

A Supervisors Primer
Being a collection of hints for new supervisors compiled by
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and reflecting nobody's opinions but his own.

Those that can, do. Those that can't, teach.
And those who can't teach, teach teaching.

The Faculty Board also issues a guide to supervisors
which has the advantages of being shorter,
more official and considerably less opinionated.

There are many ways of supervising well. The purpose of these notes is not to provide a set of unalterable rules but to provide a model for you to modify and to react against. My own practice differs in many respects from that set down here, sometimes because I fall short of my own ideals (I am too disorganised to run any sort of record system) and sometimes because I have made a deliberate decision to do things differently (as a Director of Studies I use a mixture of linked supervisions and classes for my first two years).

During their first two years at Cambridge mathematics students are usually supervised in pairs twice a week. The supervisions will be in a group of subjects and each supervisor will expect to see their pairs once a week for eight weeks. The supervisors are chosen by the Director of Studies of the particular College the students belong to. In the third year students have supervisions in specific subjects (generally 4 supervisions for a 24 hour course and 3 supervisions for a 16 hour course). Most Colleges belong to one of three groups (or 'circuses') which organise supervisions on a joint basis.

Why Supervise? Here are some possible reasons with my comments.

(1) **The money.** This is not a bad reason but you would do well to calculate how much you expect to earn before you start. You will find that the sum involved is useful but no more than that.

(2) **It will look well on a CV.** This is not usually a good reason. The number of openings for which having supervised at Cambridge is a strong positive recommendation is non-zero but small.

(3) **'My College or my Research Supervisor expects me to.'** This is a bad reason. If you are a research student your College and your Research Supervisor want you to do good research. Everything else is secondary.

(4) 'It will help me decide if I like teaching.' This is an excellent reason. If you like supervising you may like teaching in general — if you do not like supervising, you certainly will not.

(5) It is a good introduction to teaching. Again an excellent reason. Like most skills teaching is mainly learned by doing and where better to start than with a small group of able and motivated students? In supervisions you can actually see the effects of your teaching and learn both what teaching can achieve and what it can not.

(6) The best way of learning something is to teach it. Undoubtedly true, but you must remember that you will be improving your general mathematical culture rather than learning things which are directly useful in your research.

(7) It is a change. Research is a lonely occupation in which long periods may pass without apparent progress. Supervising provides social contact and immediate rewards as you see your teaching having its effect.

(8) It provides a way of putting back into the system something of what you have gained from it. Not a bad reason, particularly if you were a Cambridge undergraduate.

Whatever your reason for starting supervising you should not continue with it if you find that you do not enjoy it or that it takes up too much time. In the first case you are cheating your students, in the second you are cheating yourself.

Why Let You Supervise? Stephen Leacock described the Oxford method of supervision as follows. (His description dates from 1922 but things change slowly in that university.)

I understand that the key to this mystery [the Oxford method of education] is found in the operations of a person called the tutor [i.e. supervisor]. It is from him or rather with him, that the students learn all they know: one and all are agreed on that. Yet it is a little odd to know just how it does it. 'We go over to his rooms,' said one student, 'and he just lights his pipe and talks to us.' 'We sit round him with him,' said another, 'and he simply smokes and goes over our exercises with us.' From this and other evidence I gather that what an Oxford tutor does is to get a little group of students together and smoke at them. Men who have been systematically smoked at for four years turn into ripe scholars¹. [From *My Discovery of England*]

¹Leacock goes on to say that 'Of all the various reforms that are talked of at Oxford, and of all the imitations of American methods that are suggested, the only one worthwhile to my way of thinking, is to capture a few millionaires, give them honorary degrees at a million pounds sterling apiece, and tell them to imagine they are Henry VIII.'

Many ‘arts’ subjects rely on the pipe-smoking method of supervision and, since only mature scholars can successfully smoke at students, they tend to look down on subjects like mathematics which use graduate students as supervisors. There are however many positive reasons for using young supervisors. Here are some.

(1) Younger supervisors still remember vividly the problems they had with the subject and are therefore (with the exception of a few arrogant bastards whom no Director of Studies in their right mind would employ) more sympathetic to the needs of students.

(2) Even the youngest supervisor appears to students as incredibly old, but, with an effort of imagination, students can identify with a graduate student in a way they can not with a more senior figure. It is important to convey to them that mathematicians are endlessly building and rebuilding their subject and that mathematics is not a fixed permanent structure designed and inhabited by men wearing frock-coats and long white beards. It is therefore your duty to make remarks like ‘I use this result in my research’ or ‘As Wiles said in his seminar’. Hardy held that it was the job of lecturers² to exaggerate both the importance of their subject and of their place within that subject.

(3) Although mathematicians learn more about their own particular subjects as they get older, their approach to the remainder of mathematics tends to stick in the groove formed when they were undergraduates. The use of younger supervisors counteracts the natural conservatism of the system.

