

IMA/MEE 6th Conference and SEFI-MWG 14th European Seminar 2008

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Background

A unique event in engineering mathematics education took place at Loughborough University, UK between 6th and 9th April. The Institute of Mathematics & its Applications and the Mathematics Working Group of the Societe Europeenne de la Formation des Ingenieurs collaborated to hold a joint meeting of over 80 delegates. The IMA Mathematical Education of Engineers conferences have been held at Loughborough since 1994. They began partly in response to the steady decline in mathematical preparedness of undergraduate students entering engineering programmes at UK universities and were noteworthy for the focus they put on the core and key knowledge that student engineers might gain. The IMA actively addresses the needs of employers in its branch meetings so a key feature of all the IMA/MEE conferences has been links with industry and industrial delegates being invited to give keynote talks. The SEFI-MWG began its work in 1982 as an international forum for exchanging experiences in engineering mathematics, understanding the role of mathematics in the engineering curriculum, fostering cooperation in course development and support material, and recognising a role for mathematics in continuing engineering education. In 1992 the SEFI-MWG published an advisory core curriculum of mathematics to be followed in European institutions where professional engineers are formed, and in 2002 both updated and revised this curriculum with the inclusion of learning objectives. Its current activities include a comparison of the widely different forms of assessment in European institutions, an ongoing interest in the most effective use of technology, and styles of teaching that should be adopted to optimise student understanding.

Themes of the Conference/Seminar

Over three working days the joint Conference/Seminar featured many of the presentations and activities that have given each form of event its special identity. There was a keynote lecture on each of the three days, twenty short talks, eleven presented posters and two group discussion sessions, looked at later. In the keynotes, Ole Christensen, Aalborg University, spoke about problem/project based learning in which top-down methods delve towards the resource of mathematics. In one example involving image manipulation he described how photo-flaws such as 'red eye' could be removed in a filtering process that utilised linear algebra. Chris Haines, City University London, asked how we would identify a good mathematical modeller. The teaching of modelling has grown in fashion in recent years, and though many approaches are different, there is a strong view that modelling is a cyclical and refining process. A successful or maybe experienced modeller, should be able to focus on the abstraction between the real and the mathematical world, and would have acquired the skill to weigh carefully the features of the problem between total inclusion and total exclusion. Alan Stevens, Rolls Royce, speaking about the 'good, bad and ugly' tools of the trade, noted seeming flaws and limitations of worldwide software or 'Worldware', such as Microsoft Excel. Both lecturers and industrial software designers use the spreadsheet Excel when perhaps a more sophisticated but suitable package like Mathcad, Matlab or Maple is more

appropriate. Very long lines of difficult code can result which can be fearsome to check. However he was clear to point out that the spreadsheet totally fulfils its specification though its users may be less aware of its full documentation and intended limitation. In a short report such as this it is not possible to name all speakers or poster presenters and summarise each contribution, rather we pick out some of the many, and in some cases, enduring themes.

Decline in Mathematical Preparedness. First observed seriously in the UK as early as the 1980s but by the mid 1990s this had become chronic. By contrast no such major decline was noted in continental Europe but since the 1990s, not only Europe, but much of the rest of the world has been experiencing major deficiencies in mathematics in the backgrounds of students entering degree programmes requiring mathematics.

Diagnostic Testing. Some but not all UK universities try to identify mathematical sufficiency by testing fresher students. A few of these follow up the test results with a programme of reinforcement and remediation whereas others are far less prescriptive.

Drop in Sessions. Support for those needing assistance with mathematics is increasingly being provided via dedicated additional classes in which a student or students can receive assistance on a one-to-one basis.

Dedicated Centres. The Loughborough Mathematics Education Centre provides a more generally available support resource than any timetabled session and other institutions might find that they too need a centre. 'The Helping Engineers Learn Mathematics' (HELM) resource books/dockets give students bite-sized access to specifically focused topics.

