1 About this document

This document has been provided by the Faculty of Mathematics Teaching Committee. Please send questions, comments, suggestions and corrections to undergrad-office@maths.cam.ac.uk.

2 Introduction

The aim of this booklet is not to provide a comprehensive guide to lecturing, or even a comprehensive guide to lecturing mathematics. Instead, the focus is very much on lecturing in the Cambridge Mathematics course, the Mathematical Tripos.

It is a mistake to think that because you are a fine mathematician you will effortlessly lecture well. It is also a mistake, if you have lectured elsewhere, to think that you can seamlessly transfer the methods you used previously to a new context. It all takes work, and this booklet is intended to give a bit of help. There is of course no one way of lecturing, so the best such a booklet can do is to explain the system and present some ideas.

There are vast numbers of books, conferences and learned papers on mathematics education at university level and much can be gained from engaging with this material. You may well find food for thought in the following (both available in the Moore Library), and there are no doubt many other similarly useful texts:

- *Mathematics Teaching Practice: A Guide for University and College Lecturers* by John Mason (Woodhead Publishing, 2002);
- *Ideas from Mathematics Education* by Lara Alcock and Adrian Simpson (available on-line as a pdf — google it).

However, the audiences we face in Cambridge consist mainly of high achieving, highly motivated and very able students, and our challenges are not always the ones addressed in the standard literature. In contrast, there are rather few useful books or articles on how to give a good maths lecture.

The central university Human Resources department provides some relevant Personal and Professional Development courses, including a course on lecturing in the sciences which may be of interest to you. You can find details of all PPD courses on http://www.training.cam.ac.uk.

Our undergraduate students are issued with a booklet 'Study Skills in Mathematics' (http://www.maths.cam.ac.uk/undergrad/studyskills). There is a section on lectures from the students' point of view which you might find interesting.

3 Why give lectures?

It is often argued that traditional lectures as a means of teaching undergraduates are obsolete in the digital age. Lectures were used in Cambridge before the invention of the printing press, when students sat and wrote down verbatim what the lecturer said and it was so cold that the ink froze in their inkwells; how can the same format be appropriate today?

David Pritchard gives a spirited defence of the lecture format for teaching advanced (*Int. J. Math. Educ. Sci. Tech., 41(5): 609-623)*. You can read a summary of his argument in *MSOR Connections Vol 10 No 3 Autumn Term 2010*[1], and there are references in this summary to other useful articles.

Pritchard finds three ways of justifying the formal lecture: as a way of communicating information, as a way of motivating the audience and as a way of demonstrating 'modelling mathematical reasoning' — showing students how mathematicians think.

Here are some excerpts:

The effectiveness of lectures in communicating information rests on clarity, and flexible delivery which responds instantaneously to feedback from the audience. The lectures that superficially appear transmissive may not be passive experiences. To record mathematics accurately, it is necessary to understand it at least partly; meanwhile the lecturer is commenting, pausing and illustrating, so the student is led ... through a process of mathematical argument.

The effectiveness of lectures in motivating students to deeper learning involves both communicating enthusiasm and cultivating a 'learning community' within the class. A genuine commitment to teaching and an awareness of group dynamics provide a lecturer with significant opportunities to influence how students learn both inside and beyond the classroom.

Lectures can provide students with 'vicarious experience', infecting them with the lecturer's enthusiasm and sense of the subject's importance. There is evidence that this can help mediate a transition from shallower learning based on 'extrinsic relevance' (mostly to assessment) to deeper learning based on the

[1] See http://journals.heacademy.ac.uk/doi/pdf/10.11120/msor.2010.10030003.

'intrinsic relevance' of the subject. Lectures are where students are 'invited to enter the lecturer's world'.

The effectiveness of lectures in modelling mathematical reasoning keys into the 'worked example effect', and relies on the lecturer's willingness to narrate strategies and to acknowledge heuristic approaches. The essential message for students to receive is that mathematics involves active processes rather than passive knowledge, and that this applies equally to experts and to novices.

