

# Improving Student Learning through Collaboration

## Developing the Interface between Engineering and Mathematics at Edinburgh University

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### Abstract

*A few years ago the department of mathematics at Edinburgh looked at the problem of interfacing between mathematics and engineering courses and came up with a system to enable greater student understanding. The implementation of this system and how it is helping students is reviewed in this case study.*

### Level of Material: First and Second Year

#### The Execution

It is important that all students reach the stage of being able to handle complex differential equations. They need to understand the meaning of the various terms of the equation in order to decide from physical situations whether particular terms are zero because of various symmetry concerns or indeed, whether the term ought to be negligible. To be able to understand these concepts well it is important that the students have a good grounding in mathematics. A few years ago the mathematics department at Edinburgh looked at the problems of interfacing between mathematics and engineering courses and came up with a system to enable greater student understanding. Now all first and second years are taught mathematics by the mathematics department, while using examples and problems are provided by the engineering department.

The engineers supply copies of notes from, for example, fluid mechanics lectures including all the tutorials and tutorial solutions. This enables the mathematics lecturers to see the ways in which the mathematics they are teaching is going to be used later on in the course. The mathematics lecturers then select one or two examples, which are presented during their own tutorials and lecture courses. The objective is to teach first and second year students in terms of examples that are relevant to engineering to help them see the problems within an engineering context.

The comments from the students have been positive. Difficulties still exist but there are fewer complaints based on the fact that the students are seeing the relevance of what they are doing with the mathematics. This is viewed as the first step towards motivating the students to take mathematics more seriously.

### Pre-requisite Knowledge

The engineering tutors are careful in terms of the selection of students to their courses. They often ensure the level of mathematics of students is appropriate before offering them a place, and this is done in consultation with the mathematics department.

### How Are Students With Different Mathematical Backgrounds Supported?

The mathematics department has two first year courses. One course is taken by the majority of students to give them a standard background in mathematics. The other course operates at a more remedial level for students with a C in Higher Grade mathematics, D in A level mathematics or other qualification. Numbers on this course are limited to 50 students.

The main course gives some examples and goes beyond what is needed for engineering. The remedial course sticks very much to what the students actually need before they progress to second year mathematics.



## The Barriers

The biggest barrier has been getting from the issue of “what mathematics it would be nice for students to know” to “what mathematics do students need to know to do the engineering”. Whether the student can do the mathematics from first principles or not is neither here nor there in terms of engineering practice. But there is still a debate as to whether students can really use something as a tool without understanding where it has come from. The mathematics department is looking at the ways engineers use mathematics, and has tailored a number of these at first year level.

There will always be a debate over what students need to know. Some of what we have assumed the students need to know has ultimately been a barrier to their progression. Students make statements like “I could cope with this at school but now having been taught this at university I am no longer even confident of what I was able to do at school.” At school they had used rules, e.g. for differentiation, but once at university the mathematicians went back to first principles and so the students panicked over their ability to use these tools from that point onwards.

## The Enablers

The main enabler has to be the close liaison between the engineers and the mathematics department. Three or four years ago there was increasing evidence that first and second year chemical engineering students were having difficulties with the mathematics, and consequently the engineering department was facing a growing lack of interest and understanding.

The mathematics department had introduced “engineering examples” within the mathematics teaching. However, the questions tended to reiterate the mathematician’s point of view and in many cases, the content was proving too advanced for the students. It was becoming vital that the mathematics department explored engineering approaches and ways to teach mathematics from an engineering viewpoint.

The Mathematics – Engineering Liaison Committee received funding to employ a facilitator to look at the interface between the mathematics and engineering departments. The role of the facilitator was to make the mathematics department more aware of the links between the mathematics being studied and the practical engineering.

## How Can Other Academics Reproduce This?

Different universities are taking different views on the teaching of mathematics. Some engineering departments have decided to take on the mathematics training themselves. Others have gone to a halfway house, taking on board certain things themselves where the use of the mathematics is only ever going to be used in a fairly clear engineering context. Edinburgh has actually gone down the route of using their mathematics department and what is interesting is that the mathematics department have come up with a solution themselves. They employed someone with an engineering background to liaise between the two departments, to develop an understanding of what the chemical engineers were going to do in their course.

It has also relied upon the trust of the engineers – when solutions are going to be scrutinised by mathematicians it is rather daunting. But this is the only way forward.