(4) Older supervisors can not help feeling that they have been teaching students the same thing for twenty years ‘*and they still don’t understand it!*’. There is a genuine gain in expertise with age but, unfortunately, it is often more than balanced by a loss of hope and enthusiasm. As a Director of Studies I prefer hope and enthusiasm to expertise and so do most of my colleagues.

How Many Hours? Three hours of supervision use up one afternoon a week. Most people will find that their main work does not suffer, and may, indeed, benefit from one afternoon a week doing something different. Six hours of supervision use up two afternoon a week. If you are badly organised, or if afternoon seminars and morning lectures already eat deeply into your time, this may be too much but many people can manage this amount of supervision without their main work suffering. If you find yourself doing more than six hours of supervision a week on a regular basis you are almost certainly doing too much for the health of your research. (In addition, many scholarships and awards specifically limit the amount of teaching you may

²He actually wrote professors, but we live in a democratic age.

do to six hours a week. The same restriction applies to all students studying for a Cambridge PhD³.)

There is another way of approaching the matter. Observe that the amount of preparation required is much the same whether you give one or three supervisions. There are thus substantial economies of scale in giving several supervisions on the the same exercises but, as the number of supervisions increase, you will become aware of the diseconomies of boredom and staleness ('Have I already told them that, or was it the previous pair?'). Most supervisors find that if they give such a series of supervisions they are happiest with the second or third supervision and that their satisfaction with their own performance then tails off.

Finding Supervision Work Supervisions are arranged very early in the term so, if you wish to supervise, you should start looking for supervision work a few days before lectures start. (There is rarely any point in starting earlier than this since Directors of Studies have better things to do with the vacations than worry about the next term.) If you are a member of a College which takes undergraduates it is considered courteous to offer your services first to the Director of Studies at your own College. Even if he or she can not offer you anything directly they may pass your name on to an organiser of a Part II circus. (Even if you belong to a Graduate College it may be best to start with with your own Director of Studies, if such a person exists, since he or she may well have good connections with an Undergraduate College.) If this does not work, your Research Supervisor may be able to help (though such assistance is not part of their duties towards you). Both Departments maintain Notice Boards for advertising demands for, and offers of, supervision work⁴. In addition there is now a World Wide Web page (accessible from the mathematics faculty page) for advertising demands and offers. I suspect that, despite the Luddite tendencies of people like myself, this will rapidly become the main forum for this kind of thing. It is generally considered that Part III students should be so busy following this gruelling and testing course that they should have no time to supervise others.

Directors of Studies prefer, if possible, to use experienced supervisors for the general first and second year supervisions where bad supervising will do most harm. Frequently the Director of Studies will do mainly first and second

³See paragraph 12 of the BOGS memorandum to Graduate Students

⁴Directors of Studies in subjects like Natural Sciences and Economics may also be on the lookout for supervisors. Such supervisions are what is called *service teaching* and you may find that quite a number of your supervisees are less competent and less enthusiastic than you would, ideally, wish. If you are a good teacher and you have the backing of a good Director of Studies such teaching can be very rewarding. Under other circumstances it may come to resemble breaking stones.

year supervisions in order to get to know their undergraduates. Whenever possible, also, they use members of their own College who will, in theory, and usually in practice, feel personally involved in the success of their College's candidates⁵. On the other hand, few, if any, Colleges can fill their Third Year supervision requirements from their own resources and many specialist subjects have only a limited pool of potential supervisors. Thus the majority of supervisors start by taking on specialist Part II or Part III supervising. Finally you should remember the following points.

(1) Unless you are a Teaching Fellow of a College you have *no duty* to supervise for your College or for anybody else. If you do not wish to supervise just say so. Nobody will hold it against you.

(2) Directors of Studies may not be able to supply the exact number of hours that you want. If you ask for three hours they may offer two or four. It helps to be flexible.

(3) Directors of Studies are in the business of providing the best possible teaching for the undergraduates in their charge — not of providing pin money and teaching experience to post-graduates however deserving.

College Post The College Post is free but is sufficiently slow and erratic to allow students endless scope for excuses. If you have anything urgent (and most things involving supervisions turn out to be urgent) deliver it by hand to the Porter's Lodge of the College involved (or use a trusted messenger, or first class post).

The First Meeting It is possible to make all your supervision arrangements by post, but most supervisors find it easier to have a preliminary meeting to fix supervision times, give arrangements for handing in work, and to set supervision work. Here are some hints concerning these matters.

Supervision Times. If you have, say, four supervision pairs a week the simplest procedure is to name four times and leave it to the students to choose which pair goes to which supervision. (Remember that students are here to do mathematics, not to play cricket, act or row and that, outside lectures, supervisions have first call on their time.)