There is a nice essay by Tom Körner [2] aimed at students in which he makes the case for attending lectures. This is a bit different from the case for giving lectures, but it is still a very good and relevant read.

4 The Cambridge course

The Mathematical Tripos, which is the Cambridge mathematics course, consists of four parts. Part IA, Part IB and Part II, which are normally taken in consecutive years, lead to the BA degree, and Part III is an optional fourth year leading to the MMath degree for those who took the earlier parts of the Tripos[3]. The lectures and examinations for Part III are shared by students coming from other universities; they receive the MASt degree for the same one-year course.

Until the introduction of the Classical Tripos in 1822, there was only one Tripos and this was primarily mathematical.[4] All other Triposes are comparatively modern inventions; for example, the Natural Sciences Tripos only came into being in the 1860s.

The Cambridge course differs from most other mathematics courses in the UK and probably further afield in a number of ways. If you have experience of lecturing (or being lectured to) in other universities, you will notice the differences as you read this document; if you have no such experience, the differences don't matter but it is worth saying that they relate to the structure of the course, the relation between the examiners and the lecturers, the relation between the supervisions system (teaching the students in small groups) and the lecturers, the formality of the lectures, and the pace of lecturing.

[2] https://www.dpmms.cam.ac.uk/∼twk/Lecture.pdf

[3] Students who studied Natural Sciences can take Part III of the Mathematical Tripos for the MMath degree.

[4] Very properly, the Classical Tripos could only be taken by students who had already taken part of the Mathematical Tripos, or who were sons of peers of the realm.

5 What can I lecture?

The lecture courses for the Mathematical Tripos are broadly divided into pure courses and applied courses, the lecturing of which is organised by DPMMS and DAMTP respectively. DPMMS probability/statistics courses are organised by the Statistical Laboratory.

In addition to lecture courses for the Mathematical Tripos, the Faculty of Mathematics is responsible for providing some of the mathematics lectures in Part IA and Part IB of the Natural Sciences Tripos

The assignment of lecturers to courses for any year is decided by negotiation in the Lent term of the previous year. It is normal to lecture the same course for several years, though it is not normal to lecture the same course consecutively for more than four years. Often, lecturers lecture one Part III course and one undergraduate course each year, but there is no general rule about this.

6 Schedules of the Mathematical Tripos

The material to be lectured in each lecture course of the undergraduate Tripos (i.e. Parts IA, IB and II but not Part III) is summarised in a booklet that is issued each year to each student. You can obtain a copy from the Faculty Office or find it on the Faculty web site (http://www.maths.cam.ac.uk/undergrad/course/ and click on 'schedules').

One of the ways in which the business of lecturing in Cambridge differs from many other universities is in the prescriptiveness of the syllabus. The schedule for each course is quite detailed and meshes with the schedules for other courses (especially in the case of first year courses). All the material in the schedule must be lectured, and only material in the schedule can be examined.[5]

Besides the Schedule of each course, the Schedules booklet contains much information about the structure of the course and of the examinations. It is the authoritative source of such information for lecturers, examiners and students.

The contents of the Schedules booklet (including the Schedule for each individual course) is agreed by the Faculty Board, on the recommendation of the Curriculum Committee with advice from the staff meetings of both departments. A lecturer cannot simply decide to change the schedule. In order to allow for

[5] The schedule is said to be *minimal for lecturing and maximal for examining*.

this process, proposals for changes to the schedules for the following year have to be received by the staff meetings at the beginning of the Lent term. Very minor changes, such as corrections, or alterations to the reading list, can be suggested to the Faculty Office at any time and can be implemented on the Faculty web-site before the Schedules go to print each August.

