

**Training in Teaching for New Staff in
UK University Mathematics
Departments**

Bill Cox and David Mond

September 22 2008

Contents

1	Introduction	5
1.1	New challenges in the teaching of mathematics in Higher Education	6
1.2	Glossary	7
2	Professional values in teaching in HE	9
2.1	Background, the national context	9
2.2	The Professional Standards Framework	9
2.3	Teachers and researchers	12
2.4	The LMS survey	14
2.5	What do new lecturers want?	16
2.6	Some training case histories	30
2.7	Who should train the teachers?	34
2.7.1	Departmentally based training	36
2.7.2	Generic skills	37
2.7.3	The MSOR Subject Centre	38
3	Training in the department	41
3.1	Relations with the university's ISD	42
3.2	Learning Outcomes	44
3.3	The Needs Analysis - Designing an Individual Training	46
3.4	Keeping to a schedule	48
3.5	Assessment	48
4	Observing and mentoring teaching	53
4.1	Principles of training	54
4.2	How long is the training?	54
4.3	Beginning teaching: the first teaching duties	56

4.4	The role of the mentor	58
4.5	Some experiences of mentoring	59
4.6	Teaching observations	64
4.7	Variations	67
4.8	Teaching Observation Forms	68
4.9	Site-specific issues	68
5	Workshops and seminars	69
5.1	Attracting an audience	69
5.2	The MSOR Induction Course and Associate Module	71
5.3	Themes and topics	72
6	Writing and Reflecting	81
6.1	Essays	81
6.2	Projects	83
6.3	Questioning Assumptions	86
7	Training versus quality assurance	89
7.1	Recognising and accrediting previous experience	91
8	Resources	93
8.1	Existing staff	93
8.2	Books and journals	94
8.3	The website	95
9	Experiences of Teaching	97
10	Sample Learning Outcomes	121
10.1	Warwick University's Maths/Stats Teaching Qualification	121
10.2	MSOR Summary Assessment	123
10.3	Higher Education Council Quality Guidelines	127
11	Appendix A: The Professional Standards Framework	129

Chapter 1

Introduction

We begin with two quotes. The first:

[There are groups of scholars all over the country] who would not make a decision about the shape of a leaf or the derivation of a word without painstakingly assembling the evidence [and yet are quite content to make decisions about] admissions policy, size of universities, staff/student ratios, content of courses and similar issues, based on dubious assumptions, scrappy data and mere hunch.¹

The second:

General theory empowers and better serves the interests of educational researchers and developers whereas context specific theory empowers and serves the interests of subject specialists.²

The first succinctly expresses the case for the training of lecturers in HE, while the second expresses our belief that the main locus for such training should be in departmental apprenticeship. Drawing on experience from across the UK MSOR community, this document aims to guide UK mathematics departments in providing training in teaching for new lecturers.

We believe that a significant part of the training of new staff in university mathematics departments should be incorporated into the normal run of departmental activities, in the form of collegial apprenticeship. The book

¹Lewis Elton, [6].

²G. Webb, [32].

argues this view, and sets out to guide mathematics departments wishing to act on it. It is based in part on our experience running such a scheme in the Mathematics and Statistics Departments at the University of Warwick, where it has been successful both in training new staff, and as a means of focussing departmental interest in teaching.

We advocate a programme of training incorporating

1. Collegial apprenticeship and mentoring within the lecturer's own department
2. Subject-specific training courses taught in national or regional centres, such as the MSOR³ Subject Centre Induction Course for Lecturers new to Teaching Mathematics in UK Higher Education (see Subsection 2.7.3 below), supported and informed by input from the Mathematics Education community.
3. Institutional staff development courses, taken with lecturers in other disciplines, covering topics on which there is common ground.

We believe that the first of these should form the core of the training, while the institutional staff development centre (ISD) should provide the necessary unifying framework, training in mentoring, advice, accreditation and administration, together with the courses of the third kind.

We are grateful to Trevor Hawkes, responsible for much of the design of the departmentally based programme at Warwick, and Glynis Cousin, Joe Kyle and Michael Grove for advice and support. We also thank the staff at the Centre for Academic Practice - now the Centre for Learning Development - at the University of Warwick for their support and cooperation in the development of a departmentally based training programme in Mathematics and Statistics.

1.1 New challenges in the teaching of mathematics in Higher Education

What has led to the demands for the professionalisation of university teaching? It may be useful to have a summary of what is driving this change. Most departments will be affected of some of the following:

³Mathematics, Statistics and Operations Research

1. With widening participation we now take a much wider range of students, and this demands a wider range of teaching skills, with thorough understanding of students' backgrounds and appropriate teaching responses.
2. The UK is finding it increasingly difficult to grow its own academic staff in the sciences, and there are already fears for the next generation of UK mathematicians (see e.g. [2],[10],[25]). We are becoming increasingly reliant on foreign-trained academics to staff our departments. To respond to the shortage of UK mathematicians we need to increase the supply of UK mathematics graduates doing PhDs. One way to attempt to do this is by means of better and more inspirational teaching. (We could add that academics from abroad may need training to familiarise themselves with UK Higher Education).
3. We are continually beset with claims of different and better teaching methods (e-learning, problem-based learning, etc). We need to be informed and knowledgeable of such things and be in a position to assess them critically and expertly.
4. Student fees are leading to demands for better teaching and support for learners.
5. Global economic, social and political changes have led to cutbacks in spending on public services and to increased demands for accountability and measurement of performance in the public sector. These are frequently coupled with a scepticism of the ability of public sector employees to do their jobs properly.

1.2 Glossary

CPD	Continuing professional development - the field of which the training of new staff is a part
HEA	Higher Education Academy: QUANGO overseeing training of academics
HE	Higher Education
ISD	Institutional Staff Development Centre: unit in university or college providing training to all academic

	departments.
LMS	London Mathematical Society
MSOR	Mathematics Statistics and Operations Research; also MSOR Subject Centre: dependency of the HEA, located in Birmingham University and staffed by mathematicians specialising in staff development
Department	Academic department; also known sometimes as School
Course	Degree course
Module	Unit of instruction in a degree course, e.g Analysis I
PGCHE	Postgraduate Certificate in Higher Education
PSF	Professional Standards Framework published by the HEA - see Section 2.2.

Chapter 2

Professional values in teaching in HE

Professional values, and how to impart them, is what this book is about. A new lecturer has to strike a difficult balance between teaching and research. He or she must develop and safeguard his research, at the same time as giving good value to the students and simultaneously advancing the department's interests. He has learn to respect and educate the students who are set before him, even though they may not be the sort he had hoped to teach. He must not demand of them them his own motivations, interests and abilities. The institution has judged that these students are capable of benefiting and succeeding within the programme that he contributes to. It is his job to provide them with proper support for that - providing they work diligently, there should be no reason for them to underachieve in his course if it is designed and taught properly.

2.1 Background, the national context

2.2 The Professional Standards Framework

In recent years the training of university teachers has risen up the Higher Education agenda, prompted by the requirement in the 2003 White Paper *The Future of Higher Education* ([4]) that all new university staff engaged in teaching be trained from 2006. We quote:

At present, there are no nationally recognised professional standards

for teachers in higher education; and many of those who teach have never received any training in how to do so. In order that teaching in higher education is treated seriously as a profession in its own right, and that teachers are given the skills they need, we expect that national professional standards will be agreed by 2004/05, through the proposed new teaching quality academy, described below. These standards, to be designed and agreed by the sector itself, would then describe competences required for all teaching staff. Training of new staff to meet the standards should be possible through a wide range of different programmes and courses, as best suited to the institution and individual concerned. Once the standards are in place and command confidence across the sector we will expect all new teaching staff to obtain a teaching qualification which meets the standards from 2006.¹

The professional standards called for in this document were published in February 2006 by the Higher Education Academy as the *UK Professional Standards Framework for teaching and supporting learning in higher education* ([11]), (henceforth *PSF*). It is reproduced in full in Appendix A. The Teaching Quality Academy referred to in the quote has now come into existence as the Higher Education Academy.

However, despite the importance evidently attached to it by the White Paper, the value of the PSF as guidance to institutions wishing to train their staff is minimal. Even after extensive consultation with the sector, it consists of only two pages. Let us quote the description for “staff new to higher education teaching with no prior qualification or experience”:

Demonstrates an understanding of the student learning experience through engagement with at least 2 of the 6 areas of activity, appropriate core knowledge and professional values; the ability to engage in practices related to those areas of activity; the ability to incorporate research, scholarship and/or professional practice into those activities.

New staff will soon graduate to having

a substantive role in learning and teaching to enhance the student experience, [by which time they will be required to] demonstrate understanding of the student learning experience through engagement with all areas of activity, core knowledge and professional values.

¹[4], 4.14

Why this mismatch between the expectations of the White Paper and the feeble content of the PSF? The use of words such as “appropriate”, “ability” and “incorporate” here makes clear that the framers of this document are not able to provide a definition of good practice that conveys any information at all.² This does not mean that they are unable to *recognize* good practice, or to guide someone towards achieving it in the context of active teaching. But asked to write out a definition that covers the range of all subjects, they can find nothing useful to say. We do not argue that the failure of the PSF is due to the inadequacies of its framers. We see it as evidence that the range of skills, emphases, rituals, priorities, strategies and imagery that constitute good teaching across the different disciplines is so great that practically nothing can be said which encompasses it all.

Handing over the training of new staff to generic staff developers with necessarily limited subject-knowledge and teaching experience while giving them little more than commonplaces as guidance, and asking them to convey a common core of teachings skills to a disparate group of lecturers, in the absence of an agreed common core of any substance, is a recipe for failure. Nevertheless, in almost all UK universities, responsibility for the training of new staff has been given to a central Institutional Staff Development Centre (ISD) or Centre for Academic Practice. What qualifications should the trainers themselves have? How should they gain legitimacy (in the eyes of generally sceptical staff)? No-one knows.

Such challenges sometimes produce dynamic innovations; with no ladder to climb, creative individuals pull themselves up by their bootstraps, and valuable new initiatives can emerge. There are ISDs which have succeeded in enriching the experience of teaching and learning of staff and students alike. But, at least in the experience of mathematicians, they are the exception rather than the norm.

The result of this mismatch between imposed requirements and the realities of educational practice is that all too often, the ISDs find themselves deeply unpopular, contractually obliged to deliver generic training to new staff who see little value in it and deeply resent the time it takes them away from research. The effects on teaching are largely negative. This is multiply unfortunate. Staff time is being wasted, the White Paper’s call for improved

²Especially the word “appropriate”, which means nothing more than “you know what we mean, it’s part of our shared ideology”. This word is particularly unhelpful in the present context, where guidance in the ideology is at issue.

teaching is not bearing fruit, and the resources and skills of the ISDs are not being put to good use.³ The central concern of this book is the question of where should the boundary be drawn between the responsibilities, as regards staff training, of the generic staff developers, and of practising academics.

2.3 Teachers and researchers

One might hope that the interests of students, as educational consumers, and of academics, as teachers *and researchers* would naturally and inevitably prevail. However, we see two factors which work against this happy outcome. One, which most academics will recognise, is the monopoly which ISDs have been given over staff training, and which they are unwilling to relinquish, for the usual institutional reasons, coupled with their somewhat caricatured image of academics as incompetent introverts unwilling to tear themselves from their research. The second, perhaps less present in our thoughts around these issues, is the unwillingness of academics themselves to play an active role in training their new colleagues - perhaps partly for the reasons that the ISDs imagine. But of course there are other reasons: most senior academic staff in UK universities began their careers at a time when new staff were given no training and were expected to work things out for themselves. The concept of staff training is in some ways foreign to institutions which take academic freedom as an axiom and which operate on a basis of collegiality and mutual respect. The danger of collegiality as a *modus operandi* is that it can too easily turn into happy ignorance of what our colleagues do. Increasingly, we are called upon to deliver high quality teaching to a very wide range of students, and we will be assessed on the quality of our teaching. We believe that providing our new colleagues with appropriate training *is*, at least in part, the responsibility of academics. If we do not meet this responsibility, our new colleagues will continue to have to endure the kind of generic training which is rightly criticised by the respondents to the LMS survey quoted in Section 2.4 below, as reflected in this introduction.

For departments to start to train their own new staff will be a challenging new development. But it only has to happen once. Once the new structures are in place, and provided they are installed with sufficient thought, they will recede into the background, and we will have improved the teaching of

³For a vivid and provocative view on the issues discussed in this section, see [20].

students in our department teaching, and, we venture to suggest, we will have improved the early experience of our new colleagues.

In this book we hope to suggest ways in which a department can start to develop its resources in staff development. We hope to encourage rather than prescribe. After all, we are still learning. We strongly believe that every system must be allowed to develop and evolve. Here we aim to help departments find a place which they can evolve from.

We offer two kinds of guidance. The first is a description of some of the possibilities for departmental training, some tried at Warwick and elsewhere, some as yet untried. We emphasize its integration into the day to day activity of teaching, because that is how we believe it will be most effective as training, and because activities that draw in existing staff can help to generate interest in teaching across the department and increase communication between new staff and old.

The second is the voices of lecturers themselves. We have collected a number of short contributions by academics currently working in the UK, on two distinct themes: from the older and more established, some thoughts about their own experience of teaching, which are reproduced in Chapter 9, and from academics two or three years into their first UK teaching appointments, some ideas on what kind of training they found useful, or would have found useful had it been available. These are reproduced in Section 2.5, where the results are also tabulated. We cannot claim to have carried out a scientific survey. On the other hand, we believe strongly that teaching and learning, as the activities of individuals, are as varied as those individuals themselves. Just as we believe that lecturers should pay attention to students as individuals, we believe that the voices of individual lecturers should be heard and listened to.

We repeat: we do not believe that *all* training of new staff should take place in Academic Departments. The training of teachers of maths in HE must contain both generic and discipline-based components. We see a significant role for ISD's because they are home to skills that subject departments cannot expect to have, and which we can draw on. Training for mentors, advice on procedures for peer observation, procedures for ratification of qualifications and previous experience - all will be helpful to academic departments seeking to provide appropriate training for new staff. We might even imagine that once a significant part of staff training migrates to academic departments, ISDs will begin to advise those departments on the training they deliver. Moreover, there are clearly aspects of training that are entirely

generic - counselling skills for tutors, voice training for quiet speakers, time management and budgetary skills. The list is long and varied.

We hope that by recognising and highlighting the areas in which ISD's may be expected to have skills that academics do not, we will contribute to liberating their staff, as well as ours, from the current unsatisfactory situation. And it is unsatisfactory! In the next section we look at the current situation, as shown by the results of an LMS survey. In Section 2.6 we give some raw data which reflects the same problems. Chapter 9 contains an amusing description (Lecturer XIII) of some of the worst aspects of generic training.

2.4 The LMS survey

In November 2005, the Education Committee of the London Mathematical Society carried out a survey of staff training in mathematics departments UK universities ⁴. After being told that

... the EPSRC/CMS International Review of UK Research in Mathematics [found that] there is concern, in some cases expressed by the participants themselves, about the burden and content of the academic practice courses now required to be attended by new academic staff,

the Heads of UK Mathematics Departments were invited by the LMS Education Committee to comment on these courses, in order to help the committee decide whether and how to take the matter further. Responses were received from 20 old universities and 5 new universities (former polytechnics) - a majority of the providers of single-subject Mathematics degrees. In all except for one, the training was almost entirely generic. Two reported satisfaction with this generic training; the remainder were critical, some extremely so. Here are some illustrative quotes:

- “New staff are expected to attend many courses on a range of topics, but the universal view was that the vast majority of these courses are a waste of time.”
- “The general nature of the courses severely dilutes their usefulness.”

⁴We are very grateful to Niall Mackay and Chris Budd, of the LMS Education Committee, for permission to quote from the survey here

- “On the job training is more useful than attending courses.”
- “No-one ever asked the department what kind of new training we would like our new staff to receive. If we were asked, the answer would be something very different from the current programme.”
- “Young colleagues find these courses excessively demanding in time for the value if any. They ought to be more practical in nature, take up less time, and be subject/discipline specific.”
- “The ridiculous hoops that they have to jump through has certainly been the reason that we have lost, at least, two young members of staff. The main problem [is that] the material is neither well presented nor relevant to Mathematics and Statistics. At _____ the courses have been introduced without any consultation (as to content) with the Heads of Schools. There are some excellent courses put on (e.g. [...] by the Maths LTSN in Birmingham), but that course is not recognised by our university as an alternative to their university-wide generic course.”
- “I have had long years of University Education (as most academics do), and of course I have had experience of bad academic teachers. Therefore I strongly support the concept of instructing new academics in advancing their teaching skills. [...] However the discussion [in the generic course] is often not relevant to mathematics.[...] Since the course organisers have to cater for academics from areas as diverse as history of art and engineering in the same session, it is clear that a relevant discussion to such diverse areas can often be degenerated to cliché generalities.”
- “New lecturers are different from new lecturers in lab-based sciences - they usually have 3 or more years of teaching experience, experience giving talks at international conferences, and work independently rather than in teams. They therefore find the courses patronising as well as time-wasting, and so get nothing from them as they spend the whole course angry.”

To set against these opinions criticising generic provision, we mention

- “I have learned many things and I have gained new ideas from interacting with academics from different areas. This has helped me obtain a more integrated opinion about the concept of academic teaching and assessment.”

- “I have obtained a great deal of practical advice from the people that run the course, especially on issues of good lecturing practice and good practice on interaction with the students.”

To summarise:

1. Mathematicians see some need for training in teaching, but few academic departments have been consulted on what kind of training they want their new staff to receive.⁵
2. The generic training they do receive is believed to be of little or no value, especially in relation to the considerable burden it places on new staff.⁶
3. Reports of generic training workshops and seminars paint a picture of extreme generality and theory which is of little value in teaching practice, together with frequent invitations to reflection and self-questioning which do not make up for lack of real content.
4. ISDs are unwilling to relinquish even part of their hold over the training programme, by allowing some of it to be replaced by the universally praised MSOR (formerly LTSN) Induction Session run annually in Birmingham.
5. Training on the job is believed to be much more appropriate to the needs of mathematicians.
6. Contact with young academics from other disciplines is valuable.
7. ISDs are sometimes home to staff with skills which are of value when used in practical one-on-one advice and guidance.

2.5 What do new lecturers want?

The seventeen short descriptions here come from lecturers a few years into their first UK post. Most of them were contacted because at some time in the last four years they had attended the Induction Days run by the MSOR

⁵In fact some departments have been asked, but have not responded – see the comments in Section 2.3.

⁶See the discussion of the length of training in Section 4.2.

Subject Centre in Birmingham University. The remainder are colleagues of the authors. Each was asked to describe what training they found useful, and what training they believe they would have found useful if it had been available. The results of their lists are tabulated at the end of this section.

New Lecturer I

With hindsight I think that I would have benefited from:

1. Training in teaching large (100+) classes: in particular how to control a large class, how to judge the pace and level of exposition required in a lecture, how to make large class teaching more interactive and less passive than a standard lecture.
2. I did my A levels a long time ago so I would also benefit from knowing exactly what students are taught in School mathematics now.
3. I also think that the only useful training/advice I have received has been from experienced mathematics lecturers, both at the MSOR induction session and in discussions in my School. The generic training courses run at University level are a waste of time, often patronising and are generally focused on soft sciences and arts subjects. So I would have benefited from less generic training (Certificate in Academic Practice) and more discussion with good mathematics teachers (this could be called mentoring but it is not necessary to be so formal).
4. I hope this is of some use and if you do quote anything I would like to remain anonymous as I still have to pass a CAP!

New Lecturer II

Three things new mathematics lecturers in the British system should know:

1. Don't be surprised when tutees seem to be only interested in their marks. Most students in Britain have gained their university admission by obtaining between 3 and 5 A-levels at high school. To be admitted for Mathematics in Warwick two A-levels have to be in Mathematics. This means that many of our students had very little choice when they decided which subject they are going to study at university. Since pupils at school choose their A-level subjects at the age of 16 and many mechanisms strongly encourage them to pick Mathematics it shouldn't come at a surprise that many of our students don't really like Mathematics.

2. Don't be surprised if tutees refuse to participate in mathematical discussions. Both, A-level and university degree marks are overwhelmingly based on written exams. Moreover, students are almost never encouraged to practise the correct use of the technical language. In many cases this means that students fail to enjoy mathematical discussions during tutorial meetings and refuse to participate actively. Helping them to develop the courage to express their mathematical ideas with confidence in front of others is very rewarding for the students but not easy to achieve.
3. Don't be surprised when students are passive in lectures and vigorously demand scripts. There is no mid-term culture in Britain, i.e. students revise for the final exams not before the end of the second term. This means that many students follow the content of the lectures only in a cursory way and spend little to no time on revision or homework while attending the course. Hence, it is important to provide them with a very good set of notes and self-explanatory homework, i.e. problems that can be done without additional oral explanations.

New Lecturer III

As a recently appointed lecturer, I have received training on a wide variety of diverse topics, ranging from the supervision of PhD students through to personal tutoring. Most of the formal training sessions that I have attended have been run centrally by the University's Staff Development Unit. These sessions are obviously not targeted at any particular subject area, so do not deal with issues that are specific to mathematics, but are compulsory for all new lecturers (and take up a considerable amount of time). At a departmental level, most of the training is much more informal (often on a one-to-one level), although tends to be much more relevant to what I actually do on a daily basis. Within the department, I think that this informal level of training has worked very well for me.

From my own point of view, most of the more useful training that I have received has dealt with "practical" issues, for example we had an excellent session on voice projection. Less useful (at least to me) were some of the more abstract sessions on general theories of student learning. Similarly, some of the other sessions were largely irrelevant to mathematics - one particular afternoon on the detection of plagiarism in undergraduate essays sticks out in my mind! In retrospect, although I can see the value of some centralised training of this form, I would have preferred instead to have received training, at a faculty level, that was (like the MSOR Induction Course) much more focused upon issues that are of direct relevance to mathematics. By providing training that was more relevant, this would

have been much more time-efficient from my point of view. For example, it would be much more interesting to me to learn about ways in which plagiarism could be detected in a mathematics homework rather than in an essay. Similarly, teaching styles in scientific subjects tend to be very different from some of the more interactive seminar-based sessions that are often adopted in the arts and humanities. More detailed training on large group teaching, specifically in maths and the sciences, would have been extremely useful to me. I would also have liked to have received more specific training on the use of computer resources in teaching mathematics - I run computer practicals as part of one of my courses, but I only received very general training on “practical-based teaching”.

New Lecturer IV

Here is what helped:

1. Opportunity to talk about how to handle large classes (my very first teaching assignment was to teach a class of 150!) with
 - (a) people at the MSOR induction event
 - (b) teaching and learning staff at the university
2. Peer observation of teaching
3. Advice from mentor about handling a very difficult marker

Here is a list of thing that would have helped:

1. Quick introductions to
 - (a) the general “mathematical standard” – my initial class was too difficult by British standards
 - (b) to “student culture”. E.g., I had to learn the hard way that students here are more passive (and less polite!) in the classroom than in the US.
 - (c) how British exams work – again shockingly complicated for someone moving here from, e.g., the US.
 - (d) graduate studies – again quite different from many other countries specifics of how things work in the department
2. Opportunity to attend a second MSOR workshop for those with about 2 years experience to better reflect on, exchange and learn from experiences.

Here is what did not help:

1. Having to jump through the hoop of passing “Teaching and Learning” courses (by writing essays, of all things!). These seem to have become an end in themselves and seem to be in severe need of pruning. (Talking to colleagues in other universities I know that this is not unique to my university.)

New Lecturer V

Having completed my PhD in Statistics in the USA I was rather unfamiliar with the British University system, but have had some teaching experience. My main concerns about being a new lecturer therefore had almost exclusively to do with the British University procedures and system. In particular the concept of summer examinations, the fact that students do not have text books and are given little or no homework as well as the very different prior knowledge of students, required some getting used to.

To familiarize myself with the UK system, I participated on the MSOR induction course for lecturers new to teaching Mathematics and Statistics as well as a departmental series for new lecturers. While the former addressed many issues and presented some good approaches to teaching I feel that it was too much focused on pure Mathematics for me. The departmental series on the other hand did provide a good introduction to the specifics of Lancaster University and the Department of Mathematics and Statistics in particular but failed to address all of my initial concerns.

