QUB TEACHING AWARDS

APPLICATION FOR A RISING STARS TEACHING AWARD 2010

(Open to <u>individual</u> academic and learning support colleagues who have been teaching/supporting learning for less than 5 years)

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1. CONTEXT FOR THE APPLICATION (approximately 300 words)

Please provide a context for your application. This should consist of an introductory statement about your contribution to learning and teaching/learning support to date. Examples of the information you might include are; the subject you teach or the area of learning support you work in, the type of learning and teaching/learning support activities you are involved in, how many learners are involved, your particular learning and teaching/learning support interests and an outline of your overall teaching/learning support philosophy?

I have been a Teaching Fellow in the School of Mechanical & Aerospace Engineering working with the Centre for Excellence in Active and Interactive Learning (CEAIL) since August 2005. In that time I have developed and taught five brand new modules and co-developed and co-taught four others. All of these modules were designed:
(a) According to the CDIO ethos which fundamentally means teaching engineering in context.
(b) According to the CEAIL paradigm.

At present I am the Advisor of Studies for the Product Design & Development degree programme and coordinate and/or teach on eight modules as shown below in Table 1.

Table 1: C McCartan Teaching Responsibilities (PDD) – Academic Year 0910

Module Code	Stage	Module Name	Module Size	09/10 Class Size	Role
MEE1026	1	Mathematics for Product Design 1	1.0	32	Coordinator and sole lecturer
MEE1034	1	Introduction to Mechanical Engineering	1.0	96	Coordinator and one of several lecturers
MEE1033	1	Introduction to Product Design	1.0	36	Coordinator and one of several lecturers
MEE1022	1	Statics 1	0.5	36	Coordinator and sole lecturer
MEE2026	2	Design & Prototyping Projects 2	1.0	19	Lecturer 33%
MEE3052	3	Project 3P	2.0	20	Project Supervisor (1 of 2)
MEE3030/3043	3	Project 3B/3M	1.5	35/44	Project Supervisor for 2 individual student projects

My teaching and learning activities have primarily focused on the design, development and implementation of first-year introductory courses and first-year mathematics provision for all of our Programmes. The key goal has been to motivate and excite the students for their learning by creating relevant learning environments. In an engineering School a key premise must be to enthuse the students for their profession by allowing them to engage with meaningful active and interactive learning strategies. This is relatively easy to achieve with an introductory course, but much more of a challenge with a theoretical topic such as mathematics. Therefore, it is essential to be fully aware of the best practice with regard to pedagogy in this area.

Teaching mathematics to engineers is a worldwide issue which has inspired a plethora of publications over the last twenty years. In the UK the problem has been widely disseminated and there has been extensive funding, not only in pedagogical research on this topic, but also in actual support centres, CETLs and online resources to help both students and teachers in higher education. My learning and teaching philosophy has been based around understanding and implementing this best practice with regard to teaching engineers mathematics.

2. DISCUSSION

You should illustrate your discussion throughout with reference to specific learning and teaching activities/learning support activities. You should also provide examples of the influence of learner feedback on your learning and teaching/learning support practice.

(a) Promoting and enhancing the learners' experience (approximately 700 words)

- how you stimulate and inspire learners
- how you develop, organise and present resources
- how you assess learners appropriately

For this application I will concentrate on my activities with regard to teaching engineers mathematics. However, many of the pedagogic strategies have been implemented and evaluated on the introductory courses as well.

The CDIO philosophy to teaching and learning in engineering is that the subjects must be taught in context; they must be relevant and fully integrated so that the students can appreciate the bigger picture with regard to their learning. This is an extremely important point, especially in a vocational area such as engineering were the students are being directly prepared for their profession. Therefore, even more onus is on us to ensure they are encouraged to engage with their learning by recognising its significance and importance to their chosen profession.

In this context it is important that the teaching of the theoretical science subjects integrates well with the other more design oriented subjects in that there are plenty of active and interactive opportunities to learn. The students should not feel that there are two distinct teaching and learning strategies involved between the design subjects and the theoretical science subjects. Applying this thinking to a specific subject such as engineering mathematics might at first seem like a daunting task, but it is not. There have been many engineering education publications detailing examples of best practice in this very area.