7 Preparing an undergraduate lecture course

The Faculty as a whole takes its duty with regard to the education of students (lecturing, examining, small-group teaching) very seriously and members of the Faculty have to be prepared to devote considerable amounts of time to it. Most lecturers prepare their lectures well in advance, sometimes in the previous summer.

The first port of call when you are starting work on an undergraduate (i.e. a Part IA, IB or II) lecture course for the Mathematical Tripos is the Schedules Booklet.[6] All the material in the schedule for a given course must be covered by the lecturer.

Next, you could try to find lecture notes of previous lecturers. Normally, lecturers are happy to lend their notes to their successors, believing that this is in everyone's best interest. However, if lecture notes are not available in this way, it may be possible to obtain them from a student who attended the lectures in a previous year (an undergraduate or graduate). If you have no college connection, you will easily find a friendly college Director of Studies to help you obtain such notes.

It is also possible that notes have been placed on the student web pages; good starting points are the Archimedeans' web site[7] and the web pages of the student representatives.[8]

You will normally find that the person or people who lectured the course in previous years will be very happy to talk about the various ways topics can be approached and point out the pitfalls. They have usually invested large amounts of time in the course and are more than willing to pass on their experiences.

[6] There are similar schedules for the Part IA and Part IB courses that the Faculty provides for Natural Sciences students.

[7] See http://www.archim.org.uk/notes/. The Archimedeans is the name of the University student mathematics society. You may well be asked to give a talk!

[8] See http://www.maths.cam.ac.uk/studentreps/tripos.html. There are student representatives on the main Faculty committees: three on the Faculty Board, two on the Curriculum Committee and two on the Teaching Committee.

It is always a good idea to look carefully at the previous year's examples sheets[9] and it may be useful to look at Tripos questions from previous years[10].

Although the order of material in the schedules is logical it is not prescriptive, so you can change it if you think a different order makes better sense. However, you have to be careful because sometimes — particularly in Part IA — the order of material given in the schedules is carefully planned to allow for the requirements of other courses running in the same term.

Most of the above is written with undergraduate lectures in mind. For Part III, there is a great deal more freedom to choose what to cover and what emphasis to place on the various topics. There is much more of a sense of lecturer ownership of the courses (which might perhaps be the norm in other universities).

8 Delivering the lecture

The Faculty Board has stated explicitly that it is up to individual lecturers to decide on the form in which they present material to students. Some lecturers like to use 'chalk and talk' and students are expected to take their own notes during the lecture. Here 'chalk' could be (and, in the larger lecture theatres, often is) a euphemism for felt-tip on OHP or a stylus on a tablet computer or an 'illuminator'. Some lecturers supplement what they write with handouts which might contain worked examples (so that the audience can concentrate better while the lecturer explains the examples) or some technical proofs that would involve a great deal of fiddly writing by both lecturer and audience, or perhaps a summary of the main results of the course. Some lecturers provide complete printed notes, which can be made available in advance of the lecture, or during the lecture. Sometimes, lecturers leave gaps for diagrams or equations in their printed handouts so that the audience has something to do in the lecture. A few (actually, a very few) lecturers use power point presentations; mathematical audiences seem not to like such presentations though they have become very standard in the Natural Sciences.[11]

[9] See § 11 of this document, and also the *Examples Sheets* page on the Faculty website: http://www.maths.cam.ac.uk/undergrad/examplesheets/.

[10] See http://www.maths.cam.ac.uk/undergrad/pastpapers

[11] Tom Körner (https://www.dpmms.cam.ac.uk/∼twk/Naked.pdf) has a good analogy: seeing a powerpoint presentation of mathematics is like walking through a museum of stuffed animals. This analogy also sheds light on what Pritchard is writing about in the excerpts given in section 3.

Generally, writing on the blackboard or an OHP forces the lecturer to progress at a pace that allows the students to follow, at least roughly, what is going on; flashing up powerpoint slides can lead to lectures proceeding at a rather fast pace.