In retrospect I believe that I, as a lecturer that grew up under a different educational system, would have greatly benefited from a short, maybe half-day, workshop on the British system. Topics such as

1. the mathematical background of the different levels (GCSE, A-levels)
2. what topics are students expected to know
3. how much will they realistically remember
4. summer examinations
5. what is the usual process of setting these exams
6. what is the format of these exams
7. resits
8. standardized tests

9. how do test scores influence admission and thereby quality of students
10. what are GCSE, A-levels ... could have been useful there.

New Lecturer VI

I came to Warwick with six years of full-time teaching experience outside the UK so what follows are my preferences coming from that perspective.

1. Give facts early. Hold an orientation several days before classes start (so new lecturers have time to make webpages etc before classes start but after the orientation). Focus on information that differs from institution to institution (if the person running the orientation is not relatively new, they should ask recent hires what this is!). For example, the most important information at Warwick just before classes start is that a 9-10 class actually runs 9:05-9:55, followed by the fact that there are no classes the first Monday but your tutees will look for you at specified times (that you have no control over). Other examples would be local conventions for how many assignments are normal for different levels of modules.
2. Also give facts at any other critical time (such as the end of the year). Again, just the facts is most useful. This includes details such as rules about emailing marks, and when to expect students to ask about marks, and what advice they need to be given in each case.
3. In later training, emphasise facts and applications over theory, and remind outside speakers to define jargon. For example, it is useful for those of us new to the UK to be told about how A-levels work, but any explanation needs to remember that most of us know nothing about it, or how to calibrate what an A means. Similarly, remember that those of us new to the UK don't have the same opinion as to what an assignment worth 67 is, or know what quality of work deserves a first.
4. The hour in which I learnt most about local teaching and learning culture at Warwick was at an evening event where a cross-section of undergraduate students came and asked and answered question about what they and we liked/didn't like/expected about the learning experience. Highly recommended!

New Lecturer VII

I have never had a problem with giving seminar-style research talks: "be prepared"

seems to be a good motto. When lecturing small groups of students, this experience seemed to translate well, but I still find lecturing to large groups to be (irrationally) terrifying. I think experience will help, but one side effect is that I am very hesitant to give anything but a standard style of chalk-and-talk lecture, at least until I am comfortable with crowd control, and so forth. Much of the training I had seemed to assume that the basics of lecturing were easy, or so similar to seminars, that little needed to be said. I am hesitant to try more "experimental" methods of lecturing, which was exactly what all my training concentrated on.

Setting homework problems and exams seems easy, but took a surprisingly long time to do. I think I will put even more effort into the homeworks next time, as the students didn't always seem to learn as much as I'd hoped. I think I've also learnt a lot about what are "good" or "bad" questions from tutoring and marking other lecturer's homework problems. This seems to be an area which is vital to student learning, and is very "maths specific", so badly handled by generic training.

The hardest (from the point of view of doing my job well) thing I found was interacting with students on a smaller scale: running tutorials, supervising and marking longer pieces of coursework. For me, this was always using other people's material, and helping students with other lecturer's problem sets. I felt that I could control very little, and that often I did little more than give out answers with explanations which perhaps made little sense to the students. I had complaints about my marking (of coursework) and it was very hard to know if I was being harsher than my colleagues: I got no feedback except from students. Inevitably, any training to address these matters would probably have vary from university to university.

New Lecturer VIII

1. How to better integrate external information such as material in text books into the course. How do I get the students to do more background reading to the material presented in lectures.
2. How to use electronic presentations more effectively? Out of a 36 lectures I only did 4 lectures (a section on statistics) with a presentation made with latex, but I went too fast, and ended the lectures 15 minutes too early. I learnt a lot of useful things about teaching from mentors
3. and colleagues, but it is interesting to see how things, such as setting exams, are done at other Universities.
4. Changing a course in a safe way. New lecturers are under pressure to stop the students complaining on staff student committees and questionnaires. Feedback is good of course, but I would be nervous about making a big

change in the teaching style of a course in case the final exam mark went down by a large amount. It is not always clear whether a new way of teaching will improve student's understanding. I felt happier changing a small section of the course.

5. How to lecture to groups with mixed ability. For first year courses it seemed common to have people who are still having problems with basic algebra as well people with A grades in further maths. Ideas like flagging some problems as harder are a possibility.

New Lecturer IX

For me, the most valuable part of my training occurred 6-12 months after I began teaching and revolved around opportunities for informal discussion with peers and more experienced staff, often after they had observed my teaching. It can be hard to grasp the issues involved until you have started to teach. For this reason, I think training at the outset should focus on departmental norms and expectations. After some experience has been gained, discussions on different approaches to learning and teaching are more meaningful, and observation of others' teaching becomes invaluable. Before starting to teach, it would have been helpful to talk through the process of organising a module - from the syllabus, to writing and marking the examination. This would have included:

1. the usual structure of lectures, classes and tutorials (how many, how long? etc.),
2. setting and marking problem sheets (how often, how many?),
3. writing exams (the role of the internal and external examiner, marking, scaling),
4. a time line of the academic year (when do exams need to be written, syllabus changes suggested? etc.).
5. The mechanics of other aspects of teaching, such as personal tutoring and project supervision, should also be included where relevant to the teaching role.

New Lecturer X

When I started lecturing in the UK I have already had an experience of teaching

from post-soviet university, and this at the beginning seemed as a certain barrier I had to overcome. In my previous experience, lecturing was oriented towards more academically able students. In the UK, lecturing is a totally different practice: one needs to earn the respect of students, to engage students interest in the subject, to encourage weaker students employ nonstandard ways of learning and comply with the strict procedures and rules. So, when I started teaching, I had inherited the course notes, which I actually did not like – too many words, not enough proofs and examples. I had to write an exam paper and to decide how many tests to give before the start of teaching. It was not possible to ask the advice of previous lecturer as she was on a leave. To make things worst, I was not getting any direct feedback from students, as the system was working in the following way: students would send complains to their tutors, and tutors would send complains to the level coordinator. I felt intimidated and had no courage to show any initiative to change the situation. I knew I could approach someone from my Department about my problems, but at that time it seemed to me that this would be considered as a weakness and I would be branded as a not that good lecturer. Over next year, I was quite lucky to find information about MSOR Induction Course for lecturers new to teaching mathematics and statistics in UK HE. It was incredible to talk to other new staff and discover that they had similar problems although working at different institutions! And what a relief was to hear one of lecturers talking about the role of own course notes, and what a disaster is to follow the course someone else wrote. During second year of teaching, I wrote my course notes, put lectures Power Point slides and feedback form on the module web page. I was really satisfied with how teaching went on. My only regret is that MSOR runs introduction course only once a year and I had no luck to attend it before my teaching responsibilities had started.

New Lecturer XI

We describe some thoughts on teaching training for young faculty in the UK system. It is worth noting that the majority of new hires in recent years come from researchers trained outside the UK, and in most cases completely unfamiliar with its system. In particular this means that in addition to teaching training an effort has to be made in topics such as

- the UK A-Level system, and the background of the students in general.
- the UK undergraduate system in general. (i.e. structure, grade system,...)
- Structure of the degree in the specific institution

- Tutorial sessions...

This topics can be covered by means of some short notes, or in an induction meeting for new faculty. Since it is common in many departments to assign a mentor or supervisor to new junior hires, these should be topics of discussion during regular meetings.

Regarding more specific teaching training, here are some thoughts (without entering into the specific structure of the training)

1. It is important that the training isn't felt as an imposition, via a heavy load of compulsory activities, that might end up having a counter productive effect.
2. It is crucial that the trainee received feedback through a peer review process, conducted by an experienced lecturer. In my experience this sessions can be extremely useful in identifying aspects of the teaching that can be improved on. Since teaching very much depends on the personality on the lecturer, it is in this review session where more specific and useful information can be provided on topics such us
 - blackboard use
 - quality and size of handwriting
 - audibility of the lecturer
 - structure of lecture / defined goals for the lectures...

New Lecturer XII

1. Personal tutoring - what are the duties of a personal tutor? What are common problems brought to personal tutors? How to handle them.
2. Writing exams - how to write them in such a way that you are, in a single exam paper, testing all of the students - the weaker, the moderate and the stronger ones - rather than just some of them. What I mean is that if the paper is too easy, you cannot distinguish between the strong and the very strong students, and if it is too hard, the weaker students all fail. Questions need to cover a range of difficulty.
3. Designing lectures - different styles that can be adopted. Advantages and disadvantages of providing written lecture notes.
4. Student expectations - it is a long time since we started at university. what do students expect these days of their lecturers?

5. Supervising students' research projects - what is the point of such projects? how to help students get the most from the experience? how to avoid or deal with problems that can arise.
6. Combining teaching and research - can your research programme benefit from your teaching? if so, how? Supervising students' research projects is probably the most likely way of making your teaching contribute to your research work.
7. Time management - if, until now, you have been doing only research, suddenly you may be faced with a larger number and wider range of tasks to perform. So, it might be useful to learn some time-management techniques.

New Lecturer XIII

I have been involved in learning community since 1994 when I joined to the Faculty of Mechanics and Mathematics at the Lomonosov Moscow State University. At the end of 2005 I moved to the School of Mathematics at the University of Birmingham. So, I have had 15-year experience in teaching mathematics on the university level. Among trainings for new staff, I found the training in the assessment system as most interesting and useful. I would like to note a few features which were new for me:

1. impact of continuous assessments into the final mark,
2. splitting questions for sub-questions,
3. dominating practical questions in theoretical modules,
4. dominating the written assessment forms.

In comparison with the Russian university assessments, the British system is more formal but it provides the equal rights. In the Russian system where the oral assessment form usually is applied the examination has a personalised form but, at the same time, it is the part of the teaching process. The written assessment forms do not allow teacher to evaluate how student understands module content as a whole. Students often can derive some formulas but they do not understand the course methodology. I think that the oral forms could be applied in advanced courses.

New Lecturer XIV

I thought carefully about your email and about my initial experience in Warwick.

Before coming to England I had some experience dealing with students as a teaching assistant in Switzerland; more importantly, I taught for seven years in the US in three different universities. The range of my teaching was rather wide and included basic math courses (calculus, probability for engineers, etc...), as well as courses for graduate students.

The organization of English universities, and the English students, are quite different from both Continental Europe and the US. I needed to adapt in many respects. I was grateful to several colleagues for many pieces of advice.

Your email is about which topics would be best taught in a training course. The truth is that I can only envision a limited role to training courses. One, maybe two hours dealing with tutoring would be useful.

Dealing with tutees is a bit peculiar, and nothing really prepared me for that. A meeting with basic information would be useful indeed (I might well have attended some, I cannot remember). It could actually help to suggest a complete organization of tutoring:

1. how to schedule the tutorials;
2. what to do then;
3. what to do when students do not show up.
4. Also, for second year students, how do deal with the second year essay.

Of course, tutors are given great latitude to organize things as they wish. But it would help to have a very concrete possible plan.

As far as teaching is concerned, I found it very useful to get informations about similar courses taught in Warwick, as well as past exams. I am also a strong advocate of teaching evaluations, that help detect and correct many problems.

I attended a few meetings and training sessions about funding opportunities, which I found extremely useful. They were run either by the university or by EPSRC.

New Lecturer XV

The MSOR Induction Course in Birmingham was my first exposure to UK Higher Education: having moved to Britain only a few weeks previously, I was still a very recent arrival when I was encouraged by my School to attend. The Course itself touched on many of the topics I expected to hear about in this context; particularly useful were the modules on presenting and assigning relevant examples in class and on marking and providing feedback to students. Both modules involved group work on actual examples and assignments as well as ample time for discussion, which greatly helped me in digesting the large amount of material presented. The

module on online assessment proved more relevant than I had expected, since my institution has since started debating the introduction of that type of assessment. I returned home from the Course not only with a slew of information, but also with the comforting realisation that my situation was not unique, in that there are scores of beginning lecturers each year facing the same challenges as me. The reality of teaching my first class here in Britain turned out to be much less clean-cut than it had appeared when parcelled out into neat modules. I struggled to keep up with the sheer amount of information that needed to be processed in the run-up to the term. Apart from dealing with the day-to-day management of my class, I had to make sure to respond to the often time-sensitive requests from the various layers of bureaucracy involved in the course organisation. That being said, I received a lot of advice and support from the more experienced colleagues in my School, who saved me from committing any serious blunders. What has struck me so far as the biggest difference to my lecturing experience in the US is that less of the decision-making is left to the lecturer, at least when it comes to first- and second-year courses. Rather, most decisions seem to be committee-based; this was most striking when it came to deciding on the final course marks. In retrospect, I have to say that I am satisfied with the outcome of my first year of teaching in UK Higher Education, and convinced that the knowledge I now have will leave me better prepared for the future classes I will be teaching here. Looking back at the training I received, though, I would have appreciated an introductory module on how the British course system typically works and in particular on how the various levels of bureaucracy are organised.

New Lecturer XVI

As a new staff member (and foreign national) I would have found the following useful:

1. Discussion of the terminology of UK academic qualifications (A levels etc).
2. Training in how to write British-style exams - specifically, guidance on how time-consuming this can be.
3. Some training in personal tutoring, and discussion of how this can complement supervisions etc.
4. Discussion of what students do, can, and should not expect, with regard to lectures, lecture notes etc.

New Lecturer XVII

I got my training as a teacher in the USA. There I attended a proper “teacher training”- course, and later even participated in teaching one. It was very helpful, and the lessons learned can be quickly summarized as follows:

1. One has to be explained that handling the ”board work” correctly is extremely important. (May be a short training in that would be useful: e.g., to give a person a simple example and ask them to work it out on the board. Teaching a person various small tricks, e.g., use of coloured chalk, etc.)
2. May be being taught how to explain thing (e.g., breaking an explanation into relatively simple steps, etc.)
3. Standing and moving in front of the class can be a bit tricky (videotaping a person and then discussing it with them can be very very helpful)
4. Speaking to the people at a ”proper volume” is a good thing :).
5. Keeping eye contact with the audience is another important key.

These probably are the basic things that should be explained to a starting teacher.

“Peer observation” was extremely helpful to me personally when I came to Warwick. That was the first time I was teaching a class of 300 students, and I was feeling rather insecure and unsure in myself.

Below we have tabulated some of the information gleaned from the seventeen pieces just presented.

<i>Item of training</i>	<i>Number of requests</i>
UK student culture: expectations, problems of passivity, lack of motivation, marksism	8
Setting and marking problem sheets and exams	8
Structure of the degree/departmental specifics/local information	7
Tutorials	6
Teaching large classes	5
Use of computer resources, electronic presentations, textbooks and printed lecture notes	5
What incoming students know: GCSE and A-level mathematics	5
Mentoring and teaching observations	5
Project supervision	2
A second MSOR-type workshop after some time in post	2
Lecturing to mixed-ability groups	1
Using your voice	2
How to modify an existing course safely	1
Interviewing prospective students	1
Combining teaching and research	1
Blackboard techniques	1
Didactics (how to explain things)	1

2.6 Some training case histories

These are the replies of seven new lecturers to our questions about the training and and induction they had received.

Lecturer A:

1. No APL
2. She is given a mentor but everyone is so friendly she feels she can go to everyone.
3. Lighter load, no admin duties
4. Assessment: No grades are given, just pass fail.
5. There are no teaching seminars. Everywhere has research seminars.

Induction of new staff into the departmental community needs to be thought about and planned.

What is the right environment to discuss teaching? Is it a formal seminar or a comon room conversation?

6. There is a (central?) learning and teaching advocate who coordinates and encourages workshops.
7. Central staff development do not train mentors. The MSOR Subject Centre should put on a session on mentoring.
8. Central staff development does not use any departmental people at all. There is no liaison between ISD and departments.
9. She supported LMS survey that central staff development is no good for maths.

Lecturer B:

1. Informal help from colleagues. Mentors are OK but informal help is crucial.
2. Was mature student, did PhD in his 30's. Valued generic training. Being older, he appreciated the need for it more.
3. Had lighter load to begin with
4. ISD does mentor training.
5. Department could have been more responsive in supporting him in his teaching.
6. Have regular teaching workshops at faculty level, on key issues: widening participation, dyslexia etc.

Lecturer C

1. Unusual: is a postdoc with teaching duties. Received no training whatsoever.
2. From abroad. Had done some teaching in home country. Was given first year course to teach. Floundered, not knowing students' background.
- 3.
4. Home students are better prepared than foreign.
5. Not obliged to take any training, as postdoc. Only training was MSOR induction, very good.

Lecturer D

1. Straight from PhD, pure maths. Had never lectured before, though has helped in tutorials. No needs analysis. Was sent to ISD as condition of his appointment. Usual stuff - workshops, dissertation, etc. We have to do a dissertation to show reflective practice, as if we didn't already think about our teaching.
2. Would happily engage with Maths Ed theory, but doesn't think there is much in maths. It is not impinging on his practice.
3. Most of Teaching Certificate was rubbish. Tutors don't believe in subject specific training, and don't believe there is anything special about teaching maths.
4. Mentors are not trained.
5. Can talk to his colleagues, but doesn't know what to ask! Only when things go wrong and problems come up.
6. Importance of keeping new staff informed. Students came to see him as their project tutor, but he hadn't been told that he would have any!
7. They are given APL at discretion of head of dept. Profs do not do the teaching courses.
8. Peer observations: no real expectation that peer observation should take place. You can avoid it, and no-one does anything.
9. Lighter load.
10. Teaching certificate useless. He is not motivated to do it, has not enquired into assessment. Regarded it as an irrelevance. It doesn't address maths teaching. Doesn't have any issue with general teaching skills, but ISD courses don't come anywhere near dealing with the specific problems he had with his maths teaching. They can't even understand them.
11. ISD places huge emphasis on new technology.
12. MSOR Induction was useful.

Needs analysis might sound rather formal, but new staff may not know what they need to know

13. At both MSOR Induction Course and other training, he hears many new ideas, but this all goes out the window when he returns to department. Example: at Oxford he did a little tutoring. Was encouraged to make students think for themselves. At Leeds he is expected to go through problems and practice them, so students can get through exam. A lot of the problems/issues he has, he has no control over. He has no power to alter the approach to learning practiced by his department. Has no scope to put into practice things he has seen elsewhere. Pressure from need for his students to pass exams prevents him from trying out new ideas.
14. In ISD, there is workshop on small group teaching, but content bears no relation to how it works in maths.
15. Department has no staff development co-ordinator.
16. Department doesn't give much formal support.
17. MSOR Induction is not taken into account in Training Certificate.
18. In generic course, all students are given the task of finding out about their respective networks.

Lecturer E

1. Small, close-knit group, so lots of support from department.
2. APL, as was lecturer at Oxford for a year, but has to do some of certificate.
3. Work for certificate is not assessed, just get certificate of completion.
4. Was told not to spend much time on certificate as it distracts from research.
5. Mentors trained. Mentor observes his teaching.
6. No teaching meetings.
7. Got through probation without completing certificate, although it was originally a condition of passing probation. Now told that if he wants to be promoted he will have to complete it!

put new staff on Teaching Committee, as observers

8. Department will provide reactive help when things go wrong, but nothing available beforehand, proactively. Can ask anyone a question, but doesn't know which questions to ask.

Can reproduce his article from Connections?

Lecturer F Paul Baxter at Leeds. Example of question he didn't ask: should I use overheads? He wrote them then found it very difficult to pace himself.

Add workshop on how and whether to use lecture notes, or write overheads, etc, to list in Section 5.

Lecturer G

1. Went back full of zeal after MSOR Induction and tried to teach Carathéodory theorem on convex sets. It was not a success. I should have known about the background of the students, their expectations. No induction course can teach that!

But induction course can teach you that you need to find it out!

Ausubel's principle: to teach students, first find out what they already know

2.7 Who should train the teachers?

So much for the current situation. In this section we argue the need for three different providers of training: academic departments, ISDs, and the MSOR network.

We believe that the principal locus of training should be in academic departments, and that it is the responsibility of departments to recognise this. Teaching is one of those activities best learned in practice. This point seems so obvious that actually justifying it requires some reflection. Every research mathematician will be aware of the danger in such a state of affairs. The obvious but hard-to-justify is often simply false. Indeed, the conjunction of apparent obviousness with difficulty of justification should be a warning sign of the presence of unquestioned assumptions of dubious validity. So, is it true that teaching is best learned in practice? To answer this question we make a comparison. If a non-mathematician is asked which is more obvious: that there are infinitely many prime numbers, or that a simple closed curve drawn in the plane divides it into two regions, the answer is quite likely to be the second. Nevertheless, as mathematicians, we are well aware that a proof of the Jordan curve theorem⁷ requires a lengthy technical foundation, and that the majority of mathematics undergraduates never even see a complete proof, whereas Euclid's proof of the infinity of the primes can be explained

⁷Camille Jordan was the first to realise that the statement even needed a proof, but his own attempt, c. 1892, was flawed, and the first correct proof was published by Oswald Veblen in 1905.

to an A-level student. The explanation for this disparity is that the evidence for the Jordan curve theorem is sensory and experiential, whereas the only access we have to prime numbers is through abstract thought. We all spend every waking hour seeing, and piecing together visual data, but devote far less to experiencing the integers. Someone who spent their childhood listing primes might of course form the conviction that the list is endless.

Teaching is something we have all experienced, at school, at university and at home, for hundreds or even thousands of hours, before we come to practise it. It is such a fundamental and essential part of every human experience that we all begin our teaching careers with a huge body of information, understanding, and prejudice about teaching. All, or almost all, of this will be present at an intuitive, un-axiomatised level, like our knowledge of the Jordan curve theorem before we become mathematicians. So what is the best way to approach beginning practitioners who already know so much? Well, certainly it is not to attempt what a mathematics degree does with the Jordan curve theorem! The purpose of training is not to arrive at a rigorous foundation for a theory of teaching; here the analogy diverges from the situation we are discussing. It is to give us the means of improving our teaching in practice. The irritation and frustration felt by many beginning academics subjected to the generic training courses can be compared, in the light of our analogy, with the disorientation felt by many beginning mathematics students exposed for the first time to epsilon-delta arguments in real analysis - an essential, though very preliminary step on the way to understanding a proof of the Jordan curve theorem.

Coupled with the richness of each of our experience of teaching is its variability. Beginning academics begin to teach with a huge range of different styles, unconscious theories, and levels of competence and insight. To attempt to address them as a group, at a theoretical level, on any aspect of teaching at all, is to run the almost certain risk of saying what is obvious to one section of our audience or incomprehensible to another.

Why is any of this an argument for learning on the job? Precisely because learning on the job (and being taught, and critiqued, on the job) allows the beginning lecturer and their trainer to discover and respond to the individual and highly variable level of knowledge, skill and achievement that each of us brings to our teaching. It is this highly individual, one-on-one instruction that is likely to bring real progress. We can have no idea what a beginning teacher needs to work on until we see him or her teach. So we see the primary location for a new lecturer to progress in as being his or her classroom, and in

the common room or the office in a debriefing and discussion after a lecture.

Two kinds of input are useful in helping a new lecturer develop.

2.7.1 Departmentally based training

The first is from someone who understand the material the lecturer is trying to get across, and can comment on its accuracy, its organisation, and its appropriateness to the audience. *Such a person must necessarily be a mathematician, and to the extent that site-specific issues are at stake, should ideally be a colleague from the new lecturer's department.* Departmental mentors should play a fundamental role in the training of new staff. Of course, this is contingent upon the mentors having the skills the department wants its new members to acquire. If this is not the case, some other approach will be needed. Such might be the situation of a new mathematics department, or a department undertaking, for the first time, to teach a new group of students. But we expect that the majority of departments will be home to most of the skills they would like their new staff to acquire, and describe in the pages that follow a number of activities that help departments to make them available to new lecturers. However, one of the principal resources that can drive a training programme is the energy and commitment of new staff themselves, who in the majority enjoy teaching and can see its value and importance. We have to create a situation in which this enthusiasm can be channelled into effective learning.

At this point we mention a theme that will recur in the rest of this book. This is the effect on the department of the introduction of a departmentally-based component to staff training. This will become clear as we discuss some of the activities in detail later on, but the key point is to open up activities that are nominally part of the training to other members of the department - “old” staff with an interest in teaching (all of them, we hope!), undergraduates, graduate students who are probably engaged in some kind of teaching or supervision of undergraduates in any case, and have a natural interest in teaching because of its likely role in their future career. The existence of training programme can help to energise departmental interest in teaching, and thus benefit a wider group than the small number of trainees it is nominally intended for.