⁵According to Cornford in his *Microcosmographia Academica* 'An appeal should be made, wherever it is possible, to *College Feeling*. This, like other species of patriotism, consists in the sincere belief that the institution to which you belong is better than an institution to which other people belong. The corresponding belief ought to be encouraged in others by frequent confession of this article of faith in their presence. In this way a healthy spirit of rivalry will be promoted. It is this feeling which makes the College system so valuable; and differentiates, more than anything else a College from a boarding-house; for in a boarding-house hatred is concentrated not upon rival establishments, but upon the other members of the same establishments.

Arrangements For Handing in Work. Almost all supervisors prepare for supervisions by marking students' work in advance. In this case you must set a deadline for handing in work. (If you have an official deadline and a later unofficial deadline you will find, within two or three weeks that all the work is handed in five minutes before the later deadline. You are therefore well advised to have a single deadline and stick to it.) It is unfair to students to ask them to hand in work more than 24 hours, say, before the supervision⁶ and, if you do demand a longer period the students may forget what they were thinking when they wrote their work. Make sure that the students know where to hand in the work ('My pigeonhole at College', 'The pigeonhole marked K in DPMMS' [remember that the departments are closed over the weekend] etc).

First Week's Work. If you intend to use the lecturer's example sheets, remember that many lecturers do not issue the first example sheet until after a week or so has passed. You may be able to get round this by asking the lecturer for a copy of his or her first example sheet and Xeroxing it or by getting a copy of the first example sheet for the previous year. The main problem (and the reason for the lecturers' delay) is that most courses start slowly and students will not have covered much ground in the first week. You might therefore prefer to set questions which revise relevant previous work or questions which take them slowly through some exemplary case. (For example, the motion of a slightly perturbed particle in a bowl with equation $z = x^2 + 2hxy + y^2$ provides an excellent and easy introduction to normal modes.)

Lecturer's Handouts. It is a good idea to ask one of your students to take an extra copy of anything handed out by the lecturer and to give it to you. Example sheets for Applied Courses and Core Courses are placed on racks in DAMTP and example sheets for Pure Courses are kept in a small filing cabinet close to the mail pigeon holes in DPMMS. (You can also sign a list in DPMMS asking for Pure Examples Sheets to be sent to you.) Example Sheets for Statistics Laboratory courses are held in pigeon holes by the Statistics Laboratory enquiry office.

Pairings Usually your students will have been put in pairs by their Director of Studies or by the circus organiser. Although an attempt is made to pair according to ability, other factors affect the success of a pairing. It is, for example, much more important that a pair be friends than that they be intellectually matched and, at Part II level, circus organisers try to pair people from the same college. If you feel that some other pairing might be more successful feel free to try it but my own experience suggests that unless

⁶Do you really need longer to mark it?

two students are obviously ill matched it makes little difference.

Number in Supervision If you are supervising 1A or 1B (non-O) courses no student should drop out and the number you teach per hour is a matter for the Director of Studies. If you are supervising Part II or a 1B O course then students may drop out. Unless a College has specifically told you otherwise you should assume that it would prefer paying for supervisions in pairs to paying for a singleton. You should do your best, by merging and rearrangement to fall in with this assumed wish — but if it can not be done then it can not be done and you should not worry.

What Does The Course Contain? The contents of each undergraduate mathematics course are closely specified in schedules which bear the lapidary phrase ‘These schedules are minimal for lecturing and maximal for examining’. Copies of the schedules are given to each undergraduate and further copies are available from the Faculty Office in DAMTP. Once a course has been running for a couple of years the Tripos questions will help flesh out the schedules and should also be consulted. (Copies of the last three or four year’s Tripos papers, or ‘Specimen Papers’ where appropriate may be obtained from DAMTP enquiries. Copies of the last 30 years Tripos papers are held in both Departmental Libraries.) If you are in doubt as to how the lecturer intends to cover part of the course ask the lecturer or consult the lecture notes of one of your better students⁷.

What Work Should You Set? If you are teaching a first or ‘general’ second year course then you should discuss what to set with the Director of Studies. In many Colleges the Director of Studies may specify the questions exactly. (For example the third term work may consist in going through the questions of last year’s examination on the subject.)

If you are teaching a ‘specialist’ second year or third year course then it is up to you to choose what to set. The traditional system was to set five or six old tripos questions per supervision. The modern method is to use the example sheets provided by the lecturer. The lecturer should make it clear how many example sheets he or she intends to use. (Frequently the lecturer for a 24 hour course issues 4 example sheets, each one intended to supply enough work for a complete supervision for an able student. This is not, however, a universal model.)

The majority of supervisors use the modern method. (If the course is new, there is no other possibility. Even if the course is an old one, syllabus changes may mean that the old Tripos questions no longer reflect the course content

⁷It is useless to ask a student directly whether a lecturer has done such and such in the lectures. You will meet either with puzzlement or stout denial.

accurately. Using the example sheets keeps the lectures and supervisions in parallel.) There are however some arguments for the old system.