Many students, particularly those in Part IA who may have been spoon-fed mathematics at school and are not yet used to a more independent approach, believe that printed lecture notes will solve all their problems. The Faculty Board has always resisted pressure to place a requirement on lecturers to provide such notes, though if you are lecturing to Natural Scientists you will find the audience expects to receive printed notes.

It is absolutely essential that, at the end of the course, the students have a set of notes that is good enough for them to revise from. There is no text book (or 'book of the course' as is normal in universities in the US) for most Cambridge courses. This means that your lecture notes must be well-organised into sections and subsections, clearly labelled. Some lecturers number theorems, lemmas and the most important equations for easy reference. Students find it helpful if notation is clear and consistent throughout the course.

Normally, students will write in their notes exactly what you write on the blackboard (if that is what you are using). They will not have time to annotate with your witty or penetrating asides, so if you want them to have a record of something, you must write it out. It is therefore very important that what you write should make sense on its own: you can't just write the equations and expect the audience to fill in the all-important in-between words.

Many lecturers read out loud what they are writing as they write it (even the equations), and students find this helpful.

Some lecturers deliver their entire lecture without reference to notes, or perhaps with just a surreptitious glance at a back of hand aide-memoire. However, most lectures find it less stressful to work have a complete set of notes, and refer to them during the lecture. If you are considering lecturing without notes, or just want to enjoy the wit and wisdom of a very accomplished Cambridge lecturer, you can do no better than to read Tom Körner's essay 'The naked lecturer'.[12]

[12] https://www.dpmms.cam.ac.uk/∼twk/Naked.pdf

9 Lecturing

Generally, lectures take place only in the mornings (from 9.00 to 1.00 to be more accurate).[13] They start at 5 minutes past the hour and finish 5 minutes before the hour in order to allow students to get from one lecture theatre to the next.[14] It is important to try to keep to time at both ends; it makes life difficult for the next lecturer if you finish on the hour and are still dealing with student questions when he or she wants to start, and it can create problems for the students, not least because some may have three or four consecutive lectures and are glad of the 10-minute breaks.

Part IA and Part IB lectures are held in the town centre (Cockcroft lecture theatre for Part IA of the Mathematical Tripos and Mill Lane lecture rooms for Part IB), because there are no lecture theatres in the CMS large enough for the full cohort (of up to 250 students). The lecture theatres are fully equipped with audio-visual aids, including microphones, which some lecturers find useful, overhead projectors and data projectors.

Part II and Part III lectures are held in the CMS. The lecture theatres in CMS are also well-equipped. The smaller ones are more like classrooms, so microphones are not needed.

The lecture timetable[15] is constructed in June for the following year. All lecturers are consulted, but are asked to be as flexible as possible because of the severe constraints placed on the timetable by the many courses in the Mathematical Tripos running concurrently, by the requirement to fit in with other Triposes, by lecturers' other commitments, and by the shortage of lecture theatres (large lecture theatres in particular). Saturday lectures are for many students and staff an unwelcome necessity; everyone has to do their fair share, but family and other commitments are be taken into account when the timetable is drawn up. For each lecture course, there is a regular time slot days (nearly always MWF or TThS for 24-lecture courses) and, once the slots have been arranged and advertised, they are altered only if there is a very compelling reason. Sometimes, you may have to miss a lecture, through illness for example, but it is expected that you will arrange your other commitments round your lecturing timetable. If you know in advance that you will miss a lecture, then it

[13] This applies to the undergraduate Tripos; some Part III or other graduate lectures may well take place in the afternoons.

[14] The 9.00 lectures given for Part IA of the Natural Sciences Tripos start on the hour and finish at 9.50 because the next lecture theatre may be in a different part of the town.