I have approached the teaching of engineering mathematics in a systematic way. I continually review pedagogical publications in this field, and where possible, apply those that are relevant to me, and which I have the resources to implement. The basic preparation of the engineering mathematics modules that I have designed and implemented involved several logical steps, the objectives of which were essentially to develop teaching, learning and assessment practices that are student-centred:

Firstly, it was necessary to be fully aware of the background and abilities of the students in order to tackle the ensuing pedagogical issues associated with teaching mathematics to engineers. I accomplished this in two ways: mathematical diagnostic testing at entry as recommended by the Engineering Council UK [1] and learning styles inventories [2]. The former provided information on the new students' mathematical skills and the latter indicated particular predominant learning preferences. This information then helped me with regard to developing module content, teaching methods and effective assessment criteria that ensured students received a more balanced learning environment.

The generic CDIO approach to course and module design is founded on teaching engineering in context and applying specific CDIO Standards which emphasise not only the design of an integrated curriculum (Standard 3), but also the inclusion of integrated learning experiences (Standard 7). My goal was to ensure that my mathematics modules could integrate with the other more design oriented modules and espouse active and interactive learning strategies in order to keep the students engaged and motivated throughout. Other benefits that this approach can achieve are [3]: higher success and retention rates; higher quality graduates; and shorter times to graduation. The CDIO methodology also helped me identify relevant learning outcomes, skills and attributes which I completed by interviewing all the appropriate teaching staff on the programmes, which, again, follows best practice with regard to integrating the learning of mathematics within an engineering curriculum [4]. This further helped me realise other objectives for mathematics support such as teaching key mathematical concepts "in context", and the elimination of unnecessary duplication throughout the curriculum.

The teaching methods on my mathematics modules are varied to facilitate active and interactive learning in class, thus conforming to CDIO Standard 8. In addition, I have implemented effective and well-evaluated assessment strategies to promote and encourage out-of-class active learning, based on previous experience and best practice. The details of how I achieved this can be seen in the references below [5,6,7,8].

A key aspect of my teaching approach is to continually evaluate my courses and, to date, all of my modules have been continually evolving each year. With an active and interactive learning paradigm this is instantaneous as I get feedback from the students during every class in relation to how they are engaging with the learning objectives, which means I know in real time what is working at what is not. Keeping a teaching journal has helped me keep a weekly log of my teaching and has proven essential when upgrading the modules at the end of the academic year. The assessment of my mathematics modules contains a considerable amount of coursework and class tests which has received very positive feedback from the students in terms of recognising its benefits to improving their learning; and this has been realised in their overall attainment. In addition, it encourages them to actively and interactively learn outside the classroom which is essential in a subject, which really demands continual practice; Computer Aided Learning (CAL) and Computer Assisted Assessment (CAA) tools have proven useful in this regard.

[1] Engineering Council UK, Measuring the Mathematics Problem. A report published by the ECUK in June 2000 and available from: http://www.engc.org.uk/ecukdocuments/internet/document%20library/Measuring%20the%20Mathematic%20Problems.pdf [cited 30th March 2010].

[2] Hermon J.P., "The Use of Learning Styles as a Tool for Curriculum and Personal Development", Proceedings of the 3rd International CDIO Conference, MIT, Cambridge, Massachusetts, June 11-14, 2007.

[3] Carpenter J. and Schröder B., "Mathematical Support for an Integrated Engineering Curriculum", ASEE summer conference, session 3565, Charlotte NC, 1999.

[4] Willcox K. and Bounova G., "Mathematics in Engineering: Identifying, Enhancing and Linking the Implicit Mathematics Curriculum", Proceedings of the 2004 ASEE Annual Conference & Exposition, Session no. 2465. American Society for Engineering Education, 2004.

[5] McCartan C.D. and Hermon, J.P., "Systematic Development of a First Year Engineering Mathematics Module", Proceedings of the 4th International CDIO Conference, Hogeschool Gent, Belgium, June 16-19, 2008.

[6] McCartan C.D., "Evaluating Assessment in an Engineering Mathematics Module", Proceedings of the 4th International CDIO Conference, Hogeschool Gent, Belgium, June 16-19, 2008.

[7] McCartan C.D. and Hermon J.P., "Implementation and Efficacy of Active Learning Strategies in Engineering Mathematics", Proceedings of the 5th International CDIO conference, Singapore Polytechnic, Singapore, June 2009.

[8] McCartan C.D., Hermon J.P. and Cunningham, G. "A Validated Approach to Teaching Engineering Mathematics", Proceedings of the EE2010 Conference, Aston University, Birmingham, England, June 2010.