One further argument in favour of a departmentally based component to the training programme is that far more than a central, generic programme, it can seek and respond to the needs and interests of the new staff undergoing

the training, and of the department they belong to. Being local, it can evolve in response to local needs.

2.7.2 Generic skills

A factor complicating training as a teacher is the proximity of teaching skills to other relationship skills that we very rarely receive any instruction on, that are indeed rather intimate and personal. We might be willing to receive guidance on the way we speak to strangers or discipline our children, but only if we have a great deal of respect for the person offering it. There is a significant potential role for ISDs as purveyors of these skills, though they do not come across easily through formal instruction. However, they do make up a significant segment of what are known as generic skills, and which might be developed by a central ISD rather than within departments. Among the generic skills are

- skill in engaging and empathy with students
- skill in assessing the learning needs of students and designing modules and teaching strategies to meet these needs
- skill in delivering prompt and effective feedback which takes account of personal issues
- skill in assessing the success of one's teaching

Every teacher must possess these skills. Many teachers can benefit from generic presentations of such skills in the company of lecturers from other disciplines.⁸ Precisely because they are generic and fairly easily appreciated and assimilated, and particularly if they are presented in a laboured and patronising way, staff from many disciplines (not just mathematicians) often regard them as obvious, anodyne, and having little real content. The same may be said of the axioms of a field, all of which have been known for centuries. They are all 'obvious' to most A-level students, and of course are generic in the sense that they apply to lots of different examples of fields. But this does not detract from their critical importance and utility. They make plain important similarities between disparate objects.

⁸Holton ref.

We all believe we understand the importance of effective feedback, but may have only experienced a rather narrow range of different kinds of feedback, and of the degree to which it can succeed or fail. A well-delivered generic course can open our eyes to possibilities we have not imagined. If the generic ISD provider understands the need for examples and contextualisation, and moves things along with speed, stimulating participants, whether they be mathematicians or historians, to invent and exchange their own examples then they will be doing a good job. Unfortunately, this is a very challenging role, and few succeed in it. Many instead resort to vacuous platitudes. After all, because of the way that the requirement to train new staff was rather suddenly imposed by central government and university hierarchies, many ISDs have had little opportunity to develop expertise in this role.

So there is much to be said for properly delivered and empathetic generic training, provided by a centralised ISD. But it is clear that the training cannot ignore the contextual demands of chalk-face teaching.

2.7.3 The MSOR Subject Centre

The Higher Education Academy supports a network of Subject Centres, whose aim is to provide the subject-specific content missing from generic training courses. The Mathematics, Statistics and Operations Research (MSOR) Subject Centre, based in Birmingham University Mathematics Department, with branches in the University of Glasgow and at Nottingham Trent University, runs courses and induction sessions both in Birmingham and in requesting institutions. It has a staff of ten academics and five administrators. Its brief is to provide expertise and collegial support and networking across the whole MSOR community. It acts as a bridge between the Mathematics Education community, and university mathematics staff – it has run a number of one-day conferences bringing together mathematicians and mathematics educationalists⁹. Through its induction courses and workshops, it provides specialised training, and opportunities for new lecturers to meet and discuss with their peers. Among its main activities are the carefully named *Induction Days for Lecturers New to Teaching Mathematics and Statistics in UK Higher Education*, held in mid-September each year in Birmingham. These take place over two days partly to provide an

⁹See the website [23].

opportunity for social time in the evening. Details of the 2008 event are not yet posted online, but the schedule of the 2007 event is still available at <http://www.mathstore.ac.uk/workshops/induction2007/index.html>. Some university staff training programmes count attendance at the MSOR Induction Days towards completion of their training programme, but as yet they are a small minority. This highlights one of the problems of the current situation: in the absence of departmental involvement, there is no straightforward mechanism by which the Subject Centres can deliver their resources and expertise. Relations between Subject Centres and ISDs are not always easy. ISDs see themselves as primary providers of training, and are often unwilling to relinquish the status and funding that this gives them. Instead of drawing on the resources of the Subject Centres, they sometimes see them as rivals. Since different Subject Centres offer different levels of provision with different degrees of success, including this provision into university staff training programmes, and counting it appropriately, can become an administrative headache to ISDs. This is borne out by the results of the LMS survey, and by the experience of the MSOR Subject Centre. *Here again, a departmental component to staff training can begin to resolve the problem.* A departmental staff development coordinator can become the conduit through which the resources of the Subject Centres can become available to his or her department, or, indeed, to the ISD. *We strongly urge anyone beginning, or considering beginning, a departmentally based component to staff training, to attend the MSOR Induction Days in September.* They are well run, thought-provoking, enjoyable and not excessively demanding. You will learn what other people think about the issues we are discussing here. And making a link between two of the vertices of the training triangle we have described in this section, you will begin to enable the free flow of information upon which a successful collaboration depends.

Chapter 3

Training in the department

A department wishing to run its own staff training should appoint an experienced staff member, who we will refer to as the Coordinator, to oversee it. The role will be described in what follows.

The Coordinator should have a strong commitment to teaching and a good knowledge of the department's teaching activities. Anyone taking on this role should be prepared to fulfil it for several years; once the programme is in place, the task becomes a lot easier, but continuity is an important requirement. It is a demanding role: over the first two years it probably needs as much time as being (departmental) Senior Tutor or Director of Undergraduate Studies. On the other hand, besides the contribution it can make to teaching, a departmental training programme should save new staff many hours unprofitably spent on generic activities.

The resources a department can devote to training their new staff depends on the annual turnover of staff. If one has a regular turnover of a few staff a year, then it will be worth setting up a durable infrastructure to deal with their training needs. If there is just one new appointment every few years then the role of overseeing the necessary training might be adequately filled by the mentor(s) for that appointee, although there should still be some durable framework that ensures any lessons learned and experience gained are passed on for future years. In fact, with the increasing importance of teaching it will probably now be sensible for any reasonably sized department to have a staff development coordinator concerned with teaching and learning for all staff.

The training infrastructure within the department and those engaged in providing it, should be adequately recognised and resourced. The Coordina-

tor will certainly need secretarial support.

As we have said, one of the first things the Coordinator should do is to attend the MSOR Induction Course held in Birmingham in mid-September. Apart from its immediate benefits, described above, it will help to demonstrate a serious commitment to staff training in the eyes of the ISD and the university hierarchy. Since deciding to take control of staff training is potentially contentious, as we describe in the next section, this can be politically valuable.

3.1 Relations with the university's ISD

It is likely that the Coordinator's first task will be to negotiate with the ISD or other university authorities for the introduction of a departmentally-based component to the training scheme. The initiation of a training programme like the one described here may be seen (with some justification) as an implicit criticism of the training the ISD is delivering, and this can easily lead to suspicion and ill-feeling. Negotiating this source of conflict may require strong resolve and the active support of the Head of Department. It is important to make clear that the aim is to provide better and more appropriate training, and not to enable new staff to avoid training. Academics are often perceived as arrogant and uninterested in teaching, especially by CPD professionals, again with some justification. Pleasurable though open conflict may be, it is in the end necessary to satisfy the ISD that your training programme will deliver, partly because it is almost certain that it is through them that the qualification you offer will be accredited. Ultimately all university Teaching Certificates have to be accredited by the Higher Education Academy, and it is preferable to have a central university body such as the ISD mediate between departments and the HEA than for each individual department to negotiate directly with the HEA - unless, that is, the ISD is so inflexible that it resists all attempts to bring in some component of departmental provision.

To convince the ISD to allow a departmental component in the training, the Coordinator will have to present a clear programme for that component. At the simplest level, the department could propose to replace some of the generic workshops with its own. If the aims and structure of each of these are coherently and clearly set out, the ISD should have no reason to object to their incorporation into the training programme. Representatives from

the ISD can be invited along to witness or participate in the departmental workshops. Since there is a great deal that can be usefully conveyed to mathematicians through such workshops - that is, they run little risk of being devoid of content - the ISD's representative should be impressed and won over. In Section 5 below, we list some of the workshops we have run at Warwick, with comments on their successes and failures. A mathematics department with patience and resolve may be able to develop such a programme incrementally.

Here, as elsewhere in the book, let us voice, and briefly answer, an unspoken question which nags at the edge of our thinking: why should mathematicians spend our time running events previously run by the people in the ISD paid to do it? The answer is twofold: because we can run worthwhile events which benefit our new staff in ways that generic events do not, and because the benefits are not limited to the new staff, but may extend to a significant part of the department's teaching. We cannot convince the reader of this in the abstract. Instead, we hope that it will become plain in our discussion in Section 5 of the workshops themselves.

If the department wants to take on a larger role, as principal provider of the training, as was done at Warwick, then it has correspondingly to make much more detailed plans. At Warwick, where the generic programme was quite seriously resented by new staff, the decision was taken to plan the complete programme in some detail, and Trevor Hawkes, a senior member of the Mathematics Institute, was seconded for a year to the ISD, with the preparation of a suitable departmentally based programme among his responsibilities. It is worth mentioning that in the midst of a heated polemic inside the department about the inadequacies of staff training, in which the department's leaders insisted that we had no choice but to accept the generic training, we expected resistance from the ISD to our proposal to run the training ourselves, and were then amazed by the openness of the ISD to the idea.

The Coordinator must take into account the other training inputs from outside the department, and weave these in with the department's training. It is important to find out what the ISD is able to offer. In general, it seems that workshops with generic titles like "Teaching Large Classes" or "Running Seminars", intended for new staff from all departments of the university, are of little or no value to mathematicians (we do not speculate on their usefulness to others). But the ISD may be home to valuable expertise in areas of professional development such as running teaching observations,

training mentors, use of the voice, and counselling skills for tutors, and this expertise should be harnessed wherever possible.

The Coordinator should be sufficiently familiar both with the ISD's resources and expertise, and with each new lecturer's training needs, to be able to advise new lecturers on which of the ISD's activities they should participate in.

The Coordinator has to maintain a delicate balance between the ISD and staff in his or her department. If it is the ISD which accredits the training programme, they have to be satisfied that it meets their demands. Many academic staff find some of these demands excessive, and feel angry and hostile towards the ISD's generic programme. The Coordinator has to convince staff that the departmental programme will save time currently spent on useless generic training, and that the time they are asked to contribute as module mentors (see Subsection 4.3 below) will be well spent. Their goodwill and cooperation are essential. Provided the departmentally-based programme is clearly understood to be different from the generic programme, the hostility staff feel towards the latter can become goodwill towards the former. However since the requirement for transparency (Principle 2 in the introduction to Section 4 below) sometimes clashes with embeddedness (Principal 1), this goodwill can be tested. The Coordinator needs to have a light touch and a willing preference for the possible over the ideal in order to avoid losing staff goodwill or the acquiescence of the ISD. It is probably worthwhile to go to some effort to arrange workload reduction for staff who act as module mentors. This should not be too hard in departments which operate a workload equalisation scheme. In a department which does not, even something as trivial as exam marking credits can provide at least a nominal compensation for time spent mentoring.

3.2 Learning Outcomes

What do we want of our training? At a minimum, we want the new lecturer to meet the demands that the university and the department place on their existing lecturers. For this to be possible, it is a good idea to make these demands explicit. This might seem like a Herculean enterprise - both the defeat of the Hydra and the cleaning of the Augean stables come to mind. In fact, we believe it is possible to write down a list of requirements that is reasonably complete without being unreasonably long. Two such lists, one

produced by MSOR for its Associate Module MSS013 in 2007-8, and one produced by the Warwick Mathematics Department, are included here as Appendices. Most of what they contain is fairly obviously desirable. In case you, the reader, feel that the lists contain too many obvious points, we offer the following

Local falsifiability criterion: An item deserves its place in the list if you have ever come across a lecturer, in your university or somewhere comparable, who did not achieve what it describes.

We have applied this criterion to our lists! It is, of course, a quite different matter whether giving a lecturer the list would have brought about the necessary improvement. Nevertheless, a list of this kind can be useful. It can guide lecturers in what is expected of them. It can provide a checklist for observations, potentially the most effective part of the any training, reminding the observer what to look out for. And it can provide a written statement underpinning departmental insistence where a lecturer does not teach to a satisfactory standard. This may be invaluable in case of a dispute. The first and third of these reasons make it plain that the Head of Department should endorse the list as a description of what the department expects.

However, lists of desirable attributes do not make a coherent set of learning outcomes. It is necessary to find principals which inspire the lists, and can then inspire training activities which will encourage trainees to take them on. Ideally a much shorter list is called for: there should be fewer axioms than theorems.

Niall Mackay (University of York) has suggested the following list.

1. **Teaching:** Lecturers should
 - (a) construct detailed teaching materials, appropriate to the level and ability of the full range of students, from a course syllabus or outline;
 - (b) deliver such material effectively and persuasively to large and small groups;
 - (c) design exercises and deliver small-group teaching which enable students to master the material through self-study;

- (d) design and implement effective forms of assessment, both formative and summative;
- (e) reflect on, critically evaluate and thereby improve their work under (a)-(d).

2. **Administration:** Staff should

- (a) act professionally in a pastoral and academic supervisory role to students from a wide range of backgrounds and levels;
- (b) work collegially and competently in performing teaching support, administrative and organizational tasks

3. **Research:** Staff should

- (a) develop their research programme and its current and projected outputs;
- (b) utilize funding, collaborative and presentation opportunities to enhance their research programme.

3.3 The Needs Analysis - Designing an Individual Training

Many programmes now begin with a Needs Analysis. The new staff member fills in a form describing the areas in which he or she wishes to develop. On the basis of this response, with the Coordinator they plan a sequence of training activities. ISDs catering to all new staff in a university will typically run a large number of generic workshops, on topics like Teaching Large Classes, Curriculum Design, Varieties of Assessment, Using your Voice, The new staff member selects and books a place at the workshops they want to attend.

Needs will of course vary, depending on the type of teaching to be carried out as well as the individual being trained. In a department with a strong tradition of teaching and plentiful teaching materials, one of the main requirements on a beginning lecturer may be to familiarise him- or herself with the material relevant to their first modules they will teach. A new department, or one undertaking new teaching, may instead need its new staff member to study the programmes of other institutions.

3.3. *THE NEEDS ANALYSIS - DESIGNING AN INDIVIDUAL TRAINING*47

Anecdotal evidence suggests that the Needs Analysis should be managed with tact and care. New staff may be surprised to be met with such a requirement, especially if coming from abroad. They will not necessarily view it with respect. In almost all UK Mathematics Departments, the overriding pressure on new staff is to develop their research. As a result, they may devote only cursory and sceptical attention to the Needs Analysis.

The situation can be improved by early action of the Coordinator. If the new staff member can be made to feel part of a teaching community whose values and aims are successfully projected as worthy of respect, then he or she will be less inclined to see the Needs Analysis as merely a bureaucratic requirement. The attitude of the Head of Department is also crucial here, as it is throughout the new staff member's initiation to teaching.

We should also remember that the lecturer often has 'hidden' needs, in the sense that they don't always know what are the right questions to ask. They only become aware of these when a problem arises in the classroom. One of the jobs of the department should be to anticipate these, as far as possible, from its superior experience. This is one reason why some kind of induction session is needed before the lecturer is exposed to the perils of the classroom, and why it may be a good idea for the new lecturer to do some teaching before carrying out the Needs Analysis.

A departmentally based programme is clearly not able to offer participants a choice of workshops. Instead it should run a small selection of events which all participants should attend. Part of the strength of a departmentally based training is its ability to foster a teaching community and encourage discussion of, and interest in teaching, and this is only possible if participants attend the same events. Restricting the range of events participants can attend a price well worth paying for the increased usefulness of subject-specific training.

Some space should be left for participants to attend events run by the ISD, both for political reasons and because specific generic events may be exactly what is needed - we are thinking of workshops on using your voice, for example.

Examples of Needs Analysis Forms

3.4 Keeping to a schedule

New staff often have to complete the training in order to complete their probation. Thus they have a strong incentive to complete. On the other hand, they are also busy meeting new challenges, and preoccupied with getting their research going in a new environment. So they have a strong incentive to procrastinate. It is possible for the Coordinator to feel responsible for shepherding them through the training, and then to lose a lot of sleep worrying about it. To avoid unnecessary stress, we strongly recommend that the Coordinator should make the requirements and schedule of the programme as public and accessible as possible, by running a website where all the details are clearly displayed. He or she should then arrange for the necessary reminders and enquiries about progress, to be circulated by clerical staff. They are better at this kind of thing than academics! It is important for the Coordinator to put such a system in place. Once this is done, new staff should be told that it is their responsibility to complete the training, and not the Coordinator's job to chase them.

3.5 Assessment

Assessment is a thorny topic. We have to think about its overall form early on, in order to suggest elements of assessment as we describe the training in the following sections. At the moment, the suggestion that new lecturers should sit exams to assess the effectiveness of any training they participate in would be met with ridicule from most academics. But there is no doubt that some form of assessment of a programme of training and education is essential. Imagine teaching a mathematics module without assessing it in some way - how does one judge whether the students have learnt anything? We all know that non-assessed coursework is as good as wasted on most students, since they don't do it!

And how confident would one be to get on a plane, knowing that the pilot had been on training courses that were not assessed? This is precisely what, until recently, most universities expected their students to do. If the lecturer needed to learn about setting exams, they might go on a staff development course for an afternoon, doze through the talks, participate resignedly in the activities on offer, and comment soothingly on the feedback form. They then might return to the office without providing any input at all, or giving

any evidence that they had actually learnt something from the experience. With the advent of teaching certificates in HE this is no longer considered adequate. So what kind of assessment is necessary, and what is possible?

The White Paper and the Professional Standards Framework leave institutions free to decide how to assess the results of training. As educators, we are presumably experts at least in certain forms of assessment, though not necessarily of the kind of qualities we are looking for in lecturers. But decisions about assessment cannot be isolated from the issues of recruitment, legitimacy and collegiality.

Recruitment is currently (2007) in crisis:

“If university managers are to deliver the high quality we expect from higher education, it is essential that institutions are able to recruit and then retain staff of the highest calibre. The recent annual HEFCE survey provided evidence of a worrying rise in unfilled vacancies across the university workforce. Among academics, particular recruitment difficulties were reported in a range of subjects (IT/computing, business-related subjects, professions allied to medicine, science, and engineering) where higher salaries were on offer elsewhere. At the same time, as reported in the recent Roberts review, there are anecdotal reports of a decline in the quality of new applicants for academic jobs.”¹

Young academics have to spend several years in fixed term positions, as postdocs or temporary lecturers, between completing a PhD and achieving a stable permanent position. A permanent position is by no means assured, and only the most successful are free from the anxiety that at the end of five or six years of temporary positions they might simply find themselves out of a job. Academic salaries have lagged significantly behind the salaries of others with comparable or even shorter training and less stringent entry requirements - doctors, chartered accountants, lawyers. British universities are, increasingly, relying on foreign academics to staff them.² We believe that to add another significant and uncertain hurdle to the path to stable employment would exacerbate the already severe shortage of new entrants to the profession.

Assessment regimes that carry a serious threat of termination of employment cannot be implemented in academic staff training without giving rise

¹[4, Paragraph 4.20]

²Statistics and comments on the crisis of recruitment can be found, for example, in [25], published in April 2002, especially in Chapters 5 and 6.

to serious bad feeling, whether this training is carried out by a central staff training body, or within individual departments. ISDs and Staff Training Centres are rarely respected by the staff they train, and therefore do not have the legitimacy to decide that a member of staff is not fit for employment. In the case of departmentally based training programmes, such threats would impose intolerable strain on collegiate relationships.

Finally, a training scheme that sets out to earn the consent of staff cannot begin by imposing punitive sanctions if its standards are not met. Perhaps one day we might have the knowledge and legitimacy to set our new colleagues precise and measurable challenges which they must meet or else lose their job - but not yet. Because of these circumstances we believe that the assessment of staff training in teaching should be a modest hurdle. It should be designed to maximise learning and engagement, but it should not be a filter or a block to professional advancement. It should oblige staff to take their teaching seriously, and to think seriously about how to develop as teachers, but it should not function as a means of correcting ill-advised hiring decisions. If universities care about teaching, they should make sure that they examine the attitude and aptitude of applicants at the time of hiring. Job candidates can be asked to deliver a sample undergraduate lecture, or otherwise demonstrate teaching ability. A simple statement of commitment to teaching during the interview is not really enough! Although research-intensive departments may inevitably focus on the job applicant's research abilities, a sample teaching lecture also allows an applicant to display brilliance and originality.

It should be possible for every new staff member to successfully complete the training by investing reasonable effort. Though once again, let us flag up the fact, to which we do not offer a response (beyond the effort we have put into writing this book), that roughly half of our job is teaching, but the means by which our suitability and performance is measured are vastly greater in research than in teaching.

Most universities to some extent sidestep these questions by making completing the training a necessary condition for passing probation. This postpones until the end of the probationary period the effect of a failing grade in a training programme. The decision on termination of employment is in the hands of a probationary review body rather than the staff trainers themselves. Nevertheless, we believe that the effects of a punitive assessment regime would be damaging.

However, any training programme must demand something of its participants. They must question their assumptions; they must examine their

make comparisons with other professions which recruit and then train: accountancy, medicine, armed forces

own teaching critically and objectively; they must read about teaching and learning; they must attend talks and workshops. *There must be some way of checking that they have met these demands.* If there is none, then however well-intentioned the lecturer, the demands of other activities where evidence of success is required - in other words, everything else that the lecturer has to do in his or her job - will lead inevitably to neglect of the training. The trainee who is not asked to do anything is in a similar position to the lecturer attending another colleague's lectures out of a desire to learn the subject. Unless we submit to the discipline imposed on the students, going through our notes and doing the exercises each week, we become increasingly detached, and quite quickly lose our grip on the material.

We believe that assessment should be carried out by means of a portfolio which the new lecturer accumulates over the year or two years that he follows the training programme. In each of the relevant sections which follow, we suggest portfolio items designed to ensure that the new lecturer has taken this part of the training seriously and participated effectively.

Who does the marking? Allocating marking duties implies of course another resource demand, and this needs to be recognised. The task could be anything from marking a 2000 word essay to something closer in size to a PhD thesis, and such comparisons can be used to determine what would be an appropriate time allocation for such marking. In any programme, whether departmentally based or wholly generic, there should be two markers, one from the central ISD and one from the department. Of course the first requirement for markers is that they should be qualified to do the job! This alone may restrict the possible candidates. As with allocating mentors, one has to strike a balance between overloading particular individuals and ensuring that only committed, conscientious markers are recruited. It would be preferable to have one good, dedicated person marking two project reports than to have one marked by an inadequate marker. But then of course the extra load on the person recruited must be recognised (which, sadly, does not always happen).

Chapter 4

Observing and mentoring teaching

Every lecturer has been a student, and even beginning lecturers have a wealth of experience of watching other lecturers at work. As enthusiastic and committed students, almost all will have formed clear views about teaching. Most new lecturers are good at their job. In fact they may have some advantages over older staff: they are more often passionate about their subjects, and able to transmit their enthusiasm; and they are closer in age and experience to their students. The aim of staff training must not be to deny this experience and these advantages and start afresh.

However, high academic achievement, youthful enthusiasm and good intentions do not necessarily imply good teaching.

In fact new staff come in many shapes and sizes, and, increasingly, with different levels of involvement in teaching and different backgrounds. A crucial requirement of staff training is therefore flexibility and responsiveness to the needs and abilities of new staff. It must provide support and advice to new lecturers where they have difficulties, without forcing this support and advice on those who don't need it. And it must enable new staff to develop their skills and to integrate them into the activities of the institutions where they work.

4.1 Principles of training

Let us frame a principle that we believe to be essential in the in-service training of new staff: it should be

- *Student-centred: it should contribute as directly as possible to enhancing the departmental provision for students.*

Most departments have enough real problems associated with teaching and learning. There is no reason to waste the intellect and effort of a new member of staff on artificial exercises for their (possible) benefit only. If they write a reflective essay, then ensure that this reflection serves the purposes of teaching. If they do a project, then make it one related to specific teaching issues in the department. If they have to assemble resources, make sure they will be available to the department. This principle is not simply making a virtue out of a necessity (though this is no bad thing). If the training is divorced from the realities of teaching, it will be viewed with disdain by new and old staff alike. If it can be seen to contribute to departmental practice, then teaching and training will enrich one another.