(1) If you choose the questions your supervisions will better reflect your style of teaching and, perhaps, the needs of your students. There is a general belief that it should be possible (if only the lecturer worked a little harder) to produce an example sheet suited to all students and all supervisors. I do not share this belief.

(2) The occasional question not yet covered in lectures will encourage students to consult the College Library. (But the first few times you will need to give pretty explicit instructions — the idea of doing mathematics by consulting books rather than lecture notes is will seem strange to most first years.)

(3) Since the students will have to do Tripos questions rather than example sheets in the exam it makes sense to give them some practice at doing Tripos questions. In my experience students' confidence in themselves rises substantially after they have conquered a few genuine Tripos questions. (It is usually possible to find a few Tripos questions which, although genuine, are rather easy.)

In spite of these arguments, beginning supervisors will probably prefer to stick to the lecturer's example sheets. (Though even here you will have to decide what it is reasonable to ask your weaker students to do.) As you gain in experience and confidence you ought, at least, to consider replacing some of the lecturers questions by Tripos questions or other questions of your own.

Rearranging Supervisions You may well need to rearrange your supervisions once or twice during the term. In return you should be sympathetic to students who need to change their supervisions for good cause. However a small percentage of students do trade on the good nature of their supervisors so you should make sure the cause is good (being ill is a respectable reason, college football is not). Whether it is you or the student who wishes to rearrange, as much notice as possible should be given.

Failure to Attend Supervisions My comments here depend on whether the supervision is a Part I or a Part II supervision.

Part I (non O-courses) It is very unusual for a first or second year student to fail to turn up to a supervision without notice . You should ask his or her supervision partner to check what has happened. It usually turns out that the student is ill and all you have to do is send a get well soon message. If the student is not ill (or if the illness persists through to a second supervision) you should contact the Director of Studies and tell him or her what is happening. (Do not expect to be effusively thanked, you have just added another worry to the Director of Study's load.)

Part II (and O-courses) Unfortunately failure to turn up to a Part II supervision is a less rare event and often only reflects the thoughtlessness of the student. Reasonably enough, students normally start rather more courses than they expect to take seriously for the exam. More unreasonably, they sometimes forget to tell the supervisor when they do drop out. You should make it clear that if a student fails to turn up at a supervision without telling you in advance you will

- (a) charge the College for the supervision, and
- (b) tell the College why you are charging.

Other Bad Signs Very good students produce uniformly good work even when suffering from flu and a rocky love life. Good students may produce the occasionally poorly prepared supervision and you should not worry if a first or second year student has one bad supervision out of eight. If however he or she has more than two such supervisions in a term, or if the general standard of the work is such as to make it clear that the student can not cope, you should not wait for the end of term but discuss the matter as soon as possible with the Director of Studies ⁸. Once you have done this, your responsibility ends. The Director of Studies is paid to worry about such things. You are not.

More generally, if Directors of Studies wished to hire amateur psychiatrists or social workers in place of a mathematicians, they would do so. If a student is going through a bad patch, he or she will probably derive greater security from a supervisor who demands good work and no excuses than from supervisor who pries, however sympathetically, into their private lives. Although Mathematics students exhibit (in common with their elders) a range of behaviour which might cause comment in the outside world, they are in Cambridge parlance ‘low tutorial risks’ and you are very unlikely to see anybody with really serious problems.

Copying From time to time you will become aware that two students are producing identical stupid mistakes. This is not as easy to handle as it looks for two reasons. The first is that students often react like the prisoner who complains that that he is the victim of a miscarriage of justice because he has been convicted of robbing a bank in Bristol at a time when he was actually robbing a bank in London. If you accuse A of copying from B when in fact B copied from A or cite as an example of copying the one question in which copying did not occur, the students may use indignation to obscure the issues

⁸You will probably only see a third year student four times in all and you do not know if your course is one that he or she is taking seriously. If the student is doing badly you should say so in the supervision report but you need not take any other action.

not only from you but from themselves.

The second is more fundamental. Mathematicians spend much more of their time co-operating than competing whereas clever schoolchildren spend more of their time competing than co-operating. Many Directors of Studies actively encourage students to discuss questions and problems together. Your best plan is, perhaps, to talk generally about the virtue of collaboration (where ideas pass through the brain before reaching the paper) and the vice of copying (where the brain is by-passed). I tell my students that if, when they finally write out their supervision work, they are alone in a room with no-one else's answers, they will not have overstepped the boundary of acceptable co-operation.