(b) Supporting colleagues and influencing support for student/and or learning (350 words)

- ways in which you contribute to the development of colleagues within your area
- how you contribute to institutional initiatives
- your contribution to regional/national/international initiatives

Within our School I am involved in a mathematics committee, which was set up three years ago to evaluate the teaching and learning of mathematics within the School. I have played a pivotal role in influencing the direction we take based on my direct experience with teaching this subject, and specifically my understanding of applying CDIO and CEAIL strategies to the learning and teaching of engineering mathematics with the first-year Product Design students. In the last couple of years we have targeted a serious learning issue affecting the first-year Mechanical and Aerospace students. We have applied my CEAIL and CDIO methodology to transform what was previously a very traditional didactic approach to teaching engineering mathematics. In the original module, attendance was low, engagement was low, attainment was low, and the student feedback was very poor. I was able to help colleagues apply my systematic approach to designing and implementing a more student-centred engineering

mathematics module, and subsequently, the attendance increased to an average of over 90%, the feedback was excellent and the average assessment marks rose from 43% to 63%. In addition, very few students actually failed the module compared to an average of 40% beforehand, and their formative feedback was extremely positive with regard to all aspects of teaching and learning on the module. The resulting efficacy of the module had therefore improved, and continues to do so.. I should note that the new assessment strategy employed was closely scrutinised and evaluated to ensure parity of esteem with previous years and to ensure we were simply not "dumbing-down" the module.

I have been involved, with my Director of Education, in a Faculty-wide meeting with the Dean to address the generic problem with teaching mathematics. Our approaches in this regard were well received by everyone at the meeting and the possibility of forming a Faculty-wide committee to address these issues is under discussion.

For the last two years I have disseminated my approach to teaching engineering mathematics within our School, with an article in the Reflections Newsletter, at the CETL-MSOR conference and at several CDIO International conferences. In June and July of this year I will be presenting papers on the subject of teaching engineering mathematics at three conferences: the 6th CDIO International conference in Montreal, the HEA EE2010 conference in Birmingham and the ISEE2010 in Cork.

(c) Ongoing professional development (350 words)

- professional development activities undertaken
- how you have used these activities to review and enhance your practice
- how this is has led to improvements for your learners.

As a collaborator in CDIO and member of CEAIL I have pursued a broad based CPD programme, seeking to develop an elevated knowledge of engineering education. As discussed in the previous sections, I regularly contribute to conferences on engineering education where I not only present my work, but also get the opportunity to hold workshops on Introductory Courses and Active and Interactive Learning. This affords the opportunity to keep abreast of much of the current best practice in this regard.

In February, along with CDIO colleagues from Strathclyde and Liverpool universities, I was awarded a Higher Education Academy "Mini-Project" grant. The project will investigate the skills of students entering engineering degree programmes with the aim of providing them with better early support and hence ensure a higher retention rate. I am also involved in a STEM project in a similar vein.

I have ongoing development plans for my engineering mathematics learning teaching. One specific area is in the application of more CAL and CAA. At present I utilise the HELM resources which lend themselves perfectly to CAL and CAA, but time and resource are required to set this up. However, I have attended many conferences, read many publications and spoken to many authors who have had excellent successes in these areas. As a consequence, I have developed a Stage 2 mathematics module for the Product Design programme based almost entirely on CAL and CAA. I presented the evaluation of this module and my very positive findings at the 5th International CDIO conference last year in Singapore.

In addition, I attend STDU courses, CED conferences and the Guest Speaker series of lectures and workshops. Many of these events have certainly helped influence my teaching with regard to changes and refinements I have made.

I am also a practising professional engineer and continue to write technical articles and attend relevant conferences whenever possible. I also like to involve the undergraduate students in my real engineering design and research projects and hence provide them with valuable experience in that regard. Several of these collaborations have resulted in successful engineering conference contributions for the students.

Teaching Awards 2010
Criteria Profile

The following are suggestions of the type of information you might wish to include in your analytical application - it is not an exhaustive list. You may also wish to draw upon educational literature within your application.

Promoting and enhancing the learners' experience	Evidence of • how you stimulate and inspire learners • how you develop, organise and present resources • how you assess learners appropriately
Supporting colleagues and influencing support for learning	Evidence of • ways in which you contribute to the development of colleagues within your area • how you contribute to institutional initiatives • your contribution to regional/national/international initiatives
Ongoing professional development	Evidence of • professional development activities undertaken • how you have used these activities to review and enhance your practice • how this is has led to improvements for your learners.