We add this principle to the three proposed by Trevor Hawkes¹ in the design of a departmentally-based training programme in Mathematics: training should be

- *Embedded: as far as possible the activities should be closely linked to the normal run of activities undertaken by a beginning lecturer.*
- *Transparent: the process of training and the evaluation of participants' progress should be clearly visible to the university's ISD, or, for example, to the HEA.*
- *Self-sustaining: once in place, the programme must run itself, with a robust administrative system that is not a heavy burden to any academic in the department.*

4.2 How long is the training?

In most HE institutions, the completion of training is marked by the award of an institutional Postgraduate Teaching Certificate, or membership of the

¹MWTC Documentation

Higher Education Academy. The term ‘Postgraduate Certificate’ has a precise meaning in UK higher education: it consists of 60 CATS at Master’s level, with each CAT itself having an expected time commitment of 10 hours. New staff are therefore officially expected to spend 600 hours on their training. Taken literally, this seems rather daunting: twenty hours per week over a thirty-week academic year, if it is to be completed in one year. Even half of that seems like an extraordinary commitment from staff who are already expected to teach and carry out administrative duties, and whose overriding concern may very well be their research. The total only becomes reasonable if a significant contribution is made by the time spent teaching and preparing to teach. These activities are the focus of in-service training, and must be recognised as an integral part of it. Here is a suggested time budget for the training.

Activity	Hours
Preparing lectures	100
Delivering lectures and tutorials	80
Discussions with mentors	20
Preparing exams	40
Marking	40
Attending and reflecting on workshops	60
Essays (including preparatory reading)	80
Project	80
Research supervision	25
Other	75
Total	600

“Other” might include research-related training, e.g. in writing grant proposals and managing grants, or in administration. Some universities now include such components in their centrally delivered staff training programme, and any departmentally based programme should reflect that. But we say nothing more on this topic.

4.3 Beginning teaching: the first teaching duties

Each new lecturer should build their training around two modules². These may be the first they teach, if they want to complete their training as quickly as possible. If there is less pressure to complete, and the new lecturer's teaching skills is not obviously deficient, it may be a good idea for them to do some teaching before beginning the training. In this case the Coordinator should arrange a preliminary teaching observation, which need not be included in the final portfolio produced for the assessment of the training. New lecturers are often - even usually - competent teachers. And they often have other preoccupations when beginning a new post, principally with regard to their research. Burdening them with training as well as teaching may create an unwelcome imbalance. On the other hand, many probationary staff are anxious to complete probation as soon as possible, and will undertake anything which will bring this about. And some departments may require new staff to begin their training at once. However, where possible, if they can be gently persuaded to hold back on the training for a term, this may be their advantage.

Here are our views on the choice of the two modules on which the training is focused.

One of them, usually the first, should be an optional module, at a high level, close to the lecturer's research interests, and taught in the third or fourth year of the undergraduate programme, or in the MSc. It may be a new module of the lecturer's own design, or it may be an existing module in which, nevertheless, the link with the lecturer's research area is clear, and in which the lecturer has the opportunity to modify the syllabus in line with his or her interests. The audience will be small, able, and highly motivated, and therefore less at risk from problems due to the lecturer's inexperience. The lecturer should in any case minimise this risk by putting together a reasonably complete reading list, so that if the teaching is unsuccessful, students can study independently outside class.

The second module should be larger and at a lower level, perhaps one which all students have to take. It should be a pre-existing module with some departmental tradition and experience, which the new lecturer will have to

²How long is a module? We mean a term's worth of teaching in one subject - perhaps 30 lectures or their equivalent in classes or lab sessions

come to grips with in the process of teaching it. This is not to say that he or she should not take a critical attitude towards it, but should do so at the same time as making efforts to understand its place in the undergraduate curriculum, and the rationale for its current form.

These two modules will be the focus of the new lecturer's departmental training. For each, they and the Coordinator should choose a *module mentor*. This should be someone with relevant subject knowledge, who has previously taught the same or a related module. Ideally it should not be the lecturer's departmental mentor³, as this might create conflicts of interest. The module mentor will meet with the new lecturer at various stages:

1. before the module begins, to discuss the syllabus and objectives, and to help the new lecturer gain an idea of what the students will know when they start;
2. during the module, when the mentor will formally observe the new lecturer's teaching in action, making a written record of the observation. This is discussed in more detail below. The record should be made on an appropriate form which guides both the lecturer and the observer in what is required - an example is included in Appendix B. These records of teaching observations should form part of the new lecturer's portfolio. One observation per lecture-course may be enough, but the mentor or lecturer may decide that more observations are needed.
3. when the new lecturer sets the module exam - the module mentor should check it for accuracy and appropriateness, and help the new lecturer improve it where necessary.
4. after the exam has been marked, when the new lecturer will be most aware of the successes and failures of his or her teaching, to discuss and review the module.

This arrangement should be flexible and responsive. Most new lecturers are talented and enthusiastic teachers, and there is no point prescribing the length of their meetings with their module mentor, provided the mentor is alert to any possible problems. Where there are difficulties, on the other

³Many departments appoint a mentor for each new member of staff, independently of any training, with the brief of looking out for their well-being in all aspects of their professional activity.

hand, the module mentor should be prepared to play an active role, advising the new lecturer and visiting their lectures more than once. The primary responsibility of all university departments is to their students, and in fact a flexible arrangement like this, which is able to concentrate help and support where it is needed, is of more benefit to students than an arrangement which obliges all new lecturers to sit through the same training sessions, irrespective of their skills and talents.

4.4 The role of the mentor

The mentor's job is important and can be difficult and time-consuming. We appreciate that it can be hard to persuade staff to take it on. If it is seen as merely another bureaucratic requirement with no real value, then it will not be willingly undertaken. Here it is important for the coordinator to stress the flexibility of the commitment. It will only be demanding if it is valuable. For a well-delivered lecture-course, a single visit will be enough. Only if the lecturer has real problems will the mentor's role become more than a formality. Our experience at Warwick is that at this point the mentor can make a crucial contribution, and one which any department which takes seriously its responsibility to students should be prepared to make. The presence of an experienced mentor, advising an inexperienced lecturer, can save a module from disaster. In the hopefully rare cases where the mentor has to make a significant contribution, the department should find ways of recognising this subsequently, perhaps by reducing the mentor's administrative load in other areas.

At the moment, no-one undergoes training for the specific role of discipline-based mentoring. No-one is yet an 'expert'. This is always the case when a completely new professional activity emerges - we pull ourselves up by our bootstraps, and it doesn't take long. We can learn from our neighbours in this area. The university's ISD would be a good place to start.

And as well as the technical aspects of training, the ethos of the department has to be right. Does the department have a teaching culture it is proud of and wants to impart? Is there a self-critical pride in teaching and its development? If so, then it is more likely that the staff members are themselves competent, and capable of setting good examples to new staff and helping them to develop. Mentors will have skills to impart and can advise new members. Again, as well as technical aspects of training, men-

tors should have good interpersonal skills and concern for students, and the department will value people with these skills as leaders in training. The Coordinator and the module mentors can take available courses, if only as observers, in order to gain entry to the culture and community of trainers. The annual MSOR Induction Sessions in Birmingham are worth attending for this reason.

As part of his or her preparation for the role, a module mentor should be given a clear statement of the qualities of teaching they should be looking out for and encouraging. Subsection 3.2 below, on Learning Outcomes, returns to this theme.

4.5 Some experiences of mentoring

A.

1. An observee can get very defensive when her teaching is criticised. This could be a sign that she cares a lot about her teaching and is upset that her best effort is falling short of the mentor's standard. In that case, the mentor should take advantage of this positive point and reassure the observee that the comments are meant to help the observee achieve her goals.
2. New lecturers tend to overestimate the level of commitment to the subject by the student. As academics, we are passionate about our subject and we tend to think that students are equally committed and able. The slickest proof of a theorem may not be the most instructive one for the average student in a class.
3. Each observation session occupies about two and a half hours, including a 10-15 minute meeting prior to the observation, follow-up discussion and writing up the report. Mentoring a colleague for one term takes 8-10 hours.

I think I was effective with X (he may not have benefited much himself - he did not get a permanent job - but I think his students benefited from his improved exposition), less so with Y. Z has said that he found my comments on his teaching useful.

You could cut down on the time (as much as 45 minutes per observation) by not insisting on written reports which is the part I hate most and the part that is LEAST effective, because the issues would have

already been discussed with the observee. Of course, documentation is necessary for follow-up observations but perhaps this ought to be reserved for the truly problematic cases.

I think teaching is important and therefore, spending time on mentoring is time well spent, when it's effective. It's not really worth mentoring the likes of Y who we're going to hire anyway because of his splendid research and who is a competent teacher but with no real desire to give students not fully committed to mathematics as positive an experience as possible. He is a brilliant teacher for budding mathematicians.

Other comments

We have a culture in which research is valued more than teaching; good teaching equals poor research. So why improve one's teaching?! Most mathematicians want to be good teachers but can be misguided about what good teaching is.

In peer observation of senior colleagues, the observer lacks authority.

We need a short presentation to staff about

- (i) why it is in our interests to be good teachers!
- (ii) the observer's role in peer observations.

B.

I start from the assumption that teaching is a major part of our professional lives and is something that we should approach with pride. At the same time I also recognize that most academics in our Department are research-driven and that any procedure designed to improve teaching standards must recognize this fact, if it is to be successful. It should be clearly useful to mathematicians, and not burdensome in time.

The new in-house system, developed in Mathematics, has gone a long way to incorporate recognition of the above viewpoint. I believe that observing others lecture, and having others observe and comment on one's own lectures (and lecture preparations), is very valuable.

I spent two–three hours on the observation and discussion of a lecture (preparation, lecture, debriefing). It is probably pointless to watch someone twice unless there is a serious problem whose resolution (or otherwise) one can try and observe.

C.

Some questions to get you started: how many observations of ____ 's lectures did you make? How long did they take?

I went to three or four lectures of his course on ____, talking to him before and after, but fairly briefly.

How effective was the mentoring? Did you feel it was time well spent?

I did get the impression of some improvement. It was essential !

What other options for improving ____ 's teaching do you think could have worked?

The Capital Centre have occasional training sessions on acting techniques applied to lecturing etc. that could well have helped – or indeed individual coaching by one of them. I think a period of guidance on voice production, standing up straight, looking the audience in their eyes, was needed and the Capital Centre have that expertise – we do not. Perhaps some form of sanction if he turned up late to a lecture might have had some impact!

Could some training or guidance on the mentor's role have been helpful - any suggestions?

D.

I once mentored a Postdoc taking on his first class - a hundred first year engineers. In preparation he was sent on a weeks course for new lecturers at Oxford Brookes Staff Development Centre, and I assumed he would therefore be well prepared for his first class. Within minutes of the end of the first class students were knocking on their Senior Tutor's door complaining about this new lecturer. When I asked him what had gone wrong, what did he learn at the week away we had paid for, he said that that had been all about the 'theory' of teaching, not about what to do in the classroom. He was a very conscientious guy and had tried his best and thought he had done a good job and was devastated at the students' response. I sat in on his next lecture, and had to agree with the students that it was appalling, but it was not for want of trying on the lad's part. He was very earnest and enthusiastic, and had prepared good notes for the board. But he made every classic mistake in the book. He either faced the board or buried himself in his notes. He stood in front of the board so students couldn't see

it. He went much too fast, and spoke in a monotone, if shrill, voice. He never once engaged the students and focused entirely on writing down pristine notes on the board, which the students couldn't read. Straight afterwards I pointed out all these common errors. He was very keen, learnt quickly, and the next lecture he was vastly improved. We went through a few more things, which he took on board and by the next lecture I was quite confident to leave him to it. In fact, he soon turned into an excellent lecturer and within a year was one of our most popular lecturers. Here was a case where the lecturer was very keen and willing, had prepared his content well, but was let down by lack of basic classroom skills, which a few teaching observations were able to put right. By the way, none of this was formally recorded on peer observation forms and such like. It was simply an old hand helping out a new apprentice. But the point is that for a couple of weeks the students suffered. This could have been largely avoided by a simple mock lecture before the start of the course.

E.

An foreign lecturer with five years previous experience in her own country took up a lecturing post with, for her, an unusual amount of teaching. She openly admitted she didn't like teaching and only wanted to do research, but she made the best of it and attended the MSOR Subject Centre Induction Course and then the Institutional Staff Development Teaching Certificate. She soon dropped out of the latter however, fed up with the discursive, theoretical approach which seemed totally irrelevant to the classes she was teaching. In order to fulfil the contractual requirements for some sort of training she opted to join the HEA by the individual route. I was able to help her to complete the application, advising her how to present her case. She was successful and became a member of the HEA, thereby fulfilling the university's requirements of her in terms of teaching. However, at no time had anyone observed her teaching (it being assumed her previous experience in here home country covered this), and it was only later through informal student complaints that it became clear that there were a lot of problems with her classroom teaching, mainly arising from her non-native language and lack of knowledge of the UK system. Also, she had somewhat unusual assessment methods in her coursework. In fact, after the event, it took quite a lot of work to improve her teaching to an acceptable level. The point here of course is that she had still been able to avoid the ISD teaching certificate, and

become a member of the HEA, while still teaching below a satisfactory level.

F.

New (UK)lecturer of some experience in teaching who did his ISD's Teaching Certificate. As part of the requirement for a reflective essay he submitted one of his MSOR Subject Centre articles on teaching. This was rejected because it didn't show sufficient reflection on his teaching. This happened twice. Each time he was able to reverse the decision - how was it possible to write an article on teaching without reflecting on it? The point here is that he had to waste time arguing with what was clearly inflexibility and lack of understanding on the part of the ISD. He was lucky in that he was supported by a very senior member of the university, the outcome might have been different otherwise.

G.

A foreign lecturer doing the ISD's Teaching Certificate had a number of uncomfortable experiences with his ISD tutor. His first teaching observation was his very first lecture on (for him) a completely new course, give to him at short notice because someone had left. He had little idea about the background of the students, or how they would take to the course, so he didn't prepare any material for the first lecture, deciding to use it to get to know the students and their backgrounds and to gently introduce them to the topic, with a general overview. His ISD observer told him this was unprofessional, not to prepare learning materials before the lecture. He would let it pass this first time but expected something for the next time he observed. This lecturer was a 'traditional' chalk and talk mathematics lecturer who was so on top of his subject that, as I later found out, he could write down stuff on the board off the cuff and ad lib as necessary, and did so while engaging and interacting with the students. This did not result in neat line by line board work. When he was next observed the ISD observer again accused him of lack of professionalism because he wasn't using Powerpoint. Again he defended himself strongly, and it was becoming clear that this did not go down well with the ISD Tutor, so next time he asked me to observe him, which I did for a joint lecture tutorial session of two hours. This proved very interesting. There was a lot to criticize in the detail, at first sight. His board work was not well

organised and at first I was not impressed. But as the class progressed it became clear that the students had no trouble understanding him, and they regularly asked good pertinent questions, and there was a very relaxed empathetic atmosphere. When he threw out a question to the class he did so in an unchallenging and almost playful way and invariably attracted a number of intelligent responses. It took me most of the two hours, but eventually I was convinced that this guy was an excellent, natural Maths teacher, who despite appearances thought deeply about his teaching (as I later found in the debrief afterwards, and in subsequent exams), had high standards and made the learning enjoyable. But I could not fully understand how it would have been impossible for a non-mathematician to appreciate this. All the ISD tutor would have seen would have been the apparent lack of organisation, the somewhat cavalier and light-hearted and relaxed approach. And when I came to fill in the teaching observation form afterwards I found it really didn't fit the situation.

Later, perhaps because of his previous run-ins with the ISD tutor the lecturer's portfolio was rejected. His essays were not reflective enough, he did not underpin his rationale with evidence, etc. On paper I had to agree with some of this, **but** my problem was that this guy was a very good maths teacher! There is a danger that if we over-formalize and vocationalize our teaching, seeking to label every skill and weigh them critically in a scientific or accountancy way then we may lose sight of what teaching really is. One thing is sure, here is a case where the generic, non-mathematician observer, is incapable of seeing the wood for the trees, and cannot make judgements on the teaching.

Portfolio contribution from module materials All documentation connected with each of the first two courses: course descriptions and synopses, aims and objectives, lecture notes, course exercises and solutions if provided, student evaluations, marked homework where possible, and final exam with solutions.

4.6 Teaching observations

Teaching observations are among the few activities of generic training programmes that are regarded as worthwhile and helpful by all, or almost all, participants. They are also crucial in ensuring that new lecturers are competent to teach. Demonstrating a reasonable level of competence in teaching

must be a necessary condition for completing the training.

We distinguish four types of observation:

1. Each of the new lecturer's first two lecture courses should be observed at least once by the module mentor. Once may be enough, if all seems to be going well, but the mentor may wish to visit again if he or she has suggested changes and wants to check on their implementation.
2. If the training is accredited via a generic training programme run centrally, then lectures should also be observed by someone appointed by the university's central training agency, as part of the necessary verification of teaching competence. In fact such observations are often extremely helpful - whereas central training agencies may be hard put to produce workshops of value to audiences from widely differing subjects, their members often do have real skills in discussing concrete practice in a one-to-one relation.
3. Participants in a training programme can observe one another. The change of roles may be helpful to the new lecturer.
4. Besides *being* observed, new lecturers should also have the opportunity of observing an experienced colleague's lecture. This is especially valuable if the observed lecture is part of a lecture course that precedes, or follows on from, a course that the new lecturer himself is giving. Quite apart from any benefits that come from seeing an experienced colleague perform, the new lecturer will profit from seeing how what he or she is teaching fits into the degree sequence.

The results of each teaching observation should be recorded on a suitable form, containing

1. a preparatory section in which the lecturer described what he or she intends to do, and what he would like the observer to comment on, to be completed before the observation takes place.
2. Space for the observer to take informal notes during the observation
3. A section for recommendations and conclusions (this may be omitted in the case of observations of type 4).

We include examples of Teaching Observation Forms in Appendix B.

Usually either the observer or the observee arranges a preparatory meeting to discuss the criteria, purpose, and conduct of the observation. It's useful to clarify, perhaps on the observation record form, whose responsibility this is. The lecturer being observed might ask the observer to take particular note of certain points they are specially concerned with: response to students' questions, audibility, explanation of tricky points and so on.

De-briefing after the observation is of course essential, and the advice for the observer here is very similar to what one might say about individual feedback to a student: don't begin by telling them what they have done wrong. Discuss with them how it went generally, mentioning good and bad points. We are all much more sensitive to criticism than probably we should be, and this is especially the case in activities which, like teaching, have a strongly social aspect.

Don't overload the observee with feedback - concentrate on the major areas that need attention. If there is more to comment on than can readily be digested by the new lecturer in one session, then probably a second observation is called for. The observer needs to remember that they do not necessarily have all the answers, or at least all the answers that are practical for the new lecturer to take on board. A particularly important instance of this arises when the observee has problems controlling the class. An experienced teacher will have knowledge and tools for dealing with this that are most probably inaccessible to the nervous new lecturer. The reasons for lack of control may range from boring, unsympathetic lecturing to a small core of badly behaved students. The response in each case is widely different. The observer needs to identify precisely what the problem is and discuss with the new lecturer what they think is practical for them to do about it. The best advice may be to refer the observee to another member of staff who is known to have just the right expertise to deal with the situation.

On the other hand, one should not be afraid of alerting them to deficiencies in their teaching. For example, some are incapable of getting onto a student's wavelength and do not appreciate that this might not be because the students are weak, but because their explanation and teaching skills are poor. Some can't write a reasonable length essay (and yet will expect their students to do so). Some complain about the students' lack of interest or willingness to study the topics that interest the lecturer, and yet strongly resist any activity that does not interest them!

The observer must remember to watch not only the lecturer but the au-

dience too. Whereas everything the observee says is likely to be clear to the observer, for the students it is all new and much of it may be incomprehensible. The observer must be able to put him or herself in the students' place and learn to think about how it all sounds to them. For example, the lecturer's language may be too sophisticated; if they refer to a "piecewise-continuous function", are they sure that the students appreciate this readily enough at the speed of the lecture? As a detached observer you might notice clues to this: puzzled looks from some students, whispers to their neighbours, etc. So you have to watch the students as well as the lecturer.

Traditionally, peer observation consists of sitting discreetly at the back of a lecture hall, hoping you won't be noticed. People often shy away from carrying out teaching observations in tutorials because it is thought that the observation will interfere with the process - it is difficult to hide in a group of five tutees! This is of course a problem if the observation is for formal summative purposes, but need not be when the purpose is to help the new lecturer develop. Then there is no harm in another lecturer joining in the tutorial, provided all agree.

There is a lot of literature on the benefits and protocols for such observations. Practically every university in the country has a website describing its approach, and a Google search for "Teaching Observations" throws up a vast numbers of sites. Among the websites that seem useful are [26] and [31]. Other references include [16], [8] and [9].

4.7 Variations

New lecturers can

- Have one of their lectures videoed; this likely to be a valuable experience, though disconcerting.
- Give a course in tandem with a senior colleague.
- Visit the maths department in another university in order to study some aspect of its teaching.

4.8 Teaching Observation Forms

Portfolio contribution from teaching observations The completed forms from all the participant's teaching observations should all be included in the portfolio. There should be at least one observation per module by the module mentor, and one by a representative of the ISD.

4.9 Site-specific issues

Understanding how their new department works can be as important to a new lecturer as learning about how to teach (see Section 2.5). The departmentally based component of staff training is especially valuable for this reason. Workshops and discussions which attract old staff as well as new help the two groups to make contact, and give the latter the opportunity to benefit from the experience of the former. They may also give established staff the opportunity to discuss aspects of teaching and departmental practice that they do not normally have. Because of the benefits of bringing together new staff and old, it is worth trying to run events which offer something to established staff as well as newcomers. First on the list of successful inducements is, of course, food and drink. A reasonable supply of each can help to establish a friendly and relaxed atmosphere in which discussion can thrive. Don't leave the refreshments till the end - they do the most good if they are consumed during the meeting! They can help to keep a late afternoon meeting going beyond the point at which staff would have gone off to eat otherwise.

Not surprisingly, another way of attracting established staff is to run workshops and meetings on topics that are likely to interest them. A workshop entitled "How students understand proof" will probably appeal only to the very committed, but something on a topic of recognised departmental concern - "How can we increase our student numbers and avoid closure?", or "The balance between Analysis and Algebra in the first year curriculum" - may well attract a larger public. Although such meetings may not at first sight contain any element of training, the experience of participating in such a discussion, and seeing established colleagues participating, together with the exposure it brings to significant issues of departmental policy and practice, can be extremely valuable.

Chapter 5

Workshops and seminars

5.1 Attracting an audience

A strong argument in favour of departmental rather than central staff training is the possibility of running subject-specific workshops and seminars. However, most departments do not have enough new staff to provide, on their own, a reasonable audience for such events every year, and this has been one of the main arguments in favour of leaving the running of workshops to the university's ISD. So what can be done? There are several approaches to the problem.

1. Run events which attract not only new staff but old hands too, as described in Section 4.9. Invite interested students. Events with a wider range of participants than just new staff can be very valuable. The *Undergraduate Learning and Teaching Forum* described in the list below is a case in point.
2. Make events more attractive by offering food and drink. Make them a more social occasion - why is it that only managers and politicians seem to appreciate the exceptional lubricating qualities of even average wine and cheese?
3. Some events, such as the workshop on A-level maths which we now run annually at Warwick for the benefit of our largely foreign-trained new staff, can be run in conjunction with other departments, such as Physics, Computer Science, Engineering and Economics, whose undergraduate entrants are expected to have Mathematics A-level. This is,

for example, the arrangement adopted at Oxford, where Mathematics works with Science and Engineering in supporting new staff. Sharing activities with other departments may be a good idea in any case: a solitary new staff member may feel isolated, and might benefit from contact with other young staff. Such groups could be initiated and coordinated by the ISD with consultation with departments. This would provide a middle ground between purely discipline-based training and purely generic training

4. It is possible to share the organisation of events with Mathematics departments in nearby universities. Because of the travelling involved, it may be a good idea to alternate the location. Another possibility is that groups of new staff from neighbouring institutions could come together in regional centres coordinated by, say, the MSOR Subject Centre. Such an arrangement was made in the case of the Subject Centre's module *Supporting Postgraduates who Teach Mathematics*, and proved to be very successful.
5. Run some parts of the training programme in alternate years. Many new staff postpone by a year or two the start of their training in any case, so will not necessarily feel deprived. A good staff development coordinator can alert new staff to pressing issues if the workshops which deal with them will not take place for another year, especially if he or she has been involved in assessing the real training needs of new staff in preparation for a departmentally based training programme.
6. Run new events under the same rubric. An "annual discussion of some topic of departmental interest" can focus on something different each year, and offer a valuable venue for an open discussion. See *Directing Undergraduate Research Projects* and *The role of computing in the undergraduate degree* in the list of events below.