*Pie-Crust Promises*⁹ One of the supervisors who commented on the first draft of these notes remarked that novices should be warned against aceding to requests to defer supervisions to the start of the next term 'since . . . experience suggests that never quite as much or as good work is executed in vacations as students predict'. More generally supervisors have problems with what I would call 'pie-crust promises' — that is promises which 10% of students actually keep but which 90% believe when they make them. All that I can suggest is that you try to modify the conditions to make it easier for the student to stick to their resolution — for example by deferring the supervision to a week after the end of term rather than the beginning of the next term. (However, I must admit that even this ploy fails more often than not.) If a student uses the line 'Well I tried really hard on lots of the questions but I wasn't able to write down anything' tell him or her that they should write down everything that they think is relevant (definitions, statements of theorems etc) and that you expect at least ten lines of writing for each question. Sometimes students suffer from 'mathematician's block' and this demand actually produces a cure. Sometimes a student is coasting and will decide that it easier to do the work than feign incompetence. In the remaining cases, though the knowledge may not be of any practical use, you will at least be able to distinguish whether the trouble stems from laziness or genuine inability to cope.

What Should a Supervisor Teach? The supervisor's main duty is not to the Departments or even the College but to the student and, so far as the student is concerned, your main duty is to teach them to do as well as possible in the examinations. Since the way to do well in the examinations is to know lots of mathematics, to be able to write it down coherently and apply it appropriately it will be seen that your duty runs almost in parallel with the

⁹Easily made, easily broken

higher ends of education.

If asked what a supervisor actually does, the student will probably reply that supervisors answer questions about the the courses, mark supervision work and show how to do the exercises the student can not do. The student thus sees the supervisor as teaching specific items of knowledge. However a good supervisor teaches more general things as well.

Since students are not taught how to write mathematics in school one of your main tasks, particularly in the first year, will be to teach them how to organise a mathematical argument. One of the hardest parts of supervising is to convince students that a particular argument is inadequate and genuinely needs to be replaced. (The lines ‘He who is convinced against his will is of the same opinion still’ come to mind.)

Most students come from school with the impression that mathematics is taught and learned in a dull monotone. (witness the set of notes in which every second sentence is highlighted in Day-Glo yellow). They need to learn that each course has a few central ideas and that once these ideas are identified and understood the rest will fall into place. In the same way they have to learn that the gigantic dinosaurs of formal proof are frequently controlled by a rather small brain of an idea.

Students, in general, arrive with no mathematical conscience. If they can get to the end of a question they breath a sigh of relief and move on to the next one. They do not ask ‘Does it generalise?’, ‘Is the answer plausible?’, ‘Where have I used each hypothesis?’, ‘Which general theorems did I use?’ and they would not dream of subjecting their own arguments to a hostile examination. Initially you must do all this for them, acting as an external conscience, but over two years students must learn to do this for themselves — internalising their supervisor, as it were — and you must help them do this.

In the long run, too, students must learn what it means to think like, say, a numerical analyst or an algebraist. You can help their development by taking time off from *marking* questions and using it to *discuss* questions — what they test, where they come from, where they might lead and so on.

Be Specific I was once told by a Swimming Trainer that it took 24 hours of training to modify a swimmer’s stroke. It is very hard for students to modify their behaviour and it is helpful to give advice in the form of simple rules. For example the advice ‘Write out your questions more neatly’ might be usefully replaced by ‘Write on alternate lines’. If a student fails to give the statement of the theorems he or she uses tell him or her to write out the statement of the main theorem used in *every* question. This produces a close approximation to correct behaviour and once the student has achieved

a little extra mathematical maturity the advice can be allowed to lapse.

Timing An hour is a long time and being supervised is a stressful experience for a student. Towards the end of the supervision the supervisee's only thought may well run along the lines 'Please teacher, can I be excused? My brain is full.' You should therefore deal with the most important things (perhaps the questions that the students could not do, or perhaps the questions which are most central to the course) first leaving less essential things to last or even omitting them. It is not how much you tell your students which is important, it is how much they remember. It will help your students if you vary the pace. After half an hour stop for a few minutes and ask them about the courses, or offer them a cup of tea or talk about your aunt who once killed a tiger with her bare hands, so converting a long one hour supervision into two short half hour ones.

You should occasionally check how much time you are spending on each member of a supervision pair. It is not necessary that you should divide your time equally between them, indeed students would expect you to spend more time on the weaker member of a pair, but if you do not divide your time equally you should be aware that you are doing so. There are certain kinds of supervisees such as 'Black Holes' (who sit poker-faced through an entire supervision), 'Barrack Room Lawyers' (who spend their time arguing about the exact meaning of your questions and their answers) and 'Gee Whizzers' (who talk endlessly and enthusiastically just off the point) whom it is easy to unconsciously neglect.