[15] See http://www.maths.cam.ac.uk/undergrad/lecturelists/

may be sensible to ask a colleague to give the lecture for you using your notes. Otherwise, you can run one lecture behind schedule and give the final lecture on the day after lectures would normally have ended.[16]

In the schedule for the undergraduate lecture courses, you will find an approximate number of lecture assigned to each paragraph. It is important to keep your lectures roughly in time with this assignment, because the students' work will have been arranged in advance (see the section on examples sheets).

In Parts IA and IB, there is no possibility of changing the term in which a lecture course is given. In Part IA, the only times available are 10.00 and 11.00 because the lecture theatre (Cockcroft) is shared with other faculties so the choice of times for any given course is very limited. In Part IB, the lecture theatre (lecture room 3 in the Mill Lane lecture rooms) is used mainly, but not exclusively, by the Mathematics Faculty so we have more control over the timing of lectures. For Part II and III, there is much more flexibility in the choice of time for a lecture course.

Some Part IA courses in the Mathematical Tripos are attended by students from the Computer Science Tripos; and some Part IA courses are not attended by students taking the Maths-with-Physics option of Part IA Mathematics. You have to remember, if you are lecturing in Part IA, to be careful when referring to material in other courses since some (a very few, actually) students will not have attended all the other courses. In the Easter term, the Part IB lecture courses are attended mainly by first year students but there will also be second year students revising the material or meeting it for the first time. Again, you have to bear in mind the inhomogeneity of the audience.

There are about 35 lecture courses in Part II. There are only 8 slots (MWF, TThS) in each term, and no lectures in the third (Easter) term, so clashes are inevitable. If multiple clashes are minimised, then every course will clash with at least one other, and nine courses will clash with two others.

On average, students attend about 8 lecture courses in Part II. There are two types of course: C-courses and D-courses. C-courses are intended to be straightforward and accessible, and of general interest, whereas D-courses are intended to be more demanding. Students tend to choose the courses that interest them most, with the weaker students following the Faculty Board's recommendation to include some C-courses in their choice.

The timetable is arranged so that no C-courses clash with each other and any course clashes only with a course in a disparate area of mathematics

[16] The first day of lectures in each term is always a Thursday (though individual courses may start on the Friday or Monday) and the last day is the Wednesday eight weeks later.

(Waves with Algebraic Topology, for example). The lecture theatres in the CMS vary in size, so the timetablers have to guess how popular each course is going to be. Inevitably, they do not always get it right, and there is some swapping of lecture theatres at the beginning of each term.

In Part III, there are more than 70 courses and multiple clashes cannot be avoided, though again clashes in similar subject areas are avoided.

10 Common student complaints

1. *The lecturer is inaudible.* This is usually in the larger lecture theatres. It is a good idea to ask the audience if you are generally audible (it is anyway a friendly overture); if not, then shout or use the microphone.

   Sometimes it occurs because the lecturer is talking to the blackboard and not to the audience. Some degree of interlocution with the blackboard is inevitable; lecturers tend not to remain silent for the periods when they are writing, and students generally find it helpful if lecturers read out what they are writing as they write it. However, when you are explaining something, a conscious effort to turn and face the room can have the effect of capturing the audience's attention.

2. *Writing is too small/scruffy/illegible.* In the larger lecture theatres, you have to write very large on the blackboard or use the OHP. In all lecture theatres, when you have filled all the visible blackboard space, you have to ensure that you clean the boards thoroughly before reusing them, and this sometimes presents a challenge: occasionally blackboards are so deeply engrained with chalk dust that considerable effort is needed.

   After the first lecture, and periodically thereafter, it is a good idea to go to the back of the lecture theatre and check that what you have written is easily readable.

3. *The lecturer doesn't explain what he or she is doing.* Some lecturers like to sprinkle their lectures with 'What I am just about to do is ...', or 'What is actually going on behind all this algebra is ...', or 'the key step in the proof is going to be ...', etc, and students find this helpful.

   Some lecturers make the mistake of assuming that the audience remembers what it heard in the last lecture (or indeed what it has just heard in the current lecture); of course, some students will remember, but even they

seem to like to be reminded of definitions and theorems when they come up again ('Then we just apply the mean value theorem — remember that the MVT says ...').