The main point is that once the department has identified specific training needs for their new staff, they may be able to fulfill these by a range of collaborations with outside agencies such as MSOR Subject Centre, and other departments within their institution, or in their local region. They do not have to provide everything themselves.

Use workshops to address issues that need dealing with anyway. Some of them will change from year to year. There is no need for the sequence of workshops in the training programme to be eternally the same.

5.2 The MSOR Induction Course and Associate Module

Staff can be sent on appropriate courses at the Subject Centre, such as the MSOR *Induction Session for new lecturers* described below in the list of events. Recently, the MSOR Subject centre, in collaboration with Birmingham University Staff Development Unit, has introduced a new Associate Module for University staff in Teaching Mathematics in Higher Education. This 20-credit module is the first discipline-based Teaching Certificate of its kind in higher education and so the distribution of activities and hours is somewhat experimental, but comparison with other HE Teaching Certificates suggests it is not untypical. It is designed to be departmentally-based, with the bulk of the training coming from mathematics provision of one kind or another, primarily from mentoring. The work can be split into:

1. 31-35 hours of taught component (comprising mostly attendance at MSOR and SDU workshops)
2. A minimum of 15 contact hours teaching (very crudely, for an equivalent full 60-credit Postgraduate training certificate this would translate into two typical one-term courses, a reasonable load for the first year's teaching for a new lecturer).
3. About six hours teaching observation both of the participant, by mentors and peers, and by the participant, of peers.
4. A nominal 20-40 hours engaged in discussion with mentors, colleagues within the institution and across the HE mathematics sector, either personally or in web discussion groups, within the context of the three previous components.
5. A nominal 50-100 hours developing a mathematics-based portfolio containing evidence and reflection gathered during the course of component 1-4 and in the normal course of the participant's departmental contribution during the course of the module.

More details are available from the MSOR Subject Centre.

5.3 Themes and topics

Rather than trying to characterise those events which seem useful, we give a list of events we have run, or plan to run, with a brief discussion of their virtues and difficulties, and some guidance to resources and people who may be able to contribute.

1. A two-day *Induction Session for staff new to teaching Mathematics, Statistics and Operations Research in UK Higher Education*, is run every September in the University of Birmingham (see the website at <http://mathstore.ac.uk/workshops/induction2007/index.shtml>). It is put on by the MSOR Subject Centre, which is based in the University of Birmingham Mathematics Department. It attracts staff from all over the UK, and provides not only valuable training, but also the opportunity for new staff to share their experiences with others in their position. It received unqualified praise from respondents to the LMS survey mentioned in Section 2.1. *We strongly recommend that all new staff should attend, as a recognised part of their training.*
2. A workshop on *current A-level maths syllabuses and examinations* - especially important for new lecturers from abroad, who did not receive their secondary education in the UK. We have had two different kinds of event at Warwick. The first, which is now becoming an annual event, is a hands-on session run by Richard Lissaman, a Warwick Maths PhD who is now Deputy Programme Director in the Further Mathematics Network, a national organisation which sends peripatetic teachers to schools which do not have the resources to teach Further Mathematics A-level. Running such an event is not as easy as it sounds - to convey an operational understanding of what beginning first year students know requires the right balance of information and participatory activity. Simply outlining the syllabus will not be of very much use, though, unless participants can go away with a useable summary, together with a willingness to use it when preparing first year lectures.

Because the Further Mathematics Network is spreading across the country (there are now 42 centres), and its members roam far and wide in the course of their job, they provide a useful pool of potential facilitators for such events.

The second kind of event was a talk by Roger Porkess, Director of

the A-level syllabus development body MEI, who was visiting Warwick for other reasons. He described some of the political and educational pressures on the A-level syllabus, and gave an extra dimension to our understanding of the “opening up versus dumbing down” debate.

New staff can also gain an idea of what should be expected of incoming first years by sitting in on an A-level class in a local school. This also provides an opportunity for contact between school and university which may be valuable to both sides.

3. *Teaching large classes* This is an area of real difficulty for many lecturers, and not only new ones. Classes have steadily increased in size in recent years. A class of two hundred requires a quite different style of delivery from a class of twenty, and much more careful preparation. Marking students’ homework becomes difficult without a team of TA’s, and it is necessary to find other methods of keeping students on the ball.

Sources: Kranz [14, Chapter 2 Section 14]

4. *Setting and marking exams and homework.* One of the most contentious areas in contemporary UK mathematics Higher Education! The main problem: whether we should mark students’ homework. Marking is time-consuming, repetitive and frustrating. When we have classes of 200 students, it becomes impossible without a team of graduate TAs. It seriously conflicts with our research. But in our opinion it is irreplaceable as a means of learning, both for students *and for lecturers*. We don’t mean simply assigning a mark (“summative assessment”), but also commenting, correcting and advising (“formative assessment”) Students can learn an enormous amount from this ¹. They appreciate the personal attention that is involved. Even the simple assigning and recording of a grade is a significant stimulus, probably the most significant available, to studying outside lectures. Lecturers learn too, because by marking students’ homework we can see what is being understood and what is not, and, perhaps, why. Such knowledge can be crucial in adjusting the methods or aims of our teaching to meet the needs of our students.

¹It is a pity that the practicalities of exam marking in UK universities seem to militate against its use as formative assessment.

So if we do not mark students' homework (and most of us don't), then at the heart of our practice as lecturers is the uncomfortable fact that we are not doing the best job possible. Devising ways of encouraging students to do their homework without crippling our research activity is a major challenge. Departments with a good number of graduate students can pay them to mark homework. Everyone gains from this, since the graduate students can earn a useful additional income at the same time as strengthening their basic mathematics and learning about teaching. Nevertheless, this still leaves lecturers ignorant of what their students are achieving, until they mark the exam, when it is of course too late.

See the item on Computer based assessment and drilling below for one possible replacement for marking.

The UK exam system is very different from those in countries from which we recruit our lecturers – see the essays in Section 2.5 and in Chapter 9, especially VIII. Lecturers from the US are used to administering their own exams, and running mid-terms as well as final exams – which take place at the end of the module, and not in an exam period at the end of the year. Exam marks are extremely important to students, and so there is little room for trial and error. Moreover since they are one of the few pieces of hard data with which to judge the success or failure of a module, new lecturers too can be traumatised by marks whose mean or variance deviate significantly from what is expected. Module mentors (cf Section 4.3) should check their mentees' exam papers for accuracy and level, and a great deal of the new lecturer's necessary learning can take place in the process of responding to their mentor's comments.

Because it can be painful, the period immediately after marking the final exam can be the most productive for a new lecturer to reflect on their module. If a review of their teaching is called for in the training programme, now can be the time to write it - though of course this may conflict with the lecturer's need to rush off to a conference as soon as the term is over. Sources: Kranz [14, Chapter 2 Section 10].

5. *Teaching proof to mathematics students who have not met it before.* Many different modalities are possible here. Lara Alcock, of the University of Essex, has produced DVDs showing carefully produced film

of beginning students grappling with problems where they are asked to prove or refute simple statements in set theory, and reflecting on their attempts as they go along. Her workshops for mathematicians at Warwick have drawn an audience from among mathematics postgraduates, who supervise undergraduates, and students of the Institute of Education, as well as new and established Mathematics Department staff. Workshops by David Tall, Professor of Mathematical Thinking at the Warwick University Institute of Education, and by Juan Pablo Mejía, one of his research students, and by Keith Weber visiting the I.O.E. from Rutgers University, drew a similarly wide audience.

6. *An update from Mathematics Education* As a variant on the previous topic, a workshop introducing ideas from Mathematics Education may also be useful. Since much of the work in Mathematics Education is aimed at Maths Ed researchers rather than practising lecturers, it is important to find a speaker willing to address practical questions in a non-technical way. Such people exist, and indeed Mathematics Educationalists are increasingly looking for ways of communicating with mathematicians. The paper [1] is a useful step in this direction. It gives a convincing and thought-provoking analysis of some of the common cognitive dissonances which undermine student achievement in university mathematics, and could be used as the basis for a fruitful discussion.
7. *Computer-based assessment and drilling (CAA)* One option is to use computers for drilling and practice in some of the more algorithmic skills. There are packages which generate exercises and even mark them. So far these are largely concerned with low level skills like differentiation and integration, solving ODEs, and various tasks of linear algebra. At the Birmingham Induction sessions mentioned in (1) above, Chris Sangwin (Birmingham, <http://web.mat.bham.ac.uk/C.J.Sangwin/>) generally runs a workshop on Maple-based systems. Others involved in developing CAA are Trevor Hawkes (Warwick and Coventry) and Martin Greenhow (Brunel, <http://people.brunel.ac.uk/~mastmmg/>). In the US, Mathematica-based modules have been developed by a number of people - see contribution to Steven Kranz's book [14] by Ed Dubinsky and Jerry Uhl.

At Warwick we ran a workshop which attempted to implement AiM

(one of the Maple-based CAA systems) by producing material for some core undergraduate courses. In retrospect this was excessively optimistic - one of the outcomes was a widespread view among participants that CAA requires a more significant investment of time than they were prepared to make. Indeed, implementing something of this kind is extremely time-consuming, and if it is left to the individual lecturer responsible for a single module, it will rarely happen. If it is to be undertaken it requires a departmental decision and departmental provision.

8. *Undergraduate Learning and Teaching Forum.* A group of about thirty undergraduate students from all years is invited to an evening meeting with the new lecturers over wine and a light buffet. Rather than order in a buffet from the university's catering service, we simply buy supplies from a local supermarket and invite everyone to make their own sandwiches. The cost of the food and wine for everyone is about £70. In fact a number of old staff come along as well, and the discussions have been relaxed and very enjoyable. The fact that old staff would be interested in attending was not obvious at the outset, but has come increasingly to the fore as more events have been organised under the rubric of staff training. The new staff, for whose ostensible benefit the event is layed on, provide a (more or less) guaranteed audience, but, as it turns out, a larger part of the audience comes from existing staff who attend voluntarily. In the case of the Learning and Teaching Forum, finding the students can be more problematic. Efforts to invite a representative sample of undergraduates through our Staff-Student Liaison Committee met with no success - perhaps because students on third-class marks don't like to be identified as such - and in the end we were reduced to inviting personal tutees, and some of the front-row students from a lecture-course. As it turned out, knowing many of the student's names made it easier to moderate the discussion, and so the difficulty with their selection led to a positive outcome.

In preparation for the meeting, students are asked to make a list of five things they wish lecturers would do, and five things they wish they wouldn't do, and staff are asked to prepare similar lists regarding students' behaviour. The lists provide the basis for a discussion, which rarely flags.

9. *Directing undergraduate research projects* Final year students on the 4-year MMath programme at most UK universities have to write a project, which may involve elements of research. At the end of our first year we ran a discussion on fourth-year undergraduate research projects, which was attended by about fifty people, including four students who had recently completed such projects. The ‘training’ aspect of the meeting was not even mentioned, but it was clear that everyone who attended learned a great deal about the difficulties that others had choosing and directing projects, and about their strategies for dealing with these problems. They also learned other lessons which can never be conveyed by extra-departmental training. Hearing their colleagues discuss problematic aspects of teaching, they learn who in the department shares their perspectives, whom it might be fruitful to approach for guidance, who talks too much, and how to negotiate their own position as a newcomer with views and experiences to contribute.
10. *The role of computing in the undergraduate degree* A second meeting along similar lines was concerned with the department’s computing provision. Some years ago we introduced a new core first-year module called Maths by Computer, largely at the instigation of a new professor with interests in numerical analysis. Its aim was to give students basic computing skills, and experience with a mathematical platform like MatLab or Mathematica with which they could explore topics in the other courses they were taking. For one reason or another, we had formed the impression that it was not achieving its stated aim. The meeting we organised could have been held behind closed doors in a teaching committee, but held as it was in public, it gave the opportunity for a lively discussion which ended with a departmental consensus on changes to be made.
11. *Student passivity and what to do about it* This topic, and a general perplexity with UK student culture, comes up repeatedly in the pieces by new lecturers in Section 2.5. We ran a discussion on this as the third of the open discussion meetings ([30]), which aim to help new staff integrate into their department through an open debate on some aspect of departmental policy. We had two short and provocative talks on the problem of student passivity and possible remedies, and a lively discussion. The talks, like a number of outcomes from other workshops

described here, are posted on the website run by the Warwick training programme, at [30].

12. *Supervising PhD students* A workshop on this topic is one of those often run by ISD's. However, it's not clear to what extent the same lessons apply to Mathematics, as, say, to a laboratory science, or to History. Mathematics PhD students rarely arrive with a PhD project in mind, whereas History PhDs generally do. Students beginning a PhD in a laboratory science are generally enlisted in the laboratory's ongoing research projects. The difficulty of judging to what extent students can be left to choose their own topic, and of suggesting a suitable topic for those who cannot, is a cause of much anxiety to supervisors in Mathematics², especially at the beginning of their careers. So this is an area in which there is a great deal to be gained by communication, especially at an informal level. In a recent open discussion meeting at Warwick, senior staff described their own approaches to these questions, and others intervened to reveal their difficulties and uncertainties. One unexpected result of the discussion was evidence of a growing dissatisfaction with the traditional British model of the PhD. Increasingly, foreign-trained staff want some of the same structures found, for example, in the US system – qualifying exams, advisory committees, and so on. A transcript can be found at <http://www.warwick.ac.uk/~masbm/PCAPP/Events/Discussion/phd.pdf>
13. *Dealing with students' problems in tutorials* What is the boundary between the role of the personal tutor and the role of a student counsellor? How much "counselling" should a tutor undertake, and what skills is it reasonable to expect him to develop? How could or should a personal tutor respond to a range of sample problems? Our first workshop on these issues was attended by only one new staff member but by six established staff members, and, at our invitation, by a member of the student counselling team at the university Senior Tutor's department. The counsellor revealed that despite having worked in the university for a number of years, this was the first time that she had met with a group of personal tutors! The workshop will be repeated, with the counsellor contributing a short talk on counselling skills, which will also address the questions raised above. A session of this kind is a natural place

²See Lecturer XII, *The key question*, in Chapter 9 below

to raise the topic of staff assumptions about students, as mentioned in 6.3.

14. *How to run teaching (as opposed to pastoral) tutorials* At many UK universities first-year students are expected to meet their personal tutors for mathematical, rather than personal, group tutorials. It seems that in general, lecturers coming from different backgrounds find these tutorials hard to run in a fruitful way, and regularly ask for guidance – see the table at the end of Section 2.5. We have no brief to promote this particular aspect of undergraduate teaching, but merely cite it as an example of the kind of site-specific practice where training may really be called for.
15. *Using the blackboard* Mathematicians are almost alone in privileging use of the blackboard over other means of delivering information in lectures, and as a consequence blackboard skills are rarely dealt with in generic courses. But lecturers' poor use of the blackboard is one of the most frequent complaints by students. There is room for a lot of very practical guidance here!
16. *Use of overheads, and/or lecture notes* How can a lecture be more than just the transfer of written information from text-book to blackboard and thence to students' lecture notes? Should lecturers hand out complete sets of lecture-notes at the start of a module, enabling students to pay attention, and allowing spontaneous deviation from the lecture plan, or does this encourage students to skip lectures? There are many questions and many answers; from the accounts in Section 2.5 it is clear that this is a topic on which new lecturers want guidance.

We do not consider ourselves experts on all these topics. In some cases there are experts who can be brought in from outside - specialists in university-level Mathematics Education, for example, are usually very happy to be invited to speak to an audience (mathematicians) who they feel usually ignore them - but in others we have found that meetings in which difficulties are raised and openly discussed by interested parties can be very enjoyable and therefore profitable, even without the presence of experts. We believe that simple engagement with the topic is just as valuable as having information or abstractly definable skills delivered to you by experts. Someone who is enthused and interested will go on to develop, and continue developing,

skills more effectively than someone who is subjected to a worthy but boring (perhaps because only partly relevant) training session.

In fact over the years we have been running this kind of departmental training, the interests of the Coordinator have expanded, to include running events which are of general interest to staff in the department, because they address problems which concern every lecturer.

It seems that a training programme provides a natural platform from which to embark on this slightly wider project. Its training value comes through opening up the department's teaching to scrutiny and discussion which involves newcomers and old timers alike. Through this involvement, new staff are stimulated to contribute and integrate themselves into the department.

One final, simple point: if it's a workshop over in the university's staff training centre, of course no-one but the trainees will go. If it's in the Mathematics Department, there's a good chance of recruiting a wider audience.

Structure of the workshops

Workshops run by ISDs are often carefully structured to ensure active participation by all those present. After a plenary discussion, participants may be separated into small groups for further discussions and then asked to present the results of these discussions in another plenary, Although such detailed structure has some value, it runs the risk of alienating "old" staff by imposing too much control.

Partly for this reason, and partly because organisation of this kind requires skills we did not feel we possessed, at Warwick we have left the structure of our meetings and workshops rather open. In some respects this is unsatisfactory - some new staff attend but do not participate actively. In order to promote more active participation by new staff, without alienating old staff, we ask new staff to write a brief report on the meetings and workshops they attend. This at least requires that they pay attention! New staff can be asked to post their reports on the training programme's website, as a means of informing others of what has taken place and the content of the discussion. This provides some incentive to thoroughness.

Portfolio contribution from attendance at workshops A report on each of the workshops and meetings attended.

Chapter 6

Writing and Reflecting

6.1 Essays

At some point in their training, new lecturers are generally asked to write a reflective essay of some kind. Essays are among the most unpopular parts of most training programmes, not only among mathematicians. However, we seem particularly averse to essay-writing. We are accustomed to a high level of rigour and precision in our own professional writing, and critical of the standards of argument in other subjects. The kind of reflection encountered in some reflective essays can strike us as uselessly vague.

So is there any place for the essay in the training of new mathematics lecturers? Here are some arguments in favour:

1. Essays still form the core of what students do in most humanities subjects:

Writing essays...is an essential step in promoting intellectual development, internalizing knowledge and developing the capacity for rational thought. These objectives...are the most important rationale of universities...There is still no better way of fostering intellectual development in many subjects than requiring students to produce...essays.

to quote Patrick Dunleavy, a political scientist at LSE, in [3]. Once again, a Google search throws up a wide range of resources on the virtue of essay-writing. Besides Dunleavy's book, take a look at Loughborough University's webpage [17].

For an alternative view, see two papers available from the Higher Education Academy, [5] and [19]:

2. The body accrediting the training - the university's Staff Training Centre or the Higher Education Academy itself - must be provided with evidence not only that the trainee has met the demands of the programme but that the programme itself is worthy of accreditation. A written document such as an essay can provide such evidence.
3. Employers regularly bemoan the inability of maths graduates to write reports, and in response to this many maths degrees increasingly require students to write essays. We should be prepared to do so too . . .

In this guide we distinguish between *essays* and *projects*. By the former we mean pieces of writing that are essentially reflective, requiring of the writer an assessment of some aspect of their own performance or experience, though quite possibly informed by the study of other sources. By the latter, we mean a piece of work that requires some non-bibliographic research - for example, finding out about employment destinations among the department's graduates, or making a study of some aspect of the department or university's provision.

Both type of written work are of intrinsic value in several respects, and both provide evidence for the purposes of assessment.

Here are some examples of reflective essay topics:

1. End of session module reports, including an exam report written after the marks have come in. When one has just finished marking the exam, one is most acutely aware of the successes and failures of the course, and of the areas where teaching must be strengthened or objectives reined in.
2. A comparative essay on some reading on pedagogical issues.
3. How I prepared for a recent lecture course.
4. How I learnt this subject that I now teach (we suspect that in some cases we took more time than we are now prepared to allow our students!).

5. An essay on the new lecturer's recent experience in learning, with a view to relating this to student experience.¹
6. A design for and report on a tutorial.
7. Pieces on teaching techniques you have published e.g. in *Connections*, the house magazine of the MSOR Subject Centre.

Portfolio contribution from the essay We think that written work involving elements of at least the first four topics on this list should form a part of every training. The portfolio should include a review of the participant's first year or two years' teaching, including module reports as just described, amounting to a total of around 5000 words. As preparation for the review, the participant should read at least one of the books listed in 8.2 below, or something comparable, and the review should be supported by references to this and to other academic and educational literature.

6.2 Projects

A significant part of the training may take the form of a project. As a rule, projects should aim to be genuinely relevant to teaching. They should never be exercises undertaken merely to fill a formal requirement. New staff are liable to be upset by the regressive aspect of being "trained"; accustomed to being respected as significant members of a research community, they may be irritated at having to produce written work with no real audience. In one sense good topics are all too easy to find: the coordinator and the new lecturer need do no more than find some area of the department's teaching, or the students' learning, that is less than optimal, and set out to find causes and remedies. But there is no reason to look only at failures; studying the organisation and structure of a particularly successful course might make a useful project for a beginning lecturer.

¹One reason research activity can contribute to teaching is that an active researcher is necessarily an active learner. Research-oriented learning takes place at a different level from undergraduate learning, and with different objectives, but the two still have a lot in common. Researchers, like students at any level, are trying to master new and challenging ideas and techniques. Some attempts are more successful than others. What makes the difference? Understanding this of your own learning helps you to understand the difficulties of others.

Projects give staff from other backgrounds and with experience of other educational practice the opportunity of integrating the fruits of this experience into the UK setting. This can be beneficial for all concerned.

The following projects have been carried out by new staff on the Warwick training programme:

1. A study of the effectiveness of a new approach to teaching Analysis
2. Fixing a syllabus and typing lecture notes for a core course which had lost its way.
3. Designing a module on Euclidean Geometry
4. Investigating the feasibility of using oral exams in place of written exams for high-level mathematics courses.
5. Integrating the internet into teaching using Wiki software.

The project on oral exams, in particular, is likely to be made use of in the near future. With only a small MSc programme, catering to a particularly diverse group of foreign students, we find it difficult to lay on suitable taught courses to meet the needs of all of the students. By offering, as Reading Courses, courses which have previously been taught and for which lecture notes or suitable texts are available, we can greatly increase the range of courses that students can choose from. The principle impediment to this is the exam system, which demands a written exam, prepared, checked and printed several months before it is to be sat. Having to write a three-hour exam for one student, on a course you may not have taught for some time, is more than enough to deter most lecturers from offering reading courses. The project on oral exams directly addresses this problem.

Other questions that could be investigated in a project include:

1. How can we motivate bright students to go for more than just high marks? Would a US-style Honours Programme work here?
2. Do other comparable departments teach to a markedly different syllabus from us? How do they differ, and should we follow their example?
3. Do partial exams mid-way through a module promote better learning?

4. How does being at the bottom of the heap affect student learning in mathematics? Would our bottom students learn more on a less demanding degree course? How could we persuade them to transfer?
5. What are the employment destinations among the department's graduates? What uses do they make of their mathematics training?
6. Where are the boundaries between plagiarism and group-work in assessed assignments? What can be done to avoid the former and promote the latter?
7. How useful are voluntary support classes? What are the alternatives, given the size of the student cohort?

Projects of this kind are the opportunity for real scholarship on teaching and teaching-related issues, and can encourage the lecturer to invest intellectual energy which is often confined to research.