Preparation In my experience as Director of Studies the only time students complain about supervisors is when the supervisors can not do the exercises they have set. This kind of failure is much less frequent than it was twenty or thirty years ago when supervisors used to claim that 'It does the young men good to see a mathematician at work'. Do not deceive yourself by such specious phrases. As your attempt to solve the problem goes round and round in circles the weaker students will become more and more confused and the stronger students will simply switch off. Both weak and strong students will resent the fact that you could not be bothered to think about what you set them.

If you mark your students' work beforehand this will tell you what they can not do and what you have to prepare. (If you do not mark your students' work beforehand you will have to go through the all the questions making sure you can do them.) If you can not do a question the simplest thing to do is to ask around at coffee or tea time in the department. If this fails and the question comes off an example sheet contact the lecturer. Answers to the last five years of Tripos Examination are held by the librarians of the two

departments¹⁰.

The questions that students raise or which arise naturally in the course of the supervision will give you ample opportunity to think on your feet and students do not object if in such cases you say that you can not give an immediate answer but will try to have one by the next supervision.

First Year Supervising At school students are used to being closely supervised and having their work marked in great detail. They find the transition to the more open atmosphere of University life rather disorientating. In addition mathematics students are often desperately unsure of their ability to cope with the intense courses here. (It is much more common for our students to underestimate their ability than to overestimate it, though the reverse problem does occur.) For these reasons it is very important to comment on first year student work in greater detail than is necessary (or, indeed, desirable) in later years. You should also explicitly tell first year students if they are doing well or badly.

Third Term Supervising At the beginning of the third term students have less than six weeks to go until the exam and the amount of new material they can absorb is limited. It makes sense to concentrate on making sure that what they can do they can do well. If one more push will enable a student to master a topic then help him or her to make that push; if a substantial effort is required it may make sense to abandon the topic for this term. Since it is important to keep the candidate's morale up you may choose to let certain things which you would criticise in another term pass without comment. If you think students are going to do well do not leave it to the final supervision to tell them so. Be as optimistic as possible about the prospects of all your students.

It is traditional for the supervisions in this term to centre round the previous year's examination questions. If you decide to do something else you should explain to the students why you are breaking with tradition. Although some Colleges give mock examinations in the second term (when they may well spur students to work harder) I think that little purpose is served by such things in the third term. What, after all, does a student learn by rushing through a Tripos question that he or she will not learn better by thinking about it at leisure?

What is an Alpha Question? With the exception of the Essay Paper in Part IIB Tripos questions are either standard or short. A standard question should

¹⁰It is Faculty policy that the answers are not available to students. Most, though not all, Directors of Studies feel that if answers were available they would represent too much of a temptation to the lazier students.

take a well prepared candidate between 20 and 30 minutes. A standard question carries a possible mark of 20 and a candidate who scores 15 or more is given an ‘alpha’. A candidate who scores between 10 and 14 marks inclusive is given a ‘beta’. A short questions should take half as long and carries 10 marks. A candidate scoring 8 or more obtains a ‘half alpha’ and a candidate scoring between 5 and 7 marks obtains a ‘half beta’¹¹.

Initially the examiners order the candidates by total marks and draw the class border lines using this list. They then look at the number of alphas of candidates near the border lines and promote and demote candidates using the number of alphas as a (perhaps the) major criterion. At the second/third border line they may also look at the ‘beta count’. (The third/fail decision may involve detailed discussion of how particular candidates obtained their marks.) The border line marks for the last year are not secret (though they should not be shouted from the rooftops) and may be obtained from your Director of Studies ¹². Note, however that the borderlines change from year to year according to how the marks pan out.

Examination Technique All students seek the holy grail of an exam technique so powerful that its owner can dispense with any actual knowledge. At a more rational level, exam technique does make a small difference but the great majority of your students have been competing vigorously in examinations for many years and know at least as much about the subject as you do. In the unlikely event that you have a student who needs help in this direction the following simple maxims will probably be sufficient.

- (1) Don’t panic.
- (2) A standard 1A or 1B question is supposed to take the average student half an hour. It can not therefore be very hard.
- (3) Questions which take a long time to state (and so contain lots of clues) are often easier than short ones.
- (4) Help the examiner by underlining answers. The less time the examiner spends on a question the less time he or she has to find errors.
- (5) Read all the questions on the paper. Candidates tend to start at Question 1 and work forward but the easiest questions may be at the end.
- (6) It is hard to get full marks on multipart and essay questions but it is

¹¹Inevitably the younger supervisors are beginning to think in terms of ‘new alphas’ whilst the older generation still think in terms of ‘old alphas’ with a conversion rate ‘two new alphas to to one old alpha’. These notes are written in ‘old alphas’.

¹²There is a persistent but false rumour among the undergraduates that there is a magic formula used by the examiners in deciding the border line. What is true is that the computer program used by the chairman of the examiners has a formula by which it tries to *guess* what the examiners will decide. The computer is rarely far wrong but it is also rarely exactly right.

also easy to get some marks. If things are going well avoid them; if things are going badly try them.