Confidence and Fear. The transition from the secondary to the tertiary sector is daunting enough for young adults without problems and aggravated emotions over mathematics. One speaker from Loughborough commented on how she had sought out needy and disorientated students with little desire to seek help at the education centre.

Engagement and Community. Many in the student group deeply need help but the process of persuasion can be hard. A strategy to identify the group as a cohesive community of learners sharing problems was proposed as a good way forward.

Communication Mechanisms. With widespread computer access, e/mail, the WWW, Blackboard etc give students easy access to their teachers, and with proper use these can be very helpful in resolving problems and setting up a close communication facility that was never possible in the past. The danger is in overuse and overload with students spending far too much time in front of the screen at the expense of writing, consolidating and maybe attending lectures.

Types of Learner. Students are known to learn in very different ways. One speaker noted that current methods of teaching and assessment might alienate those who learn in a deeper but slower manner.

Forms of Assessment. The SEFI-MWG is investigating different forms of assessment in European institutions and it is clear that these vary widely. Summative assessments are normally conducted by examination though formative or learning assessments are more open. Multiple choice questions tests are felt by some to be useful in assessing all-round versatility and mastery, but there was a strong reaction to this in that they can frustrate students and seriously restrict full expression.

The Use of Computer Algebra Systems (CAS). There are now widespread and featured prominently in the poster sessions with accompanying presentations in many

cases. We need to remember that such systems were initially developed for mathematical processing though their potential to enhance teaching is all too evident. In more recent years the use of CAS in teaching has been accompanied at mathematics education conferences with a message of caution and focus notwithstanding the benefits.

The Further Mathematics Initiative. The provision of a high level mathematics qualification, A Level Further Mathematics in UK schools has for many years proved virtually elusive as very few teachers can deliver it. The initiative by the MEI by which school students are transported to special centres has proved highly successful in boosting the numbers taking this important qualification. It has now received dedicated government funding.

Activities of the Working Groups

The conference/seminar broke on two occasions into five breakout or discussion groups each consisting of up to ten delegates. The discussion topics given to all the groups were 'Active Learning' and 'The Major Problems facing Engineering Mathematics Education in Europe'. The groups were chaired respectively by Dick Clements, University of Bristol, and Burhardt Alpers, Aalen University. Both have produced short reports detailing the discussion and what follows is a brief summary and interpretation.

Active Learning. All learning should be an activity but in mathematics this is often cerebral and individual with much reading, writing, consolidation and reflection. Some might call this 'passive' learning but it can be most effective. In recent years students have been encouraged to work on problems in groups and to communicate their findings. This is a much more social activity and can pose questions, clarify misunderstandings, and maybe improve the efficiency and effectiveness of grasping concepts. However not everyone in the group may be equally engaged due to a wide variety of reasons, such as fitting in socially or being occasionally absent, so teachers need to measure carefully how the activity is working. Technology such as CAS can be helpful within both the individual or group context.

The Major Problems in Engineering Mathematics Education. The lack of preparedness of students in mathematics is but one feature of their changing background. Attitude to study, a need for immediate gratification, and an ability to maintain concentration appear to be other undesirable effects. A remedy might be to task students with a wider responsibility for their own study but implementing this would need very careful thought. Better communication between schoolteachers and university lecturers could be helpful but this too needs thinking through. Also, the inhomogeneity of the background of students presents problems as the mathematics curriculum has expanded. Many more have now encountered concepts in probability and discrete mathematics in highschool, but this could be at the deficit of traditional calculus and its applications such as mechanics. Notwithstanding, the assessment of real student understanding is a difficult problem with which the IMA and SEFI-MWG will continue to be much involved.

Acknowledgements & Next Time

Many thanks must go to Carol Robinson and her team at Loughborough University for their excellent organisation. The 15th European Seminar of the SEFI-MWG is being planned for Wismar in Northern Germany in 2010 and the 7th IMA/MEE Conference for 2011.