4. *The lectures are aimed only at the top students.* Lecturers at other universities tend to envy Cambridge lecturers for their clever audiences, but of course it is not the ability that counts; it is the spread of ability. It is easy to pitch the lecture correctly when the audience is fairly homogeneous. It could be argued that in fact the students at other universities lie within a narrower ability range than those at Cambridge (the range being unbounded at the top end for our audiences). It is very easy to overestimate the ability of the audience to take in new material, or to be intimidated into increasing the pace or adding to the difficulty by the very smart students in the front row who obviously understand everything. There will always be some students for whom the course appears very straightforward and some for whom it is incomprehensible. It is probably best to aim the lectures at the middle or lower middle since the stronger students can be stretched by their supervisors (or by challenging riders to the examples sheet questions).

5. *Poor use of blackboard/OHP/etc.* Students often complain about lecturers standing in front of what they are writing or rubbing off what they have written too soon or writing at the bottom or side edges of the blackboard (or OHP) which is not visible to some or all of the audience.

   It is a good idea to plan beforehand how you are going to use the blackboard; for example, whether there are results derived early in the lecture that you don't want to rub off because you need them later on.

6. The lecturer keeps saying that results are 'trivial'. This arises because students nowadays don't understand the difference between 'trivial' and 'easy'. Most students hate the word 'trivial'; best to avoid it until more enlightened times.

7. *The lecturer just reads from his or her notes and copies them onto the blackboard.* Reading from your lecture notes seems to work in some some subjects, but doesn't seem to work in mathematics — especially if you have already given out the notes. Most lecturers develop ways of keeping the audience engaged. Sometimes it is done by appearing to create the mathematics in front of their very eyes. Sometimes lecturers

engage the audience by asking questions, or by inviting questions, though this can sometimes backfire if the audience is large and taciturn. It is possible to have a conversational style without asking questions ('Now, you may think ...'). Some lecturers make jokes.

8. *The lecturer writes too fast.* This common complaint can be addressed by looking at the audience frequently to see whether they are still busy writing and, if so, by pausing to give them time to catch up. You can ask the audience if they have caught up, especially if you are just about to rub it all off the blackboard or wind up the OHP acetate.

9. *The lecturer hadn't covered the material in time for my supervision.* Of course, this is sometimes happens because an inexperienced supervisor arranges the supervisions unrealistically early, perhaps in the hope of fitting all the supervisions into the term (rather than leaving the last until the beginning of the following term). However, sometimes it is because the lecturer gets behind and this can cause the students and supervisors considerable difficulty.

11 Examples sheets

This section applies primarily to undergraduate lecture courses.

Sets of problems given out by lecturers are called examples sheets. Lecturers are required to provide examples sheets for supervisors to use: 4 for a 24-lecture course, 3 for a 16-lecture course and 2 for a 12-lecture course. Some lecturers also provide a revision examples sheet or a selection of past Tripos questions for revision purposes. It is normal to give out the examples sheets during the lectures, and it is helpful if each examples sheet is given out in good time for the relevant supervision. Supervisors often arrange their supervisions at the beginning of the term in the expectation that it is 'safe' (in the sense that the lecturer will have covered all the relevant material) to supervise in the third, fifth and seventh weeks of term for a 24-lecture course (with the last either at the end of term or at the beginning of the following term), so to meet this timetable the examples sheets should be available about a week earlier. Nearly all supervisors use the lecturer's examples sheets.[17]

[17] A very recent development: 40 years ago, examples sheets — at least in pure courses — were unusual and supervisors used past Tripos questions.