(7) Keep a check on the time. If you have been working on a question for 20 minutes without result, move on. Inspiration may strike while you are doing another question.

(8) If you can not do anything rotate your efforts round a limited number (three or four at most) questions rather than rushing around attacking them all.

(9) Never ever leave an exam early. While there is life there is hope.

(10) Don't panic.

The various pieces of advice just given may not be very useful but at least are fairly harmless. Students also ask, directly or indirectly, what is 'the least that will satisfy the examiners'. Do not indulge them. Explain that *time* is not a problem for the average examinee. If a candidate can answer four standard questions well in a three hour exam he or she is doing very well¹³. Remind them also of the importance the examiners attach to the number of Alpha Questions and that it is therefore wise for the average student not to throw away marks by skimping on his or her good questions.

Very Strong Students It is said that there are fewer luscious blonds¹⁴ and large companies in Sweden than is generally supposed and that most of them are in private hands. In the same way, you may find fewer really able students among your supervisees than you expected. If you do have a very good student remember that even bright students need reassurance that their work is going well. Remember too, that bright students can acquire bad mathematical habits like explaining too little (after all, it is obvious) or too much ('I write at length because I am too lazy to be brief') so you must read their work critically. With such students the main business of the supervision will only take part of the hour, so you can discuss matters arising out of the questions (can the hypotheses be weakened, what happens if the field is non-constant, etc) or the course (how is Galois theory applied to differential equations, why did Markov invent his chains, etc). If you can think of nothing further to say nobody, least of the student, will mind if you end the supervision early.

No meeting to discuss teaching is complete without someone talking about the need for 'challenging problems for the very able'. In my view this is mistaken. Many of the undergraduates whom we see as coasting effortlessly along see themselves, more correctly, as engaged in a desperate and contin-

¹³What about the best candidates? In my view there are few more futile occupations than trying to train students to come top in Cambridge exams. If they are good enough to have a chance of coming top, they should be good enough to have higher ambitions.

¹⁴Of either sex.

uous struggle to keep their heads above water. In any case, it seems to me presumptuous to think that we have anything extra to teach the exceptionally gifted. Surely the best thing we can do is leave them time to think, read and learn by themselves.

Professional Courtesy Inevitably a student will come and ask you to explain some point in his or her notes which, it seems to you, the lecturer has got wrong. If you give way to your initial impulse and tell the student that the lecturer has made a complete foul up then the main lesson the student will have learned is not that mathematicians sometimes make mistakes or even that you are cleverer than the lecturer but that the subject is so hard that even the world's greatest experts can not get it right¹⁵ and so the poor student might as well give up. Instead you should consider the following models.

Wrong The lecturer has got the sign wrong.

Right You seem to have copied the sign wrong.

Wrong The lecturer's method of proof went out with the Penny-Farthing.

Right The lecturer's proof emphasises the concrete aspects but you may prefer the following more abstract version.

Wrong This syllabus misses out everything that is important.

Right Now that we have finished this week's work, let me talk a little about where the subject goes.

If you think there is a real problem with the syllabus you should discuss it with the lecturer or other senior staff. (Remember that syllabuses are constantly revised.) If you think that there are problems with the example sheets write to the lecturer; on the whole lecturers complain that they get too little feedback on their example sheets.

It is your duty to stress the importance and interest of your subject. (If you tell students that a subject is dull they will believe you.) You should, however not do this by denigrating other subjects — if you refer to statisticians as failed bookmakers make sure your students know you are joking.

Records You will find it easier to fill out claim forms and supervision forms at the end of term if you keep some notes on the supervisions as you give them. One simple form might be as follows:-

Athos	α	α	β	α	α	α	α	α
Porthos	β	α	β	γ	α	α	β	β
Aramis	β	β	γ	X	β	X	γ	β

¹⁵Many students are under the impression that their lecturers are the world's greatest experts. Remember the placebo effect and do not disillusion them.

where X marks a supervision missed and the Greek letters represent the quality of work produced.

Claim Forms Colleges should send you supervision forms and claim forms towards the end of term. You will not be paid until the College has received your completed form back. Given the informal nature of the supervision system it is inevitable that mistakes get made in sending out claim forms. If you receive a claim form from a College for which you have not supervised just ignore it. If do not receive a claim form from a College for which you have supervised walk round to its tutorial office and ask for one. Colleges do not wish to loose your goodwill or your supervision reports and the office will be pleased to supply supervision and claim forms.

In my opinion, if you have given 7 out of 8 or 3 out of 4 of a course of supervisions it is reasonable to claim for the whole course. In any case, remember that Colleges want the supervision forms returned quickly and, if you insist on only charging for work done, make a separate claim the next term rather than delaying the forms until you have done all the supervisions.

