A "Professional Issues and Ethics in Mathematics" course

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Some courses achieve existence, some have existence thrust upon them. It is normally a struggle to create a course on the ethical or social aspects of science or mathematics. This is the story of one that was forced to exist by an unusual confluence of outside circumstances.

In the mid 1990s, the University of New South Wales instituted a policy that all its undergraduates should undertake a course in "Professional Issues and Ethics" appropriate to their major. The academic community by and large opposed the plan, regarding it as an attempt to substitute politically correct hot air for serious content. But University policy is decided by a Council dominated by parliamentarians, business people and other outside interests, who believed the concentration of undergraduate education on technical content was not preparing students for the workplace. It was rumoured too that the University feared being sued in the future by employers facing losses through unethical behaviour of graduates, graduates who might then claim in court, "But the university never trained me to behave ethically."

Individual Faculties and Schools were left to develop their own course content. Disciplines such as law and medicine had in effect been doing similar things for years. Science and mathematics were caught unprepared. Given the diversity of career destinations for their graduates, what are the "professional issues"? Apart from whether it is acceptable to work on bombs, what ethical issues are there in mathematics? Most urgently, where to find someone to teach a course like that?

As the only academic in the School of Mathematics with some humanities background, I was approached by a sheepish Head of School with a message along these lines, "We're not desperate to find someone to create Professional Issues and Ethics in Mathematics; but if you don't do it, we will be." I accepted.

The gift of a greenfield site and a bulldozer is a happy occasion, undoubtedly. But what to do next? It seemed to me I should ensure the course satisfied these requirements:

- It should look good to students, to staff, to promotions committees.
- It should in fact be good, in containing content and activities of benefit to the students.
- It should allow me some space to promote my enthusiasms, such as mathematical modelling, but not too much.
- Subject to these constraints, it should take a minimal amount of work.

Looking good to other staff was easy: if it required no action from them and fulfilled the University's formal requirements, they were ecstatic. Looking good to promotions committees was probably impossible, so there was no point worrying about it; I used the time saved on the course to write a book on something else. Looking good to students, and genuinely benefiting them, took more care, especially as the course was compulsory (for all mathematics majors) and hence contained a proportion of students unhappy about being there. To make matters worse, mathematics attracts both some of the best students, often intent on a research career, and some of the worst, sometimes with poor English and substandard communication and research skills. The class size – now about 50 – and course length – 27 contact hours – means that some personal interaction is possible, but not serious individual attention for most students.

To convince students very quickly that something of interest to themselves is happening, I open the course with a discussion

of careers in mathematics. Since I as a typical academic have not soiled my hands with anything that could be called real work, I need outside information. It takes little effort to search the major job web sites for the keyword "mathematics" and show the class a selection of results, calling attention to the demands of employers for "communication skills", "teamwork", "ethical behaviour" and the like. Then I use a quarter of the contact hours for visiting speakers from "industry" (widely understood), who can speak with credibility on what it is like "out there". The School is happy to pay a fee for them, especially as there are other benefits to the School in maintaining contacts with industry. As the course has progressed, I have used ex-students of the course itself as visiting speakers, for talks on "when I was in your position a year or two ago". Students soon to graduate learn something genuine about what they face, and even the students planning research careers find their minds expanded by seeing how their discipline is used in the real world. I had my doubts about the ethical perspective of one speaker: "I would have taken the statistics job with the tobacco company, but my name would have been mud", but a productive variety of points of view will probably not damage student minds irreparably.

Then I devote a few lectures to an overview of mathematics and its uses. That goes some way to making up for the fact that a mathematics student hardly ever studies a course on *mathematics* (courses on calculus and algebra, yes, but not a course that shows where those topics fit into the big picture). So there is something on the classification of mathematics, its history in one lecture from "can cats count?" to data mining, the various fields from climate to finance where mathematical modelling is central, mathematical proof versus experimental evidence.