As well as giving out paper versions of the examples sheets, it is usual to make them available on the appropriate web pages. For DAMTP, go to http://www.damtp.cam.ac.uk/user/examples/ where you can find all the examples sheets for DAMTP courses and instructions on how to use the (somewhat antiquated) software to edit and upload the sheets. For DPMMS courses, there is a web page per course often with more than just the current examples sheets available.[18]

You don't have to start from scratch with the examples sheets: as mentioned above, the previous year's examples sheets are available on-line[19] and sheets from earlier years may well be in circulation. However, it is essential that you tailor the examples sheets to the course you are giving. It is best from the point of view of students and supervisors if the notation on the examples sheets matches that of the lectures and, most important, the order you cover the material coincides with the order of problems on the sheets.[20]

For a 24-lecture course, the students may well have their first supervision not long after the 6th lecture (in order to get four supervisions in the term), so you have to make sure you have covered enough material for them to finish the first sheet.[21] It is wise to work through the examples sheets before giving the lectures even if you are not planning to make any changes to the course of the previous year.

Supervisions are arranged by colleges. You have no responsibility for supervisions other than to provide timely and appropriate examples sheets. You do not need to find supervisors for your course or supervise it yourself. However, you may well be approached by Directors of Studies who are struggling to find supervisors for your course, and it would be kind to help if you can (for example, by asking graduate students in your subject area if they would be willing to supervise).

Sometimes, the two forms of teaching (lecturing and supervising) can become a bit disjoint. There is, for example, no easy way to find out who the supervisors for your course are.[22] Some lecturers make a point of supervis-

[18] See https://www.dpmms.cam.ac.uk/study/

[19] See http://www.maths.cam.ac.uk/undergrad/examplesheets/

[20] Sometimes, lecturers write things like 'using equation (2.33) of the lectures' in the examples sheets, which you would have to modify as appropriate.

[21] It is tempting to spend the first few lectures explaining in broad terms what the course is about and giving the history of the subject, but usually you can't afford to do that: the students need something concrete in order to tackle the whole of the first examples sheet.

[22] The best way is simply to ask your students — they will be pleased that you are taking an interest — though at least partial information can be obtained from the Supervisors' Area on

ing the courses that they are lecturing so that they can judge for themselves the amount of pain they are inflicting on the students. However, since there is no obligation on lecturers to supervise at all, there will inevitably be some who don't supervise their own course. If you are not supervising, it is always useful to talk to those who are. There is a dedicated Camtools site [23] on which supervisors can state which courses they are supervising in the current year, so you should be able to find at least some of those supervising the course.

As mentioned previously, the lecturer's formal responsibility for supervisions ends with the provision of the examples sheets: unlike in most other universities, lecturers in the undergraduate Tripos are not required to have office hours or to keep their doors open for students However, in the Faculty's Guide for Supervisors[24], supervisors are advised to consult lecturers if they are not sure how to discuss a problem with their supervisees. When approached, most lecturers tend to be helpful and patient, and to bear in mind that the supervisor may not have attended the course, either as an undergraduate or later, and might be used to a completely different approach to the material.

12 Examinations

In all parts of the Tripos, the examiners rather than the lecturers are responsible for the questions. This separation of the two duties (lecturing and examination) provides the examination process with an integrity of which the Faculty is proud, but it increases the risk of something going wrong. Examiners and lecturers alike have to be willing to give the process their full attention at the critical times.

In Parts IA and IB, the questions are actually set and marked by the examiners. In Part II, the lecturers propose questions but they may be modified by the examiners and they are marked by the examiners.

In Part III the role of the examiner is in practice that of a moderator. The lecturer sets the questions, checks with a colleague that they are correct and appropriate, and marks them. The lecturers are formally appointed as 'assessors' for their lecture course.

In Parts IA and IB, the lecturers have to check the questions very carefully to ensure that the notation is the same as was (or will be) used in the lectures,

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the Camtools Maths supervising site mentioned below.

