillars – between science and history in their original and inspired integrated course at Olin College. Sam Zhang further fuses music with materials to help students understand electron configuration.

Next we might consider who it is that enters the house. Who are our students and why do they knock at our door? How do they enter and pass through the doorway? My own paper with Elena Skryabina and Peter Goodhew explores the new and emerging exciting area of 'threshold concepts' as applied to materials engineering. Threshold concepts are areas of the curriculum which may become difficult for students to 'pass through'. Meyer and Rand (In C.Rust (Ed) 'Improving student learning theory and practice – 10 years on', 2003) describe *threshold concepts* (TC) as 'akin to a portal, opening up a new and previously inaccessible way of thinking about something' and comprehending a threshold concept is seen as 'a transformed internal view of subject matter'. We explore the thresholds that appear to be present in high school students which could possibly prevent their selection of materials as a career. The 'Lehigh model' presented by Ryan Deacon and co-workers, demonstrates the importance of the 'young teaching the young' in outreach events, in an attempt to break down some of the barriers - to help students pass through some of these thresholds and enter the profession.

The concept of viscoelasticity may well be a threshold concept. Once understood it will open up new areas of knowledge. However in my own experience it is often taught in a way that is far removed from our understanding of the concept as researchers. We reduce the concept down to a 'construct' or a model, equation or theory that approximates reality, because it is too difficult to teach the complexity of reality (Baillie and Vanasupa, 2003). However, we don't actually help the students understand that this is what we are doing. Joao Mano gives us his insight into the teaching of this difficult concept.

Once we have identified the concepts that we need students to learn, a great tool to use is *concept mapping*, to help students start to see where the bits and pieces fit together and higher levels of learning may be achieved and also to help teachers see how students are thinking. Stefanus Muryanto shows us an application of this approach in his chemical engineering laboratory class.

The final two papers in this volume deal with the web based learning environment. If its possible to finally stretch our metaphor we can imagine students in their own homes linking into the intranet to gain access into the rooms of the house without physically entering. Kurt et al discuss the potential benefits of the virtual learning environment within materials science and Hashemi et al give an example of a successful module for virtual hardness testing which the students found very useful and an excellent way of preparing

them before a real laboratory class. However it was clear that the students in this case did not want to see the actual experiment replaced by the virtual testing software. The students, after all, enjoy themselves inside this house.

Caroline Baillie
Professor of Engineering Education
Integrated Learning Centre
Faculty of Applied Sciences
Queens University
Kingston, Ontario
Canada K7L 3N6