At a more practical level, a participant could

1. Use one of the CAA packages such as *AIM*² or *Stack*³ to produce electronic drilling or assessment for a course they are teaching, or in preparation for such a course;
2. Devise a computational segment for a standard course taught in the department;
3. Prepare a web-based tutorial on a problematic topic from the undergraduate curriculum;
4. Liaise with a researcher in university mathematics education to assess the effectiveness of some aspect of the department's teaching

Portfolio contribution from the project The outcome of the project should be a written document or essay of about 5000 words, which should go into the portfolio. It could also be posted on the Training Programme's website - see comments on this in 8.3 below.

²<http://web.mat.bham.ac.uk/C.J.Sangwin/aim/index.html>

³<http://stack.bham.ac.uk/stack/>

6.3 Questioning Assumptions

Like all interpersonal activities, much of our teaching is based on unconscious assumptions, and, especially where lecturers from other backgrounds are concerned, it is important to question these assumptions. Activities should be planned to encourage this.

Because of the nature of unconscious assumptions, it is impossible to make a complete list, but here are some which we believe should be brought to the attention of new staff.

1. For many years it was assumed that the experience of having been a student was all that was needed to enable an academic to become a competent lecturer. For reasons which have already been discussed in Section 2.1, the assumption is less prevalent than it was. How justified is it?
2. Most other European countries have a much more Darwinian approach to student success and failure than is normal in British universities. It is expected that a significant proportion of students will fail at some point in their first year, and this winnowing is regarded as a normal part of the selection process. The need to select out the bottom 20 or 30 percent gives rise to a quite different attitude to struggling students than is currently acceptable in the UK, where selection is regarded as taking place before the degree begins. On the other hand, this latter approach to selection may not be ideal, and could also be questioned.
3. New staff have been academically successful in a way that it is not reasonable to expect many, or even any, of their students to be. They may have taken their undergraduate degrees in mathematics departments where the intention of a significant proportion of the students was to go on to a PhD and an academic career. It is important to recognise that these may not be realistic aims for their students now, and to find out about, and learn to respect - or to understand sympathetically - the aims and aspirations of these students.
4. The structure of the curriculum may differ significantly from what the lecturer is used to, or thinks is sensible. Second year students may not have studied all of the material that the lecturer thinks a first year student ought to know, and, even more seriously, beginning first year

students may not know all of what the lecturer thinks of as “school mathematics”.

Portfolio contribution from questioning assumptions Some evidence of reflection on the kind of issues raised here should be provided by an essay or project, for inclusion in the participant’s portfolio.

Chapter 7

Training versus quality assurance

There may be occasions on which issues of lecturing quality transcend the bounds of training. Poor teaching by a new lecturer is, of course, primarily a problem for the students. A departmentally-based training programme is much better placed to respond to a problem of this sort than a generic programme. Here is a description from an article ([22]) one of us published in the MSOR Subject Centre journal *Connections*. Although couched in hypothetical terms, it is based on real experience.

Let us imagine ... what would happen if a new lecturer had serious problems with his teaching. As currently envisaged, the system would work like this:

1. The first module mentor observes a lecture. He realises that some serious changes to the style or content are needed, and makes recommendations to the participant accordingly, both in person and in writing. At this point a lot depends on the two individuals involved. A serious participant will make efforts to improve his teaching in the light of the recommendations, or, possibly, will consult with the coordinator if he feels that they are inappropriate or mistaken. A concerned mentor will decide to visit the lecture again, to see if his recommendations have had any effect on the participant's teaching. Let us give both the benefit of the doubt and assume that they take this course of action.

2. Aware of the difficulties, the participant himself alerts his second module mentor, and arranges to have his second courses lectures visited early in the term, in order to catch the problems early on.
3. The module mentor attends an early lecture, makes suggestions, and attends further lectures. If the problems are sufficiently serious, and the participant's teaching does not improve to an acceptable level in response to the mentors suggestions, the mentor will alert the coordinator.
4. The department now has to decide how to confront these problems. Because they concern students as well as the trainee, they transcend the framework of the training. Different departments will respond to such situations in different ways. It may well be that it is possible to devise further training within the department, or to buy in specialised services, from the university's ISD, from the MSOR subject centre, or from further afield.

In any case, the system of mentoring provides a means of detecting problems with teaching at an early stage, and at least some of the means to tackle them.

In the case which motivated this description, the lecturer went through a second cycle of lectures, with new mentors. This was prefaced by a meeting bringing the lecturer together with the Coordinator and the old and new mentors. His teaching improved significantly the second time around, as reported both by the mentor and by student course evaluations, and he successfully completed the training.

Problems in teaching of the kind described are often picked up by students before the department becomes aware of them, and it is important that the department is seen to respond effectively and in the interests of students. For this reason, there should be good links and liaison between the Coordinator and the Staff-Student Liaison Committee, the department's Teaching Committee, and other quality assurance mechanisms.

If there are problems in the teaching of an individual that cannot be addressed by the department - for example the need for voice training or other communication skills - the Coordinator should be able to locate appropriate support either in the university's ISD or further afield.

The department should try, as far as possible, to integrate its staff development programme with existing quality-assurance mechanisms such as

peer observation, exam moderation and checking, etc. Wherever possible, time spent in these mechanisms should be counted as part of the training. This will save duplication of effort by the participant and by course mentors. Although this is a trivial point, it is worth making sure that, for example, clerical staff in charge of assigning exam checkers and peer observers as part of the department's normal quality control should make sure this task falls to the appropriate module mentors, in the case of new staff who are taking the training programme.

As a final point on the theme of quality assurance, we raise the possibility that a Coordinator who has successfully overseen the training of his or her new colleagues may be able to play a role in helping other lecturers to improve their teaching, perhaps in conjunction with specialists from the ISD. We are wary of asking anyone to take on the teaching of *all* of their colleagues; but many departments have one or two lecturers whose teaching is manifestly poor, and although collegiality might urge us to leave well alone, ignoring poor teaching is unfair on students and can damage relations with the student body. A training coordinator who has gained experience and authority is well-placed to deal with this kind of problem. Once again, we see the transfer of some training responsibilities to the department as potentially contributing in new ways to the wider teaching effort.

7.1 Recognising and accrediting previous experience

All training programmes must have a procedure for recognising previous experience and training, and granting exemption from some or all of the training on that basis. The procedure should be simple and quick. However, even experienced new staff should still attend events concerned with site-specific issues - for example how the tutorial system works, or, especially for staff from abroad, the level and content of A-level mathematics.

One of the complaints about generic provision is that it fails to take into account the differing levels of previous experience that are typical of new permanent staff in different subjects. Mathematicians generally spend several years between completing a PhD and getting a permanent position; this is longer than most new staff in, for example, humanities subjects, where far fewer post-doctoral appointments are available. It is important, for this

reason, that at least one member of the mathematics department - most likely the Coordinator - should be involved in any decision about full or partial exemption. This can help to remove the need for the copious documentation which can sometimes make obtaining exemption nearly as onerous as taking the training.

Chapter 8

Resources

8.1 Existing staff

The most important resource for the departmental component of training is the existing staff. Their skills, knowledge and willingness to help are what will make the greatest contribution, beyond a trainee's own efforts, to improving his teaching. This book has been written with the assumption that the department has a teaching culture it is proud of and wishes to transmit to new staff.

There is a danger, of course, that reliance on existing teaching culture will foster conservatism and resistance to new ideas. In many British universities this danger is to a large extent neutralised by the enormous influx of new ideas and approaches to teaching that arrive with foreign trained lecturers, who often make up the majority of new appointments. We believe strongly that new staff should be encouraged to contribute their ideas to departmental teaching culture, and given the opportunity, as part of their training, to propose changes to existing practice in the light of these ideas. New ideas from outside will enrich our teaching, as they have done in practically every sphere of cultural activity.¹

In a department which needs to develop new approaches, help could be sought from the MSOR Subject Centre in Birmingham, or by sending new staff to investigate how things are done in other universities, not necessarily in the UK.

¹We are more sceptical about managerialist ideas that may originate in sectors of society which feel little sympathy with the aims and ethos of university education.

8.2 Books and journals

Books and journals should be made available in the departmental or central library. There are several excellent books on the teaching of mathematics in universities. We recommend [7], [12], [14], [21], [13].

Steven Kranz's book [14] is a cogent exposition of a fairly traditional view of mathematics teaching, enlivened by a collection of essays by other authors, some of which dissent radically from Kranz's view. Steve Zucker's is one of the less dissenting essays, but one of the most interesting. Zucker focusses on the need to get students *studying*, and argues that in some respects "less is more". If the lecturer's brilliant explanations remove the need for the students to work at understanding, then at the deepest level they are hindering their education. This is a hard area in which to navigate: "less is more" can be an excuse for laziness and can lead to loss of contact between lecturer and student. Perhaps in keeping with the philosophy he is advocating, Zucker does not provide all the answers, but certainly succeeds in provoking thought.

One of the curious features of Kranz's book is the extent to which it seems that service calculus modules dominate the horizons of US mathematicians interested in education. Because US university students don't choose their major until their second year, huge numbers of less-than-committed students are obliged to take calculus modules, taught to them by lecturers and TAs from the Mathematics Department. The attitudes and aptitudes of these students provide the backdrop to a great deal of the discussion. Perhaps as a consequence, there is little feeling of fellowship with students, though a great deal of concern and respect.

The narratives of students struggling with the difficulties of learning mathematics are sympathetically and insightfully studied by Yvette Solomon in [27] and [28].

The essay by Matt Owens ([24]) offers a salutary comparison of student behaviour in examples classes and in lectures.

The MSOR Subject Centre is currently building up materials, web and print-based, that will support training.

Copies of recent A-level Mathematics papers are very useful and should be regularly renewed. Once again, the annual process of doing this should be put in the hands of clerical staff.

A recent article, [1], by Lara Alcock and Adrian Simpson presents an accessible introduction to ideas from Mathematics Education, aimed at mathematicians. See the brief discussion of this in Section ?? above.

Completed essays, portfolio material, and work of previous participants could be posted on the departmental website, along with stationery, teaching observation forms, etc.

A list of other resources can be found on the Warwick Training Programme website [29].

8.3 The website

A departmentally based training programme should have its own page on the department's website, and it should be a recognised and budgeted part of the Coordinator's role to maintain the website. It is important for many reasons:

1. It should contain a detailed explanation of the structure and requirements of the training programme, sufficient for new staff to find their way around in it without having to chase the coordinator. With the onus on new staff to find things out for themselves, the Coordinator's load, and reasons for worry, are reduced. The programme can then, to some extent, run itself.
2. It provides a resource for people taking the training. It should contain links to the MSOR Subject Centre, to suitable web-based literature on teaching and learning issues, as well as stationery (teaching observation forms, etc) needed by participants. It should also contain a list of suggested projects, each with a brief rationale. All staff should be invited to contribute to the list.
3. It provides a resource for module mentors, both actual and potential.
4. It is a natural place to publish projects and essays produced during the training. There is an argument for making this a requirement, especially of the project. Publication in this way gives essays and projects at least a notional audience, and may help to reduce the feeling that writing them is a regression to an earlier stage, left behind with the start of professional life, where one wrote only for the marker to read. It is also an admirable stimulus to quality!
5. It provides a platform for advertising workshops and seminars.

6. It provides a resource for other members of the department not involved in the training, including students. They may want to find out what was said at the Learning and Teaching Forum, or learn about forthcoming workshops.

Chapter 9

Experiences of Teaching

We include some short, anonymous pieces by a range of mathematicians working in the UK. We neither endorse nor criticise the views they express. They were invited to contribute on the basis that we knew them and thought they might be willing to write something. All but one of the people we asked did so. We have supplied the titles. The accounts are given here because we believe individual voices should be heard. They may alert the reader to new approaches to teaching, or, equally, to unexpected attitudes or difficulties. We found some of them very amusing!

Lecturer I

How I learned to teach

From my point of view as a mentee: - I don't want to be moulded into some standard format that is the norm at a given university. e.g. concrete information about the math standard of teaching and what can be expected of students is useful (e.g. past exercise sheets or exam papers), but I would prefer to form opinions for myself rather than buy into a mentor's view (I don't want to hear "students at this university can't do ...", for instance). - I would like to feel that any colleague, esp mentor, is on my side as an axiom. I'm sure that mentor and I don't agree on every point of teaching, but I don't want big debates with them about why I'm wrong. Since teaching is such a social activity once in the class, I daresay that true remarks of mentor will resonate once I experience the teaching, and any attempt at prima facie proof (or, worse, evidence from teaching literature) would probably go down badly with me. (I'm not against teaching literature, incidentally, but I don't like it being cherry-picked to lay down teaching law... there are indeed useful studies that, I think, can help one to think about the way one teaches - I

have used a very few myself to help think about a topic, both to think about why I disagree and to pick up a new idea - but I don't interpret them as things that say how one should teach.) - I find it useful when I can ask somebody how they solve a particular teaching problem (or even just how they improve on something that is already OK) and hear their reply and think about it later. I would be suspicious of any reply that went "the way to solve that problem is ...". - I very much liked your observation when we chatted in Warwick that for many things it is enough simply to know where the problem is and not to have to discuss the solution. (e.g. it could be a problem setting exams that make marking easier - not just quicker, but also fairly discriminating and with reasonable opportunities for passing. Once I've understood that this could be a problem, I can already spend a little time coming up with my own solutions). - it's useful to get an opinion about when you have done enough work for a set of students. e.g. when students request solutions to worksheets, is it OK to refuse. - I learned a lot from watching various other lecturers. At Kent I sat in on a few more experienced colleagues' lectures to get an idea of what they were doing, and it was good to see a few of their routine methods, and that they were not superhuman. But I think I got even more from hanging around other new lecturers and chatting to them about it (usual after-hours comparing and complaining and sympathising in the common room type of chat, rather than meeting up to 'talk about teaching'). Also useful to see that many different styles of teaching can work.- I did learn from a few of my peer observers (and got nothing from others). It was very useful to be told on a couple of occasions that something had gone well. I remember being told by Adrian Simpson that he thought I handled a difficult student in a big class OK and that he had no better suggestions. He may have been being over-generous, but still it gave a sense of having come to grips with the job of lecturing a big class - for me, at least, most of an hour's lecture is done by thinking on my feet (of course I have notes, prep, overall module structure,... but that is sparse information during the hour... what is dense is what you say, how you stand, when you smile, what you do with your hands,...), and to know that this can work and that there isn't some other secret method is encouraging.

(Rereading this, it sounds as though I am simply whingeing about a few personal experiences; that's not the case - my mentors have tended to leave me to my own devices, apart from formal dept requirements.)

From my experience as an inexperienced mentor: - the problems new lecturers may experience are curious and unexpected. e.g. students sense that they can attack a new lecturer, so that even pleasant people teaching fun maths can get a hard time from students for some small idiosyncrasy of delivery. - I find it hard to judge what may be useful to the mentee. e.g. some new lecturers seem to have rather thin skin when it comes to student feedback. It makes sense to help them

shrug off unfair criticism, if possible, but to look out for any germ of truth in it. Other lecturers are the opposite, and seem to be proud of poor feedback - no, that's too strong... not proud, but accept it as not personal or representative or requiring action. Perhaps that's just robust defence and in fact they do keep their eyes open to sensible criticism, but it's hard for me to read them. - I would like to be able to encourage people to teach in the way they want to without me getting hung up on each little (or big) thing I see that I might do differently. I would like to expect that a mentee will be a better teacher than I am (at least once they are at home in their new university). I tend to use phrases such as "that seemed to work, although I hadn't thought of doing it that way; I do it this way...". - please: no university training.

I have my first PhD student now and have had no advice on supervision (... I've had an ISD-type course on it, actually, and written an essay... this was even run by a mathematician... but perhaps it was hampered by being aimed across faculties... I'm not criticising, I think, but it didn't do much for me). I have (same comment - leitmotif) spoken to youngish colleagues to compare experiences. And I have my own experience of being a grad student - during which many of us discussed the merits and otherwise of our various supervisors, of course. Anyway, I tried to impose a bit of early discipline - say 6 months of force reading of Hartshorne's book and Mori's papers, perhaps, with gruelling sessions at my blackboard doing exercises - but didn't have the time or energy to keep it up. Now I wish I had, although luckily my student seems to have picked some things up for himself (or else is pulling the wool over my eyes very well). I think the PhD training is indeed very different - the acceleration required should be high... the realisation that it's a full-time job that is largely self-driven has to come from somewhere... or something...

Lecturer II

Did they learn?

One of the complaints about the university training course for new lecturers is that the course is not discriminatory. The new lecturers across the university are bundled together in the same course. Mathematics has its distinct set of issues that should be addressed separately. Well, I am "lucky" to have done a PGCE in mathematics (not by choice really, I was moving between continents and waiting for a university position). Of course some of the teaching methods were directed towards secondary school but there are some questions the course addressed that come back to me very often. Here are some of them.

Did learning take place during my lecture? How can I check that? How do students learn?

Sometimes I come out of a lecture feeling very happy, all went very well! Didn't I stop for a moment just after six o'clock on Friday and saw all students gazing at me, nobody sleeping in a class of 140, still wanting to hear more? In the following lecture I put a slide on an overhead projector, with three simple questions. The questions have the following properties: it should take no more than 3 seconds to answer each question; no calculations are required; no pen and paper should be used; they should tell me if learning took place in the previous lecture; they should introduce if possible the objectives of the current lecture. (Here is an example. After a lecture on conformal mappings, I draw two shapes, a square and a triangle, and ask if there is a conformal mapping taking one shape to the other.) I usually arrive 5 minutes before the official start of the lecture. It gives me time to go up and down the lecture theatre and engage (don't you hate these words!) with students. I listen to their answers and encourage them to have a guess if they are not sure they know the answers. During these five minutes, I find out a lot about what went on in their heads in my previous lecture and how much stayed there after a weekend without looking at their lecture notes. (There are other reasons for using "a starter" in my lectures, but I must not dwell on that.)

Where did I pick up the idea of the starters? In my PGCE course. We do talk a lot about our research. Just look at how many seminars we have every week. Do we talk about our teaching? rarely. We have a staff development day once a year at my university and we usually have one of us telling the rest about what we think we are doing right in our lectures. It is a very good exercise. But I feel I can improve substantially my teaching if we have a one day workshop from time to time (say every two-three years), where we can find out about theories of learning and what they mean in practice, where we can pick up some ideas that could transform our teaching. (The idea of the workshop came to me just now, maybe I should organise one soon in my department!)

Lecturer III

Stuck in a loop

Every year when I mark my Manifolds exam, in late May, I am beset by the same feelings of frustration with the students, and with myself. I suppose that these two feelings could be alternatives to one another, but I seem to manage both. At least, every May I do. The strongest feeling of frustration is with myself. After all, I've seen students make the same mistakes in this exam for four years now, and I still haven't adjusted my teaching to avoid them. And what is the reason? I think it is largely ambition, or what I've heard someone else (David Henderson, of Cornell?) describe as "the snare of coverage". I teach in a prestigious and high-achieving maths department which prides itself on the level of its courses. I want the module I teach to reach the level that I believe (or imagine?) my colleagues' modules do. Moreover, there is a topic — intersection theory — that I find particularly satisfying, that gives my module a destination and a justification, and, in consequence, that I desperately want to reach. So I work very hard, and try to ensure that the students work hard, with the aim of teaching them intersection theory and then harvesting some of its consequences - big theorems like Brouwer's fixed point theorem, the Poincaré-Hopf theorem on the indices of vector fields, and far-reaching definitions like linking numbers. But the result is that only very few of the students acquire the mastery of even such basic aspects of the theory as orientation or the derivative of a smooth map between manifolds. Some of them even regress — their notion of the derivative relapses to what they understood at A-level. Each May, in my miserable guilty state, I reproach myself for my excess of ambition, and resolve to ensure that next time I will strengthen my students' understanding with the substantial examples my ambitious teaching allowed no time for. But sadly, when the term begins, I find myself inexorably drawn to pushing through the preliminaries with the same ambition as before. After marking the exam, I have a clear image of a happy, sub-Alpine meadow, rich with examples worthy of study, in which students could profitably build up a fluency with the basics of the subject, which would carry them through the more sophisticated theory when it was later taught to them. And each year, when I start to teach the module again, I cannot locate the valley of examples. I look in the direction where I thought I saw it, and see instead only obscure calculations with no clear motivation. So it goes.

Other failings are connected with the snare of coverage. There is no time to check up, during the term, on what the students have really learned. It would require too much time. One has to press on!

Lecturer IV

The cynic

Lectures In the academic tradition of my native country, the students are expected to have studied the material in advance of the lecture, which then serves to expand on it, to deepen it, and to clarify questions students might have. The ideal lecture is meant to be a *collegium* (partnership) or *colloquium* (conversation). The teachers I admired most when I was a student were the ones that stuck to this ideal and brought a lot of extra insight to the lectures. However, the world is not an ideal place and these were not the lecturers popular with my fellow students, who by and large did not prepare thoroughly prior to attending lectures. The most beloved lecturers were those who presented the material in bite-size chunks and spelled everything out. One of them, a former high-school teacher, I did admire for his sheer technique: he taught statistics well, and I have not seen that ever since.

Torn between ideal and pragmatism, I try to strike a balance between the two. Moreover, I teach in England, where instead of a partnership between lecturer and students we have a *lecture*, i.e. a “reading.” And, much like medieval monks, the students receive & perceive this reading as something that needs to be taken down. The objective is to obtain “a good set of notes.” When I first saw that phrase, it struck me as utterly ridiculous: as if the invention of the printing press, never mind the laser printer, had never happened in England! In the past ten years I have become accustomed to the English point of view, which is that education mainly serves to keep young people off the street.

None of this is to say that the ideal of the *collegium* does not exist in England. Especially the brighter students are very keen to participate actively in the proceedings, and at Year 4/Master’s level my teaching experience has often come close to the ideal. At undergraduate level, the challenges are (i) to convince the students that there is a point to lectures *even when printed notes are available*; and (ii) to elicit classroom participation, even when teaching a large group.

Here are some things that work: set them a 5 minute exercise, and then have a student to it on the board. They all work hard (since they may be up next!); there is a sense that everybody has an equal chance of getting a turn; and the student feels less put on the spot since they could prepare a little. If I need to gauge a general level of understanding, I have them raise hands while I pose the question as a multiple choice. This has the advantage of giving a student reassuring feedback from his peers: you feel less inadequate if you can see that half of your fellow students also got the answer wrong. What does not work is asking questions of random students, even simple, understanding-checking ones. The student feels put on the spot. Furthermore, apparently high school teachers use this technique to penalise and humiliate students who are unruly or inattentive. I only understood

this after I received student feedback about “picking on students” who “had done nothing wrong”!

Student feedback I take feedback very seriously. I am obviously pleased with praise, amused by invective, and baffled by whingeing. One thing I have found is that taking feedback at face value can be counterproductive. You give them what they have asked for, and they are still unhappy. Example: students requested more exercises, which they were given and then did not do. So why did they ask for it? The trouble is that much feedback is simply a sublimated request to disclose the exam, a request which they know will be turned down if stated explicitly. Hence the perennial requests for more exercises and examples. A special problem here is that the lecturer and the bright student will look upon the example as a means of illustrating something interesting, whereas the mediocre student perceives example as a way of establishing a mechanical series of steps which will suffice to tackle the exam questions. This is not entirely the fault of the student: in high school the mechanical mode was precisely what earned the high grades and made the student believe they were “good at maths.” A case could be made that they embarked upon real, university-level, mathematics on a false prospectus. What I do now is that I prepare the exam in advance of the course, and describe the nature of each question. This seems to be a compromise which is acceptable to the students.

Teaching mathematics to biologists comes with the challenge that students expect that they should do well if they study the mathematics in exactly the same way as they did biology. This is plainly unreasonable, but it is hard to take people out of their comfort zone! A key difference is that you can master a deep mathematical idea if you spend hours on just one or two problems. This is often the only way of making clear to yourself just what you have hitherto failed to grasp. Once you’ve got it, a whole host of related problems suddenly becomes easy. Biology tends to be not like that, even though you could study biology profitably in much the same way. Generally, biologists tend to cover the material more evenly, and fairly shallowly.

Exams Part of the grade inflation problem is that students get trained on almost the exact same questions as they will encounter on the exam. Students expect more of the same at University, and we can make our lives a lot easier by giving in. Of course, the time-honoured ideal is that the exam question is sufficiently different from the course work in order that insight and understanding are tested.