[23] See https://camtools.cam.ac.uk then click on Maths supervising and Supervisors' area

[24] www.maths.cam.ac.uk/facultyoffice/supervisorsguide/

that the questions are appropriate to the course as given and that they are of the right level of difficulty. The examination papers cannot be finalised until each lecturer has signed off the relevant questions, for which the deadline is in the middle of the Lent term. The lecturer therefore has an important role in helping to ensure that the examination papers are error-free and appropriate.

13 Observing lectures

Under the Faculty's policy on peer review of lectures, one of your lectures will be observed by a colleague each year, and you may be asked to observe a lecture of a colleague. This can be a very useful exercise. Observing lectures is always useful, either because you find things that you could include in your armoury or because you find things to avoid at all costs. Remember that there is no element of assessment in the peer review scheme: it is intended only to be helpful to you.

It is a very good idea to attend some lectures in subject areas similar to the one you will be lecturing. If you choose wisely (and you can get advice from any member of the Teaching Committee), you will see a range of good techniques. Even if you are so pressed during the day that you do not have time to attend lectures, you can observe some on-line: David Tong's Quantum Field Theory lectures on You Tube (just Google `youtube qft`) have been much praised (but remember that they are at the Part III level); and there are good MIT opencourseware lectures, for example Gilbert Strang on Linear Algebra (but remember that the pace of a Cambridge lecture is considerably faster).

If you are new to lecturing in Cambridge, you may be asked by a member of the Teaching Committee for permission to attend one of your lectures; normally lecturers are happy to agree, in the expectation that there will be useful feedback.

14 Feedback

There are currently four ways for students to give feedback to lecturers: via the Faculty Feedback Line; via the online second-week questionnaire in each term, by filling in paper questionnaires at the end of each lecture course; and via the annual online questionnaire at the end of each year.

The Faculty Feedback Line is simply an e-mail address[25] that can be used by students at any time. The e-mails go to the Chair of the Teaching Committee who forwards them (after stripping out the identity of the sender) to the relevant person for comment or other action. The majority of the hotline e-mails are about lectures. Feedback E-mails are nearly always courteous and constructive. The senders like to hear back from the lecturer (indirectly) that their concerns are being taken seriously. There is also a weblink to the Feedback Line[26] which allows students to comment, completely anonymously. This is also picked up by the Chair of the Teaching Committee, who forwards the comment to the relevant person.

At the end of each lecture course (the middle of the penultimate lecture is recommended), lecturers give out a paper questionnaire and make time during the lecture to allow the students to fill it in. The lecturer then collects it and, when he or she has digested the responses, passes all the questionnaires to the Faculty Office. There the responses are analysed and the result forwarded to the Teaching Committee.

The second week questionnaire (a recent innovation) is sent to all undergraduate students electronically. They are asked just two simple questions about each course they attend (about comprehensibility and ease of taking notes), and the results are analysed and sent to the lecturers.

The annual online questionnaire is much more comprehensive, and allows for comments on the examinations and on supervisions. Unlike the paper questionnaires, it is received by students who may not have completed the course, and so provides different information from that provided by the paper questionnaires. Again, the results of this questionnaire are sent to the individual lecturers.

It is important to remember when reading your feedback that you cannot please everyone. Some students will be extremely critical of your lectures because you go too fast and others will be equally critical because you go too slowly. There will always be a few individuals who are having a hard time at Cambridge and will be inclined to blame the lecturers. However, most students give feedback (as mentioned above) with the intention of helping to improve the lectures by saying what worked for them or what didn't. Most lecturers find that studying the feedback often helps them to give better lectures (though sometimes it makes uncomfortable reading).

[25] feedback@maths.cam.ac.uk

[26] www.maths.cam.ac.uk/feedback.html

15 Finally ...

Nearly all lecturers will tell you that lecturing is time-consuming but enjoyable. It is a significant intellectual exercise to distil a considerable body of knowledge into 12, 16 or 24 lectures. Almost certainly, the more you put into this challenge, the more you and your students will get out of it.

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