Filling Out Supervision Reports Supervision reports are used by Colleges in several different ways.

(1) At the end of each term the Director of Studies discusses with each individual student how the term has gone and what aspects of his or her work need improvement. Supervision reports usually provide the basis for the discussion and this fact explains why you are urged to return supervision reports early. A long supervision report which arrives after the end of term is worth much less than a shorter one which arrives on time.

(2) At the end of a student's time at Cambridge, the Director of Studies will use supervision reports in compiling references. Such reports are particularly useful in adding a bit of convincing colour. ('All her supervisors comment on how hard she works', 'Although his overall examination results have not been good, his statistics supervisor speaks highly of his statistical intuition.')

(3) When students are unable to take their end of year exams because of illness or for some other reason a University committee has to decide whether they can proceed to the next stage of the course (or, if they have reached the end of the course, whether they should be given a degree). Supervision reports usually represent the only hard evidence available. Supervision reports are also used if a student fails an exam and the College must decide what to do about it.

(4) Supervision reports may also give early warning of impending problems.

Many Colleges use a standard supervision form which asks you to fill in

(i) **Name of Student**

(ii) **Subject** Fill this in by writing ‘Maths’ followed by the part of the Tripos (1A, 1B, II or III) and then the specific subject. For example you might write ‘Maths 1A, Prob & Dif Eqns’.

(iii) **Number of Supervisions on which report is based** You should note in your report any supervisions the student has failed to attend without reasonable excuse.

(iv) **Total number of supervisions you intend to give**

(v) **Term and Year** In Cambridge the Autumn term is called Michaelmas, the Winter term is called Lent and the Spring term is called Easter. (In Oxford they are all called something else again.) Since the academic year does not coincide with the calendar year I give the academic year so that I might write ‘Lent term 92/93’.

(vi) **Is the report confidential?** In my view the report is for the College and not the student so I mark my reports confidential. You may have other views.

(vii) **Summary of Performance** In this section you are asked to estimate the ability, industry and probable performance of your students. (The question asking you to estimate the spot price of oil in Rotterdam in a year’s time seems to have been missed off.) It may comfort you to know that the Director of Studies who will read your report finds it almost as hard to answer such questions as you do and will not attach an exaggerated degree of importance to your replies. Here are some vague guidelines which you should feel free to ignore.

Ability Put ‘excellent’ if the student has star quality, ‘excellent/good’ if you have no real criticisms (you are always free to mark two boxes), ‘good’ if the student has problems but can overcome them (most students should be ‘good’ or better), ‘fair’ if the student can just about cope now but may run into real problems later. If you put ‘poor’ this will ring alarm bells.

Industry Put ‘good’ if the student has worked hard for all supervisions (most students should be ‘good’). Put ‘adequate’ if one or two supervisions (out of eight, say) have been poorly prepared. Anything worse than this should be marked ‘unsatisfactory’ and, again, such a notation will ring the alarm.

Expected Grade Use your liberty to mark more than one box to the full. Since the weather tomorrow is likely to resemble that today, the safest prediction in the second or third year is that the candidate will repeat the previous year’s performance. In any case (unless you mark ‘3rd/fail’ or ‘fail’) nobody will worry about your prediction.

(viii) **Detailed Report** As a Director of Studies, I find this is often the most useful part of the report. However if you have nothing in particular to say do not worry — everybody has students who make no impression on one whatsoever.

Taxes You are only liable to taxes if your total earnings from all sources exceeds a certain amount. First time supervisors are thus unlikely to need to worry about taxes. However, if you have substantial other income (for example if you are a research fellow) then you will need to make an annual return to the Inland Revenue detailing all your income including supervision fees. Supervision fees are not taxed at source (so the Inland Revenue are particularly concerned to know about them) but Colleges send a list of their supervisors for the year to the tax offices. All this means is that you must keep a record of your supervision earnings by, for example, photocopying the cheques and placing the photocopies in a suitably marked file.

If these notes read like the clucking of a mother hen I apologise. If you have suggestions for improvement please contact me by e-mail (twk@pmms.cam.ac.uk) or otherwise. In any case let me end with my best wishes to you and to your future supervisees.

[Last revised 1 August 1996. Printed out October 18, 2016. These notes are written in $\text{\LaTeX}2\epsilon$ and stored in directory `~twk/FTP` on moa in (I hope) read permitted form in a file labelled `SUP.tex`. It may be accessed via my web home page

<http://www.pmms.cam.ac.uk/home/emu/twk/.my-home-page.html>.

Also available:-

‘Dr Körner’s Helpful Guide For Mathematicians Seeking A Cambridge Research Fellowship’,

‘In Praise of Lectures’ (how to listen to a mathematics lecture),

‘An Unofficial Guide To Part III’,

‘How to Write a Part III Essay’,]