Moving to ethics, I give my views briefly on the foundations of ethics and why it is important and considered important in the workplace. The ethical issues then treated are mostly not specific to mathematics, but arise in any job that deals with ideas, data and information – general concepts that the law uses to organise cases, like "duty of care" (when a product may be dangerous or cause loss), "conflict of interest", "professional responsibility", "accountability". Probably the issues most directly relevant to a mathematics graduate's work are in "information ethics" confidentiality including cases of commercially sensitive information and insider trading, necessary disclosure in whisteblower cases, intellectual property issues and plagiarism, the necessity to be adequately informed when making decisions. There are enough detailed case studies available in textbooks on professional ethics and in legal cases to bring the issues down to earth and to show they are taken seriously. Finally, I consider what mathematical careers are especially inspiring ethically. Is epidemiology or evaluating climate models a better way to use one's mathematical abilities than making another million for a bank?

The assessment is a little different too. In mathematics education, assessment tasks are typically small, rigidly specified, objective, individual and the same for all students. Many students choose mathematics because they like it that way. But employers of graduates, and even many graduates themselves, complain that this process creates graduates who have good technical skills but lack lateral thinking and the ability to listen or to communicate their results. The main assessment task in Professional Issues and Ethics is therefore a large essay/report plus class presentation, done in teams, on a topic chosen by the team (subject to approval). The topic must be interesting (judgement again subject to the lecturer's approval – experience has shown that certain topics always lead to uninteresting essays and need to be forbidden, such as "Pi" and "The abacus"). Some students experience a kind of intellectual vertigo at the prospect of actually choosing a topic of

their own, and plagiarism is sometimes the upshot. But it does not hurt people who have been studying for some fifteen years to let go of the alma mater's apron strings just once before they graduate and think of a question for themselves. A framework is needed, for example, some examples of titles for essays, a model essay from a previous year's student, a list of information resources where research can start, and guidelines on how the essay and presentation will be marked. But if one awards marks for what one actually wants from students, for example, for "interesting choice of original topic", one will get positive results and cost one nothing but some justified praise.

As to minimizing the amount of work for the lecturer while still extracting quality from the students, that bird has been killed by the two stones of guest lecturers and class presentations. There is some assessment work marking the essays and a short-answer test on the lecture material (a device to ensure attendance, physical and mental), but the number of essays is small because of their team nature. They are mostly marked by tutors, who are normally ex-students of the course who have become honours or postgrad students.

The experience has been a reasonably painless one for all concerned except those with English skills so poor as to constitute a hazard to employers. Student evaluations are reasonably good, and ex-students report its relevance to their work. I am subject to no more, perhaps less, stress than I would be with any other teaching of equivalent length.

The course has had one interesting spin-off. The best students in the first year, catching on to the idea of modelling, entered the excellent international Mathematical Contest in Modeling (www.comap.com/undergraduate/contests/mcm) Every year since we have had at least one team and some have brought home very good results. The intensive research and writing experience of the Contest (teams write a paper on a problem over four days) has proved good training in thesis writing for our top students.

Should the Australian Mathematical Society follow the lead of the professional societies in medicine, engineering and computer science in encouraging every mathematics degree to include a course on Professional Issues? From UNSW's experience, students and employers would benefit. It would address the problem raised in Cheryl Praeger's article (*Gazette* September 2004) as to what the AMS can do for the broad mass of mathematics undergraduates, whose prime concern is their looming job search. If anyone wishes to use UNSW's course materials, ICE-EM might like to pay to have them made into a package. Naturally, there is a problem of where to fit such a course in a crowded syllabus, but it is a fair bet that most universities are still teaching methods of integration or other topics that should have been replaced by software, some of our speakers from finance have made unkind remarks about the relevance of complex analysis. For some programs at least, those topics would not be missed. Students have plenty of teaching on technical material. They need a break on something that connects them with what they will do when we let them out.

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Received 18 October 2004.