I have two relevant experiences here. First, I once gave in to the advice that I include a simple regurgitate-the-definition starter question. What I found is that a student would write down the definition and immediately demonstrate, in the next part of the question, that this very definition meant nothing to them. So

much for the value of regurgitation. Second, students actually enjoy the element of novelty in exam questions. I recall how gratifying it was to bring your skills to bear on a new but related problem, and demonstrate that you could do it. Our students are the same bright young people that we once were; they are not quite as brain dead as the Minister of Education.

A vexed question is whether an exam should draw on general mathematics skills not covered in the lectures. Formally, this is resolved by the prerequisites, but you will still find students upset that a question requires some basic analysis skills at Year 1 level. Again, this is a matter of inappropriate expectations instilled by a rotten system obsessed with phoney statistics.

This year I went and did something that no doubt this book will warn against on some other page: setting a question that could be answered in many different ways. Yes, this does mean that one spends a little bit more time deciphering each student's take on the problem. But I actually enjoyed it. The problem was to establish a bound in which basically the same answer could be given in various different notations (I could not establish a notation in the question without giving the idea away). But a question like this reveals a bit more about how a student approaches problems and thinks about them.

If a result (e.g. a formula) is needed in a later part of the question, we should state this result and ask the student to establish it. Of course, the student will work forward from the givens and backwards from the goal, and hope that the jump in the middle is small enough to convince the marker. Now there may be a mistake in the top bit which makes the 'therefore' in the middle false. More generally, I find it disheartening when a mathematics student uses the word "therefore" when a therefore plainly isn't there. Never mind that they could not do this particular question; it just seems to betray a lack of *mathematical ethics*. But such things are hard to teach.

Lecturer V

The leader

It is a while since I did face to face teaching and since I am allergic to educational theorists I'd probably dismiss these views if they were presented to me from someone in my position. After teaching for 30 years I don't miss the marking (I'd prefer sweeping the streets!) but I do miss teaching. Anyway I have been involved in University level issues on learning and teaching, and mentoring and training so maybe this is of some minor interest.

First thing I should say is that I firmly believe that teaching is the main reason universities exist. You can't imagine the taxpayer shelling out for more than a

couple of universities that only do research! which would leave well over 100 HEIs entirely redundant and you and me unemployed. Of course the fact that universities are structured as they are, with only 24 teaching weeks, is because of the research component, but I have little doubt about our prime purpose. The other thing to say is that teaching really should always take precedence over research in anyone's list of priorities. We can work on our research again, but the students get the one chance at an educational experience; if we screw it up for them we screw it up for ever.

Having said that, I'm always a bit depressed about University learning and teaching events and initiatives. It may be harsh to say, but I don't see much correlation between those who profess an interest in learning and teaching and any expertise in terms of delivery. This is especially true of staff who have a research interest in higher education pedagogy. There are of course honourable exceptions, but too often one comes across staff who are at odds with their university position, struggling with research and whose interest in learning and teaching is motivated by the need to find a role and mutual support from others in the same boat. Actually most staff are not interested in pedagogy; they are interested in improving their teaching and irrespective of what it says in the dictionary don't see much connection between the two. The fact that we are mathematicians, and in the main strongly sceptical about social science research methods, may not help of course.

What seems entirely clear to me is that there are no hard and fast rules. We had one member of staff here who taught in a gown, only used chalk and talk, and had not changed his style of delivery in 40 years. The students absolutely loved him. Why force him to use an interactive whiteboard, or VLE or Maple? It worked for him and his students. If there were a list of rules for successful teaching someone would have written the great guide to teaching and we'd all be brilliant at it. Before anyone mentioned the words quality enhancement, staff development, peer review in universities, before the QAA was invented, there were splendid lecturers doing a wonderful job. To be fair I think that there were more useless lecturers doing a dreadful job too; maybe the new developments have improved things at the bottom end. But good teaching staff have always existed and standards at the top have not changed over the years.

Teaching is such an open-ended task, sometimes it feels a bit like parenthood; at times I have thought it was a question not so much of whether one succeeds but rather an issue of limiting the extent to which one fails. I would not go quite as far as Larkin went in criticising parents of course. We may not have such a dreadful effect on our students as Larkin would have us believe we have on our children, but one is always aware one can do better.

People do find feedback on teaching very difficult to take (myself included here),

and I have thought a bit about why this was the case. My brother now finds going to the theatre too embarrassing for him to bear. The reason is that when the actors all emerge for those excruciating encores he finds it too self evident that they are really just asking to be loved; he finds the act of asking perfect strangers for love too humiliating to endure. Of course teaching has a strong element of performance, especially in the large lecture setting and this is perhaps why we can find peer review and student evaluation so difficult. The teaching role is so tied up with us as an individual that criticism can feel like rejection of us as a person. Most of us do want to be loved by our students. The trick presumably is to be confident enough to take the criticism, but not too confident to ignore it.

There are other issues: deciding that you want to teach the students for their good and not your own: that is bearing in mind their needs and not your desire to appear smart or teach something you want to learn about and they don't. Getting inside the student's head is the big challenge; that is why we often teach best when the material is new to us. I remember a member of staff throwing his notes down on the coffee table in the common room and saying in disgust "I've been teaching this lot calculus for 20 years and they STILL don't get it". Someone tentatively pointed out that they were 20 different sets of students. One useful maxim for me has been: if 10% of the students have difficulties with my course then that is their problem; if 50% of them do then that's my problem.

The other challenge, after getting inside the student's head, is getting outside one's own. Many of us pride ourselves on our ability to judge new acquaintances in a short time (the interview process hinges on this). Yet we can live with ourselves for 50 years and still only have a vague idea of how we come over to others. I've only experienced it a couple of times, and neither was a pleasant experience, but I think there is a lot to be said for having oneself videoed and spending a long time looking at the results and thinking about how one presents.

Finally lots of staff don't much like PGCHes. Indeed most staff feel most staff development is fairly useless; it is the people you meet at events who provide the real interest. Sharing successes is good; sharing failure is even better, but you need trust for the latter. One interesting experience concerning sharing failure emerged when a former colleague, who was an open and honest man and good teacher came down to coffee complaining that he had not given a good lecture; things had not gone well; the timing was wrong; the students had struggled with the harder concepts. A self righteous prig leaned over as he left and said, with no hint of humour "I try not to give lectures like that." Now that is the sort of person that needs shooting!

Lecturer VI

How to get a response

If you don't mind something akin to a 'stream of consciousness', here are some thoughts on my teaching. Like one of the other respondents, I like to use some 'starters' - shove a question or a problem on the OHP as the students are coming in which gives them something to look at (or, you never know, even engage with) as soon as they sit down. Unlike your other respondent, though, I tend to make them a little longer (maybe a 2-3 minute thing): but horses for courses!

Actually, if I had one piece of advice for a lecturer starting to develop their own style, it would be that: 'horses for courses': by all means listen to as many people as you can talk about what they think works in their lectures, read some of the accessible research about what may or may not help students learn; but in the end, you have to be comfortable with trying things out in your teaching and sort out what works for you and your students. Let me give one example: in a course I've been teaching this year, I knew I needed lots of interaction from the very first lecture (with a group of first years). I also have enough experience to know that you simply won't get a response if you ask a question to a group of 100 people (that's why I'd used the other strategy of putting something on an OHP and then running around the room working with small groups or individuals). I'd heard what I thought was a mad idea for getting responses and I thought I'd give it a go - and it worked like a dream. Basically I chuck a ball pretty randomly into the audience (bounce it off a wall or something) and whoever it hits has to answer the question (obviously to save embarrassment, the questions have to be answerable by all, like 'what was the first thing you wrote down' or 'how did you go about this'). Whenever the next question comes up, they get to chuck the ball and whoever they hit gets to answer that question and so on. The students took it as an enormous laugh and, within a couple of lectures, I didn't need the gimmick any more: the students were very happy to just be randomly asked questions. BUT - 'horses for courses': this worked for *me* this one time, in this one context, with this particular class and, I have to say, took some mustering of courage to try it out.

The other thing that strikes me is that, having seen probably well over a hundred maths (and other) lecturers over the years in my various capacities, there appears to be a wide range of more or less natural teaching abilities amongst lecturers. I've seen people with no need of gimmicks, who were pretty shoddily prepared, and apparently doing little other than reproduce terse notes on a blackboard, hold a large class of damp, disengaged and drained students utterly spellbound for an hour. They're the exception and I simply don't belong to that group. One of the problems is that a lot of the people in that 'natural' category don't see the need for any training in how to lecture (and, perhaps, for them, they don't need much more than some advice about the local administrative technicalities: how to

switch the lights on, how to lay out an exam paper, how much ‘homework’ to set). However, the vast majority of us, who don’t have bags of natural ability really do need to think about our teaching - for ‘standard’ lecture courses, despite nearly 20 years teaching, I still need to write notes almost to the level of a script before I can give a lecture (even if I end up hardly referring to them). We ‘non-naturals’ need to fill that lack of natural ability with some learned ability: how to speak clearly, how to write out a coherent set of notes on the board, which bits of the course/lecture/proof we should highlight, how to tie different pieces of the argument together, when a diagram might help, how to have an alternative explanation and how to respond to ‘is that on the exam’ (answer ‘yes’, no matter what ‘that’ is!).

Some of this stuff is generic (how to speak clearly), some is specific to mathematics (or, at least, science) teaching (writing coherent notes on a board) and some is about really good content knowledge (having an alternative explanation).

One of the things which I’ve been thinking about for a while is the idea that ‘out there’, in that mass of 100 people, a lot of students will not be thinking about the maths in the same way I do. That’s not just that they are ‘novices’ and I’m an ‘expert’ - though there is some of that (some of them genuinely don’t see the point of proving something; some of them simply can’t see where the $\frac{\epsilon}{2}$ came from etc.). It’s that some of them really do want to see in pictures or assign significant meaning to things, while I really see the certainty of what I’m presenting as bound up entirely with the symbols (Weyl talks of ‘letting the symbols do the work for you’). If I teach to engage 100 little ‘me’s (scary thought) I suspect loads will have a real problem with what I’m doing. That’s another reason that thinking about our teaching (and teaching certificates and the like) can be really helpful (and perhaps, again, why a large slice of them needs to be mathematicians talking together, cos you can’t get much of this help from someone from a really distant subject) - you get different (valid, expert) perspectives on how you might teach something.

After all, ‘horses for courses’ is as valid a motto for the students as it is for the lecturers!

Lecturer VII

Thoughts on Teaching

I’ve been in the business quite a while now but am still trying to develop as a lecturer and improve the student experience.

When I first started, I attended a fairly brief “introduction for new lecturers” at the institution I was at. This was a couple of days of generic material but

had some useful aspects. The main one I still recall was being videoed giving a 10 minute lecture to the rest of the group, then watching the resulting videos together. Pretty scary, but actually gave me confidence that I was certainly no worse than any one else and actually delivered my material with a great deal of enthusiasm.

In fact my first lecturing experience at that university was something of a baptism of fire. I was given a 3rd year class in a topic I knew little about – though it proved to be very interesting. The class was rowdy and homed in on my inexperience. I used to memorise my lecture in the morning before the class and felt physically sick for an hour or so beforehand. However, I survived and I suppose the experience gave me strength. It was never quite as bad again!

By the next year I had gained in experience and felt much more confident. I had to take a group of engineering students who had failed Calculus I for a follow-on course, Calculus II, which they had to pass or be thrown out. They had no confidence in their mathematical ability. I put it to them straight that we were in this together and that we all had to work hard on improving their mathematics. I used engineering examples to motivate topics and gave them extra homework and tests to build up confidence that they really could understand and do some maths. It was going really well until someone noticed that I wasn't supposed to be lecturing the whole course – a professor close to retirement was scheduled to take over for the second half. I continued to attend the class as a practical tutor and was shocked by his attitude. He seemed to have decided that this group of students was destined for failure. He treated questions with a supercilious air – I had encouraged them and made it clear that no question was stupid. Anyway, I continued to support the students outside scheduled time and in fact about 75% passed. It taught me some lessons about attitude to students and motivating them, though I am not sure I would now be able to put in the extra hours I did then.

Over the years I have moved on and have honed my style and approach. I believe strongly in motivating students through concrete examples, trying to reduce the burden of note-taking (though not giving out complete copies of my lecture notes – something is gained by writing during class), using active engagement in lectures by having regular worked examples/pauses for thought. I try to mention my own research problems and explain briefly how what is being studied relates to them, even in a basic calculus class.

I have learnt at the feet of charismatic lecturers through formal and informal peer observation (as well as from anti-charismatic ones such as the professor above!). My current university has an extended programme for new lecturing staff involving regular sessions in their first year and production of a portfolio. I am rather glad I don't have to go through this – I can see it is worthy but it is so time-consuming and I think that it is unlikely to have much effect on a really

poor lecturer. Sessions I have attended and portfolios I have been asked to assess confirm my thoughts that a lot of what is contained in such courses isn't relevant to mathematics teaching. Let's all discuss Lagrange's Theorem in small groups everyone! On the other hand, I have heard with interest from colleagues about approaches to getting students to 'discover' mathematics for themselves and would love to be able to implement them. I think the idea of a syllabus that has to be got through in the term stands in the way of this approach but maybe the students would actually understand more this way than being rushed through a set list of definitions, theorems and proofs. I certainly came to really understand undergraduate mathematics through (heated!) discussions with an informal group of friends from my course.

Lecturer VIII

English ways

When I came to my current university in the UK, I had some teaching in the US before. But nothing could prepare me for this Here are several random yet important points.

1. **Lecture Notes** Students here expect you to produce a set of lecture notes. There is no way around it. The majority won't buy a recommended textbook. If you have no desire producing printed notes, hand-written (written as you go alone) will do. The students will appreciate a good set of lecture notes.
2. **Students are Strong** Whatever advanced topic you would like to teach, there will be listeners as soon as you make an effort to plan the course and to prepare the lectures well. If you are still uncertain, just tell them that the exam will be 100 % coursework at the beginning. Good lecture notes will help as well. One drawback of having advanced students is that they started specialisation quite early. This usually means that the gaps in their knowledge are everywhere. A student may know Carathéodory's extension theorem but not being able to compute an integral by Euler's substitution. It is advisable to find from time to time what students actually know.
3. **Students are Weak** On the other side of the spectrum, 50% of our students finish their degree hating Mathematics and thinking that going to do a degree in Maths was a major mistake. Unless you teach a core module, you have an option whether to keep them on board. If you speed up at the beginning, you lose most of these students. Going slowly, you will keep them.

4. **Exam** British exam is a piece of modern art. They are, in general, unscaled, which makes setting them a lottery even with experience. Remember that if the course is advanced, the students there are stronger. Hence, the averages should be higher than the prescribed 65%. Physics even has a special scaling procedure that includes Bayesian expectation of the marks. Unfortunately, mathematicians are not that advanced yet. Spend some time thinking of the exam and make sure that you can write solution of any problem on the exam in 10 minutes.
5. **Homework** If you want students to work on homeworks during the term, make them assessed. Otherwise, nobody will touch them until the time before the exam.
6. **Evaluation Forms** Some students will always like you, some will always hate you for virtually the same, just being yourself. So relax and just enjoy it.

Lecturer IX

Caring is what counts

I find teaching rather difficult. When I come to deciding how I'm going to set out my stall, I often realize that I don't understand something quite as well as I thought I did! I'm probably not the only person with this experience. I've discovered that when approached in the right kind of spirit teaching can be very helpful to my personal understanding. I also find through teaching, particularly with courses in the first or second years, that I find a new respect for the subtleties of apparently simple topics.

I have tried hard to read the educational literature, but (like the relative profundity of research papers in mathematics) it is a mixed bag. There are a number of authors in the education world who really do have interesting things to say to those of us who teach in Higher Education. One in particular is John Mason. Something he has highlighted for me is the importance of *examples* in mathematics. His work concentrates not on single examples, but the value of getting students to think about what can change ("domain of variation") and how much it can change ("range of permissible change") for the properties to still hold. There is more to this than it first appears. Does a theorem, after all, just collect together a set of examples? What is the purpose of a definition?

May I suggest one "example" (!) to illustrate what I mean by variation here? I ask the question because to appreciate it you will need to try it out for yourself.

Take a cubic with three real roots. Sketch the graph and add the line tangent to the point with x -coordinate which is the average of two adjacent roots. What do you notice? Perhaps you could use some technology, eg the free software **GeoGebra** to help illustrate the sketch when you move the roots around. What happens when you only have one real root? (can you even make sense of the problem?) With a little imagination it is often possible to wring a lot of very interesting mathematics from one simple looking example.

One of the things which is striking about teaching is that “*there are no axioms or theorems in mathematics education*”! For example, some people give calm, (dull?) traditional lectures in which they set out all the details of a piece of work. They give good notes and this can be very inspiring. Others “tell” students almost nothing, but lead them on with carefully designed problems. This is sometime frustrating, but students appreciate the value of this. People make very different approaches into effective strategies in the lecture room. The important thing is to *care* about your teaching and care about your students.

Lecturer X

Teaching as performance

When I was about to give my first lecture course I did what I expect most of us do; I thought about the lecture courses I’d attended and looked for the good things about them.

What I valued most as an undergraduate student were:

1. getting a good set of lecture notes from the blackboard,
2. lectures given with a positive atmosphere that showed the lecturer was pleased to be giving the lectures and enjoyed the material and thought it was important,
3. lectures given with a quiet authority which avoided talking down to the class but showed a desire to explain the topic in a logical and clear way.

So I began my teaching career trying to give the lectures I would have liked to listen to as a student. I did this for many years to excellent student reviews both here and in the USA (mostly at Berkeley). It helps to be young and of the same generation as the students. However students are replaced by new students and their ages are always between 18 and 22 whereas we get older, and the age gap is noticed by the students. Also student requirements have changed as their school education system has continually changed. So classes at my university became larger each year and students arrived with a poorer background in mathematics and a poorer background in studying. Lots of new students had never read a mathematics book and didn’t know how to study and work alone. So about 15

years ago I decided, one summer, to think again about teaching, especially teaching classes of 200-300 students.

I read books about teaching mathematics, such as Steven G.Krantz's book "How to teach mathematics" published by the AMS, and found these good on the practical matters such as what to do in the first lecture of the course (write the name of the course on the board, write your name on the board, explain in general terms what type of mathematics the course is about, give a little history of the subject mentioning a few things the students may have heard of, tell the students what you expect of them in terms of doing homework and reading lecture notes between lectures, tell the students how the final mark for the course is obtained in terms of the exam, homework and tests, write clearly on the blackboard and clean the boards well so that your writing stands out, etc). Since our 1st and 2nd year classes are so large I also listened to actors and entertainers talking about their craft and how they kept the attention of the audience. One evening I heard an old interview with the singer Frank Sinatra and he said "To explain a lyric (in a song) there must be some acting involved". So I tried this out when I taught Analysis II to the 1st year students. When I came to important topics, such as the definitions of continuity and differentiability, I raised my voice and changed the timing in my sentences and I walked in front of the tables at the front of the theatre and raised my arms as I explained how important the upcoming definition was. I did variations of this for all the important new definitions and ideas. I think it worked in getting the students to listen and concentrate. I think we have to emphasise what the really important new ideas and definitions in the courses are. I often tell classes they should put a pen and paper by the bedside and write down the new definition as soon as they wake. If they can't they should look it up. They should continue with this until they get the definition correct on three consecutive days. This emphasises how important the definition is. As a variation I sometimes tell them to go through the definition in their heads as they walk to the lecture room from home the next morning.

I think the following are important things.

1. Prepare the course well. This includes choosing good notation and sticking to it. It is very confusing for a weak student when a lecturer changes notation part way through the course. Try and be consistent with any book you recommend, or at least comment on any difference with the book. For example some books consider 0 is a natural number but others dont.
2. Show you are happy to be giving the course and act as if you are keen to explain the topic to the class. Make the topic seem important.
3. At the beginning of each lecture do a bit of a summary and also tell the class what results you are aiming for in the next few lectures.

4. Find ways to keep the lectures interesting and involve the class.

Lecturer XI

English as a foreign language

English is not my mother tongue, and I wish to say a few words to fellow sufferers who, like me, are forced to strain their voice cords by giving lectures in a foreign tongue to audiences of up to 200 students.

I came to Britain already having had some serious teaching experience. It was obvious for me that I had to take special care of quality of my English and I sought advice from a professional teacher of English. She videotaped one of my lectures (strongly recommend!) and helped me to identify two key issues: articulation and projection of voice.

These are interesting points. Many mathematicians frequently “talk to the blackboard”, forced to combine talking with writing long formulae on the blackboard. I always liked to look at the audience, but here it became clear that I had to entirely exclude even occasional “talking to blackboard”. My English was sufficiently blurred by a different pattern of articulation of my mother tongue, so to hide my lips from students meant to further impair communication. I took the advice very seriously and soon realised that the best way to separate writing on the blackboard from speaking was to follow simple rules:

1. I try not to speak when I am writing.
2. When I have to say something, I stop writing and press the chalk against the board immediately at the end of a phrase or a formula, so that later I am able continue my writing exactly from the point where I stopped.
3. Then I turn to the audience – keeping right hand with chalk in it on the board (I am right-handed).
4. I use this movement to free my diaphragm and rib cage and fill my lungs with air – the outstretched arm helps me to take in a proper breath.
5. Then I speak, looking at the audience, making eye contact and projecting my voice into the lecture theater. (A side remark: calm relaxed breathing means confident speech. In a large lecture theater, students’ independence is suppressed by crowd dynamics, and they are much more receptive to non-verbal and sub-conscious clues in communication. Good breathing technique is the first step to mastering crowd control. By the way, the chalk pressed against the blackboard at the end of unfinished line perhaps plays the same role as a watch on a chain or a wand in hands of a stage magician – it works as a focus of the audience’s attention and emphasises that the lecturer remains in control.)

I believe that over almost two decades of my work in Britain I delivered some decent lectures, but I felt that my voice cords were under constant strain. This is

why I arranged a session with a professional voice coach. It took her less than a minute to diagnose the problem. She asked me to pretend standing at a blackboard and say, as I usually do in the lectures, a few opening words – in English and then the same phrase in my native tongue. The problem was obvious in English I was speaking in unnaturally low voice, much lower than I normally speak in my native language. This puts a strain on voice cords. Some exercises recommended by the coach (and even more so - a simple awareness of the problem) helped.

Therefore my advice to my colleagues (especially non-British ones):

1. Even if you feel that your lecture technique is OK, propose to the Staff Development Office that they do something useful instead of their usual Powerpoint training and request them to arrange a one-to-one session with a professional voice coach.

2. You may find that it is best to avoid whiteboards – felt pens are made for writing by hand and wrist; small movements of fingers and hand suppress breathing. When writing with chalk on a blackboard, we move the whole arm, which assists the proper ventilation of lungs. The worst thing that you can do is to write on a transparent film directly on the plate of an overhead projector – it is very difficult to avoid reducing your voice to a whisper.

3. Try to videotape and watch your lectures (but be prepared for a shock!).

4. Teaching is not a science, it is art. Moreover, it is a performance art. Some lessons of theatrical acting (basic stuff – posture, voice, stage movement) would really help.

Lecturer XII

The key question

My own comments/gripes seem mostly to be on just one key question: how can we improve the degree experience for our students? Our incoming students are full of zeal and optimism (in a brief foray into admissions I got to read student files and how often I read ‘this student is the best we have had in maths at this school for X years’). We have a responsibility to make the experience fulfilling for them and I find it sad when a tutee doesn’t see me for 6 months. I don’t believe in the oft heard ‘students are adults and must make the decisions by themselves’. I also do not believe in meddling, or expending that much time and energy, but I do think we should do more to tell students what we expect, what we respect, and how to approach the degree, or perhaps how to start thinking about how to approach the degree. Of course we know many or most of them take a maths degree for the wrong reasons, but that doesn’t mean that they cannot learn to enjoy it, mostly by some self-chosen hard work, and allow this hard work to benefit them

as individuals as well. On the fringe of some central university committees (and it took me some time to treat these with the lack of respect they often deserve - Repeat after me: The centre is there to help us, the centre is there to help us...) I am hearing the scary phrase PSP (personal student plans?), which are thought through in other departments/universities, and I think that a lot of good could come from a small amount of energy along these lines. For someone used to the US or European model where students can fail and retake a module and learn by their mistakes, it may seem strange to start guiding students. How often I hear from non UK trained staff questions on exactly this. But we are stuck with the UK 'one chance and cannot fail' system at least for the moment. Tackling the key question is surely a lot of hard work (should we lecture less, assess less, use more projects, spend time developing transferable skills, run active example classes, get genuine feedback, . . . ?) and we have no real forum for even thinking about it. The training system is perhaps the place, and the department does have a tradition of backing schemes and allowing people to try things out. Certainly not the teaching committee which is completely ineffective on this (though it has taught me that staff genuinely disagree on strategy). As usual it is bursts of staff energy that lead to changes (sadly often not built on). Such bursts are easily channelled when they affect just one module, but harder to harness for wide ranging changes. 'Reorganise the timetable to everyone's benefit' I hear from my colleagues - but where on earth is the time/energy to even start to think about this? The Head of Department's strategy of giving large admin tasks to just a few (only ruin a few lives for a while and free most people maximally for research) is understandable, but does lead to staff being out of touch with the key question, and encourages the sad staff attitude that it is dangerous to be good at something, as you then get more of it to do. I would rather have a small task, try and do it quickly but well, and share in a common aim of excellence.

I have only tiny comments on my errors in working out how to prepare a lecture course. After falling into the standard trap of ignoring the previous lecturer's hard gained experience, I tried a good variety of different models with small classes (projects, essays, student lectures) and mostly these worked somewhat, typically in proportion to the energy that I put into them. But teaching large classes (over 200) I did find tricky and my views have changed on what to do with such industrial-sized groups. As ever, students respond primarily to the enthusiasm of the lecturer for the material, and this does require careful script writing. I learnt several tricks from peer-observing other lecturers, though I mostly try and avoid it now as I find I typically cannot stand watching them. Sitting in huge lecture halls allows one to see the very many styles in which students respond to lectures, from those hanging on every word, to those reading newspapers in the back. How can one lecture effectively to all these types? I no longer count putting a coherent

well-structured account for the students as a top aim of my lectures. I bang on about reading books; we must push this through tutorials too. I am pleased when students get pleasure from the module, and especial pleasure when they work hard at it - though does this mean they work less hard at my colleagues modules? It is releasing the student's energies, and making them realize that they can work stuff out for themselves, that is important. I learnt from observations a variety of tricks - a two-minute energy break; starting a lecture with something for the students to write; lowering my voice, slowing-down and speeding-up; including historical perspective; always answering questions positively: 'of course you don't quite mean that, you meant to ask this, which is a great questions because...'. I learnt that careful administration is vital to avoid 250 copies of the same e-mail. I now spend much longer on example sheets than lectures, trying to construct well motivated and do-able sheets that may tempt the students into some really hard work, and I talk about the question sheets in lectures and always promise to exploit them heavily on exams.

I have also switched energy into tutorials, where the individual approaches of one's tutees can really be affected, and real teaching can happen. I think that staff training should take on tutorials as well. In year one I use a set of 'off syllabus' problems that are aimed at engaging or re-enthusing tutees' interest. In the second year, there is real scope for helping students with the motivation for tackling tough modules like Metric Spaces or Algebra II. Tutorials should be more important to the student than lectures and there are not enough mechanisms to make them work easily and profitably (while we still have the time for them).

The greatest stress I have had is with PhD students. I greatly benefitted from finally realizing that difficult students were quite common and one should really try and detach. I am also more careful now about accepting to supervise students.

Lecturer XIII

Experiences of generic training

My first job as a lecturer was in an ex-polytechnic and it was not fun. There was a large teaching load - in my first year I worked on at least five different modules. The students were unprepared for university and as much of my teaching was service teaching, most of the students did not care about mathematics. On the positive side, this did expose me to a huge variety of situations and so I learned a lot about teaching.

During the first eighteen months of my job I studied for a higher education teaching certificate. This largely consisted of generic training, i.e., material that the course tutors deemed suitable for any subject. Unfortunately, to them this

meant material for essay-based subjects. So we had a weekly diet of how to set essays, how to mark essays, how to encourage students to write better essays, etc. Nothing on problem-solving for example.

I'm not against generic training per se. In fact I am in favour of a compulsory element of generic training. In the course I attended we were promised a session from a voice coach so that we could learn to use (and protect) our voice, and sessions on presentation from a professional public speaker and a stand-up comedian. None of these actually happened - our course tutors weren't that organized - but I feel these would have been very valuable lessons which could apply in all subjects. Subsequently I have learned a lot from such sources.

One of my complaints against university-provided courses, rather than departmental ones, is not that they have too much generic training, it is that those giving the course often have no concept of what mathematicians do. Our course lecturer (who, I am unhappy to report, liked to be called a facilitator) adamantly insisted that we tell our students that in higher education there is no wrong answer. To tell them they were wrong was demotivating. Instead, what the student wanted and what the student felt were most important in our approach to teaching.

So I suppose really that my main problem with those training lecturers is their insistence on the primacy of student-centred learning. We are expected to bend over backwards to accommodate what the students wants and how the student feels. I am not saying that we should ignore what they want, I am just saying that teaching should not be considered a dirty word. (I know a university that will not allow committee or job titles to be labelled as say 'Teaching and Learning Coordinator', they have to be called 'Learning and Teaching Coordinator', because the learning is most important.) Personally, I take the view that I am there to teach. We are more than just 'facilitators.' It is my job to *lead* the students on a path through the material, not let them blunder around on their own path. I can't just turn up at the start of a course and say, 'Complex analysis. What are your thoughts on this? How does it make you feel?' I have to give the students some material before I can expect them to provide any input. This may be different in other subjects, it is entirely plausible that in a history course the students will have a lot of relevant knowledge about say WWII and can contribute to a discussion right at the start. I just think it is a lot harder to do this in a science-based subject and the generic educators do not take this into account.

According to my course tutor, one corollary of student-centred learning was that we are not here to change people. I thought that that is precisely what we are here for. I take the view that we have to educate a student so that at the end of the degree they don't need us. Surely, that is changing them.

I should say the course was not all bad. After all, some sort of teacher training is vital as it means that you don't have to re-invent everything. (Just don't get

me started on the session where our tutor made us go outside to find a stick, name it, give it a character and introduce it to the group.) One important aspect of the generic training is that you get to meet lecturers in other subjects. It was comforting to me to see that lecturers in other subjects were having to deal with the same problems such as class room management as I was experiencing. Not only that - they often had good ideas about how to deal with certain situations. (Interesting aside: our tutor did not like us to give each other advice. If someone had a problem, then we were only allowed to ask them questions so that ultimately they could find the answer within themselves. This was rapidly circumvented by us asking questions beginning 'Have you tried ...?' This line of questioning was of course then banned.)

Another good aspect of the course was that the university gave two automatic pay scale increments to anyone who passed the course. For me, any university that does not provide a financial reward for their course should be ashamed of itself. And any manager who replies that education is about more than just remuneration should be told that if a university does not put a monetary value on one of its own courses, then why should they expect anyone else to?

Before I finish what seems to becoming a rant perhaps I should give some advice. I don't have all the answers (maybe I don't have any) so I will limit myself to one piece of philosophical advice and one piece of practical advice.

The philosophical advice I would give to a new lecturer is the following. The students are not you. Only a tiny, tiny minority will go on to be teachers or researchers in higher education. Mostly they will not have the love of mathematics that you have. Some will but many will be studying at university because it was their least worst subject, because they hate essays, because there is always a right answer, because their parents wanted them to, because they want a high-paying job, and so on. Use your own experiences by all means. But don't let them be your only guide. Just because a topic was so difficult that it challenged you and motivated you does not mean that by your setting hard challenging topics the students will suddenly become motivated. Like most approaches it will work with some students; but no approach works for all.

This may sound depressing but coming to terms with it early on may help you. Once it is accepted, you can begin enjoying teaching and most importantly, getting the students to enjoy mathematics.

Practical advice now: Get students doing. Imagine that you wanted to learn to dance and at dance school you watched the teacher dance for an hour and then the teacher says 'Ok, you have to do that next time. I'll mark your attempts and not let you know where you went wrong.' That's how I see a lot of mathematics teaching. We give students a load of material and expect them to master it without much practice or feedback. This is not how we do research, we look at examples

and we calculate as we learn each definition or theorem checking it against what we, and others, already know.

One way to achieve this ‘doing’ is to have an occasional lecture where the students calculate something during the class to help motivate them - the equivalent of being taught a few dance steps and then being asked to repeat them. For example, when teaching eigenvalues and eigenvectors to engineering and business students I showed them how to calculate eigenvalues. I then gave each student a matrix for which they had to calculate not only the eigenvalues but also the determinant, trace, product of eigenvalues and sum of eigenvalues. The data from the whole class was then collected on the board. First, they got to practice a topic and so could begin to understand it. Second, they found that the trace was the same as the sum of eigenvalues etc. This was surprising to them and had quite a few jumping up and down in their seats with excitement wanting to know why. These are engineers and business students excited about eigenvalues for goodness sake! It can be done...

Chapter 10

Sample Learning Outcomes

10.1 Warwick University's Maths/Stats Teaching Qualification

The following is a summary of skills and activities expected of a lecturer.

1. **Subject knowledge:**

- (a) Be fluent with the subject matter on which you are lecturing.
- (b) Know how the modules you teach fit into the structure of the degree - which level of knowledge you can expect from the students when you begin the module, and what other lecturers will expect of the students who have taken your module.
- (c) Pitch your lectures at a level which is appropriate to your audience, taking account of what the students can reasonably be expected to know, and be able to understand.
- (d) Fourth year MMath modules: be conversant with some current research in the area in which you are lecturing.

2. **Communication skills:**

- (a) lecture enthusiastically
- (b) lecture accurately
- (c) speak audibly and clearly
- (d) write clearly on the blackboard, taking care that your writing is sufficiently large that students at the back of the hall can read it, and using the blackboards in a sensible order, *or*

- (e) display text by some other means, such as ohp or data projector, taking care to display each page for enough time for students to copy it down.
3. **Quality of exposition:** If you do not provide lecture notes or use a textbook, then what you write or display should provide students with reasonably complete lecture notes.
- (a) These notes should be organised in the standard way, with each new result numbered or named so that it can be referred to subsequently.
 - (b) In lectures and in Lecture Notes, theory should be leavened with examples, and students should be encouraged to make up and test out their own examples.
 - (c) You should take account of the fact that students may have different styles of understanding, and offer various approaches where possible, including heuristic explanations of difficult and technical theorems.
 - (d) Where possible you should use diagrams to convey or summarise information, and encourage students to draw their own diagrams. Although not all students appreciate diagrams, enough do that this is a technique worth developing.
 - (e) The material should be accessible to all or most of the students taking the module, with references to more advanced material to stretch the strongest.
4. **Exercises/Projects/Essays** Every lecturer should set exercises, projects or essays which oblige students to deepen their understanding of the module. Exercises should be set at several points during the term; in a ten-week module, students should not have to wait more than two weeks for the first set. In particular, they should set
- (a) enough very easy and routine exercises for even the weakest students to get some practice with the basic concepts of the module;
 - (b) enough exercises at a middle level, whose solution is within the reach of most students, though requiring serious thought and effort, to oblige the students to understand the material;
 - (c) some exercises which will challenge and excite the brightest and strongest students, and provide opportunities for them to deepen their learning beyond the demands of the syllabus;
 - (d) where appropriate, exercises which display links with other modules, and draw on students' knowledge of other modules.

5. Assessment

- (a) If resources are available, some exercises should be marked for credit, in a proportion consistent with the department's conventions.
- (b) The final exam should be designed to ensure a spread of marks, consistent with the department's conventions, with parts of each question testing
 - i. book knowledge;
 - ii. the ability to perform standard calculations or elementary deductions of a standard type within the theory;
 - iii. the ability to solve previously unseen questions (to give the strongest students the opportunity to distinguish themselves).

6. Organisation

- (a) Start and finish lectures on time, taking care to observe local norms.
- (b) Make clear to students the organisational details of a module: syllabus, modes of evaluation, book lists, module description for course booklets, etc.
- (c) Make module material available and accessible to students via the internet or by producing and distributing printed copies.
- (d) Obtain and respond to feedback, student evaluations, etc.
- (e) Organise and support TAs if they run support classes.
- (f) Be available to students outside lectures, either via e-mail or through regular office hours.

10.2 MSOR Summary Assessment

Learning Outcomes for MSOR Summary Assessment Report

1. Have high expectation of students including a commitment to ensuring that they can achieve their full educational potential and to establishing fair, respectful, trusting, supportive and constructive relationships with them.
2. Demonstrate the positive values, attitudes and behaviour they expect from students.

3. (a) Be aware of the professional duties of university mathematics teachers and the collegial and statutory framework within which they work.
(b) Be aware of the policies and practices of the workplace and share in collective responsibility for their implementation.
4. Communicate effectively with students, colleagues and relevant others.
5. Have a commitment to forming learning communities among students, as in setting up peer support mechanisms, study groups, team working, with an awareness of plagiarism issues.
6. Recognise and respect the contribution that colleagues and relevant others can make to the development and well-being of students and to raising their level of attainment.
7. Have a commitment to collaborative and co-operative working, both within the department and in the wider university context, such as in staff development and externally, in MSOR community activities.
8. Work as a team member and identify opportunities for working with colleagues, sharing the development of effective practice with them.
9. Ensure that colleagues working with them are appropriately involved in supporting learning and understand the roles that they are expected to fulfil.
10. Have a commitment to, and understanding of, the implications of the outreach activities designed to increase participation in HE.
11. Understand how students develop and that the progress and well-being of learners are affected by a range of developmental, social, religious, ethnic, cultural and linguistic influences.
12. Know how to make effective personalised provision for those they teach including those for whom English is an additional language or who have special educational needs or disability, and how to take practical account of diversity and promote equality and inclusion in their teaching.
13. Know and understand the role of colleagues with specific responsibilities for learners with special educational needs and disabilities and other individual learning needs.
14. (a) Be aware of current legal requirements, national policies and guidance on the safeguarding and promotion of the well-being of students.

- (b) Know how to identify and support students whose progress, development or well-being is affected by changes or difficulties in their personal circumstances, and when to refer them to colleagues for specialist support.
15. Have a secure knowledge and understanding of their subjects/curriculum areas and related pedagogy and teaching and learning media and methods to enable them to teach effectively across the ability range they are teaching.
 16. Have a commitment to and understanding of appropriate methods for motivating and stimulating students' mathematical interests and inculcating attitudes conducive to the study of mathematics.
 17. Have a knowledge and understanding of a range of teaching, learning and behaviour management strategies and know how to use and adapt them, including how to personalise learning and provide opportunities for all learners to achieve their potential.
 18. Know how to use local and national statistical information to evaluate the effectiveness of their teaching, to monitor the progress of those they teach and to raise levels of attainment.
 19. Reflect on and improve their practice, and take responsibility for identifying and meeting their developing professional needs.
 20. Act upon advice and feedback and be open to coaching and monitoring.
 21. Have a creative and constructively critical approach towards innovation, being prepared to adapt their practice where benefits and improvements are identified.
 22. Evaluate the impact of their teaching on the progress of all learners, and modify their planning and classroom practice where necessary.
 23. Know and understand the relevant curricula for their subject area, and other relevant initiatives applicable to the student cohort they are teaching, and how to design appropriate strategies and materials to meet these.
 24. Plan for progression across the ability range for which they teach, designing effective learning sequences within lessons and across a series of lessons and demonstrating secure subject/curriculum knowledge.
 25. Where appropriate, design opportunities for learners to develop their transferable skills.

26. Plan coursework or other out-of-class work to sustain learners' progress and to extend and consolidate their learning, and use formative assessment to drive learning.
27. Teach lessons and sequences of lessons across the ability range which they teach in which they
 - a) use a range of teaching strategies and resources, including e-learning where appropriate, taking practical account of diversity and promoting equality and inclusion.
 - b) build on appropriately determined prior knowledge, develop concepts and processes, enable learners to apply new knowledge and skills and meet learning objectives.
 - c) adapt their language, to suit the learners they teach, introducing new ideas and concepts clearly, and using explanation, questions, discussions and plenaries effectively.
 - d) manage the learning of individuals, groups and whole classes, modifying their teaching to suit the stage of the lesson, and feedback elicited from the students.
28. Know how to use relevant transferable and ICT skills to support their teaching and wider professional activities.
29. Understand the need and have a variety of strategies for motivating and enthusing students.
30. Establish a purposeful and enjoyable learning environment conducive to learning and identify opportunities for learners to learn in and out of class.
31. Establish a clear framework for classroom discipline to manage learners' behaviour constructively and promote their self-control and independence.
32. Know the assessment requirements and arrangements for the subject/curriculum areas relevant to what they teach, including those relating to public examinations and qualifications.
33. Know a range of approaches to assessment, including the importance of formative assessment, and be able to match these to the learning objectives and the student profile.
34.
 - a) Make effective use of a range of assessment, monitoring and recording strategies.
 - b) Assess the learning needs of those they teach in order to set challenging learning objectives.

35. Provide timely, accurate and constructive feedback on learners' attainment, progress and areas for development.
36. Support and guide learners to reflect on their learning, identify the progress they have made and identify their emerging learning needs.

10.3 Higher Education Council Quality Guidelines

Chapter 11

Appendix A: The Professional Standards Framework

THE STANDARDS

<i>Standards Descriptor</i>	<i>Examples of Staff Groups</i>
<p>Demonstrates an understanding of the student learning experience through engagement with at least 2 of the six areas of activity, appropriate core knowledge and professional values; the ability to engage in practices related to those areas of activity; the ability to incorporate research, scholarship and/or professional practice into those activities</p>	<p>Postgraduate teaching assistants, staff new to higher education teaching with no qualifications or prior experience, staff whose professional role includes a small range of teaching and learning support activity</p>
<p>Demonstrates an understanding of the student learning experience through engagement with all areas of activity, appropriate core knowledge and professional values; the ability to engage in practices related to those areas of activity; the ability to engage in practices related to all areas of activity; the ability to incorporate research, scholarship and/or professional practice into those activities</p>	<p>Staff who have a substantive role in learning and teaching to enhance the student experience</p>
<p>Supports and promotes student learning in all areas of activity, core knowledge and professional values through mentoring and leading individuals and/or teams; incorporates research, scholarship and/or professional practice into those activities</p>	<p>Experienced staff who have an established track record in promoting and mentoring colleagues in learning and teaching to enhance the student learning experience</p>

AREAS OF ACTIVITY, CORE KNOWLEDGE AND PROFESSIONAL VALUES WITHIN THE FRAMEWORK
<i>Areas of activity</i>
<ol style="list-style-type: none"> 1. Design and planning of learning activities and /or programmes of study 2. Teaching and/or supporting learning 3. Assessment and giving feedback to learners 4. Developing effective environments and student support and guidance 5. Integration of scholarship, research and professional activities with teaching and supporting learning 6. Evaluation of practice and continuing professional development
<i>Core knowledge</i>
<p>Knowledge and understanding of:</p> <ol style="list-style-type: none"> 1. The subject material 2. Appropriate methods for teaching and learning in the subject area and at the level of the academic programme 3. How students learn, both generally and in the subject 4. The use of appropriate learning technologies 5. Methods for evaluating the effectiveness of teaching 6. The implications of quality assurance and enhancement for professional practice
<i>Professional values</i>
<ol style="list-style-type: none"> 1. Respect for individual learners 2. Commitment to incorporating the process and outcomes of relevant research scholarship, and/or professional practice 3. Commitment to development of learning communities 4. Commitment to encouraging participation in higher education, acknowledging diversity and promoting equality of opportunity 5. Commitment to continuing professional development and evaluation of practice

Bibliography

- [1] Ideas from Mathematics Education: An Introduction for Mathematicians, *to appear, published by MSOR*
- [2] A. Borovik and A.D.Gardiner, *Where will the next generation of UK mathematicians come from?*, preliminary report of conference held in Manchester in 2005, www.maths.manchester.ac.uk/avb/wherefrom.html
- [3] P. Dunleavy, *Studying for a degree in the humanities and social sciences London*, Macmillan Education, 1986
- [4] Department for Education and Science, *The Future of Higher Education*, White Paper available online at www.dfes.gov.uk
- [5] Rob East, *The use of essays in assessment: a case study for change* <http://www.ukcle.ac.uk/interact/lili/2006/papers/east.html>
- [6] Lewis Elton, *Management of Teaching and Learning: towards change in Universities*, London, Committee of Vice Chancellors and Principals and Society for Research in Higher Education, 1994
- [7] Graham Gibbs and Trevor Habeshaw, *Preparing to Teach*, Technical and Educational Services, fifth reprint 2001; ISBN 0947885560. This book is aimed at a general audience - not just mathematicians - but nonetheless has some useful things to say.
- [8] Hatzipanagos, S. and Lygo-Baker, S. (2006) Teaching Observations: Promoting development through critical reflection, *Journal of Further and Higher Education*, 30(4), 421-431.
- [9] Hatzipanagos, S. and Lygo-Baker, S. (2006) Teaching Observations: A Meeting of Minds? *International Journal of Teaching and Learning in Higher Education*, 17(2), 97-105.
- [10] HEFCE, *Increasing the number of Mathematics Graduates*

- [11] Higher Education Academy, *The Professional Standards Framework*, available online at <http://www.heacademy.ac.uk/ourwork/policy/framework>
- [12] Derek Holton (Editor), *The Teaching and Learning of Mathematics at University Level*, Kluwer Academic, 2001; ISBN 0792371917. An online review (published by the Mathematical Association of America) can be seen at www.maa.org/reviews/TLicmi.html.
- [13] Sue Johnston-Wilder and John Mason, *Fundamental Constructs in Mathematics Education*, Routledge Falmer: Open University, 2004; ISBN 0415326974 (hardback), 0415326982 (paperback)
- [14] Steven Krantz, *How to teach mathematics*, 2nd Edition, American Mathematical Society, 1999; ISBN 0821813986.
- [15] Ray Land, *Educational Development: Discourse, identity and practice*, Open University Press, 2004
- [16] Lomas, L. and Kinchin, I.M. (2006) Developing a peer observation program with university teachers. *International Journal of Teaching and Learning in Higher Education*. 18(3), 204-214.
- [17] Loughborough University web page on essay writing, www.lboro.ac.uk/service/fli/campus/essaywr.pdf
- [18] Simon Lygo-Baker, *Re-evaluating Values: The impact of Academic Developers*, *International Journal of Learning*, Vol. 12, 2006
- [19] Siobhan B.G. MacAndrew and Katherine Edwards, *Essays are not the only way: A Case report on the benefits of authentic assessment* http://www.psychology.heacademy.ac.uk/docs/pdf/p20030617_22macandrew.pdf
- [20] Niall MacKay, *On becoming a good maths lecturer*, contribution to a meeting at Warwick entitled “*Mathematicians and Mathematics Educationalists: Can we collaborate?*”, available at <http://www.warwick.ac.uk/~masbm/mvme.html>
- [21] John Mason, *Mathematics Teaching Practice: a guide for university and college lecturers*, Albion/Horwood Publishing House, 2002; ISBN 1898563799
- [22] D. Mond, *The Warwick Teaching Certificate (Mathematics), an experiment in departmentally-based training*, MSOR Connections, May 2005.
- [23] www.warwick.ac.uk/~masbm/mvme.html
- [24] Matt Owens,

- [25] *SET for Success: the Report of Sir Gareth Roberts Review into the supply of people with science, technology, engineering and mathematical skills*, HM Treasury Report, April 2002 ISBN: (no ISBN); parts available online
- [26] Reading University guidelines for peer observation,
http://www.rdg.ac.uk/Handbooks/Teaching_and_Learning/Peer_Review_Guidelines.html
- [27] Yvette Solomon,
- [28] Yvette Solomon,
- [29] Warwick Mathematics Institute staff training website,

- [30] Discussion page on Warwick Mathematics Institute staff training website,
www.warwick.ac.uk/~masbm/PCAPP/Events/Discussion/discussion.html
- [31] Warwick University guidelines for teaching observations,
<http://www2.warwick.ac.uk/services/ldc/resource/observing/>
- [32] G. Webb, *Understanding Staff Development*, Buckingham, Society for Research in Higher Education and Open University, 1996