

Guide to Supervision in the Physical Natural Sciences

Introduction

This guide is aimed at research students, post-doctoral workers and academics new to Cambridge who are intending to supervise undergraduates in the physical Natural Sciences. Supervision practice is quite similar for the different physical science courses in Parts IA and IB (the first and second years), and the remarks in this guide are directed primarily towards these courses. Astronomy, Chemistry, Materials Science and Physics all organise supervisions for Parts II and III (the third and fourth years) somewhat differently, and often in somewhat larger groups, but the same observations are generally applicable. Attention is also drawn to the seminars on Supervision which are run on a regular basis as part of the University's [PPD programme](#).

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What is a supervision and what is it for?

A supervision is typically a one hour teaching session involving two or three undergraduates and a supervisor. The supervision is an opportunity for the students to receive personal attention aimed at helping them understand and explore the subject in hand. Typically in a supervision there will be discussion of the students' answers to problems they have been set, or an essay they have been asked to write. It is also usual to encourage the students to initiate discussion on or ask for further explanation of topics covered in the lecture course. By its nature the supervision is a teaching vehicle which is tuned to the particular needs of the students involved; this is its great strength. One group of students may need assistance with understanding basic material, whereas another may have no apparent difficulties and so need to explore aspects of the subject in greater detail depth.

How are supervisions arranged?

In the Natural Sciences, supervisions are closely linked to the lecture courses which are being given. A supervisor is typically engaged to supervise a particular course or series of courses. The range of courses which any one supervisor can reasonably cover depends on their depth of experience and willingness to move outside their own specialities. It is not at all unusual for a student to see several supervisors to cover the full range of even a single subject.

In the first two years, Parts IA and IB, Supervisors are engaged by College Directors of Studies. Each student has a Director of Studies who is responsible for overseeing his or her academic work. This will involve advising on the choice of subjects and courses, finding supervisors, entering the students for examinations and so on. The arrangements for Direction of Studies vary greatly from college to college. For example, some colleges have a single Director of Studies for each year of the NST; others have subject-related Directors of Studies. The Colleges pay for supervision (at rates set by Colleges together) and so you should ask the person who engaged you as a supervisor how many supervisions you are expected to give for a particular course. You should certainly not vary this number without consultation. Some Directors of Studies will also indicate the group size and possibly even the way the students should be grouped for supervision. Again, you should not depart from these without consultation.

In the third and fourth years, Parts II and III, supervisions are generally arranged directly by the Departments concerned, on behalf of the Colleges. They follow the same general form as in early years, but there are relatively fewer supervisions, and depending on the availability of supervisors, group sizes may be larger. The Colleges still pay supervisors directly, and supervisors should communicate concerns about student progress etc directly to the relevant Director of Studies.

Following the course

In the Natural Sciences, supervisions follow lecture courses, so it is essential that you are entirely familiar with the content, scope and level of the course you are supervising. Most Departments make available booklets containing synopses of the courses, and typically the lecturer will give a relatively detailed outline as to the content of the course. It is also common for lecturers to provide students with printed or on-line handouts which serve to define the course; Departments also supply copies of old Tripos papers. You should equip yourself with as much information as you can about the course content; it is up to you to obtain such material.

Unless you are very familiar with a course and its content (for example if you attended it very recently and the course has not changed) there is really no substitute for attending the lectures themselves. By doing this you will obtain by far the most accurate impression of the level at which the course is aimed and the approach which is being adopted. In addition you will no doubt see points that you think the lecturer has missed or not explained well; you can then work these into your supervision. Some supervisors may be concerned that if the students they are supervising see them in the lectures that their authority as a supervisor will be undermined. Experience is that this is not so; most students see the presence of their supervisor in the lecture as a sign of commitment rather than weakness. Even if you do not attend all of the lectures it is important to make sure that you are well informed about the progress of the lecture course so that you are able to set appropriate written work and be prepared for the kinds of questions you will be asked.

Setting and marking work

The expectation is that you will set the students some written work to do in preparation for the supervision. In some subjects, this will take the form of questions from a question sheet provided by the lecturer. You should insist that the students hand in their written work before the supervision; be precise about when you expect the work to be handed in, for example specify "24 hours before the supervision" or "by 5 pm on the day before". You should discipline yourself to have always marked their work before the supervision; marking the work will give you a good guide as to the extent to which they have understood what they are doing. If the work is not marked before the supervision, a great deal of time can be wasted either by you looking through the work or by concentrating on the wrong topics.

The amount of work to set needs a fine judgement. If you set too much you will demoralise the weaker students and deprive the conscientious of sleep; a smaller number of questions done thoroughly is much better than a larger number of half-complete questions. You also need to keep in mind that most students will have several supervisions each week (typically four for a Part IA student), so the time they can spend on your work is necessarily limited. It is hard to generalise, but a good guide is to imagine what they can do in an evening of steady work. The guidance of colleagues who have supervised before is useful in judging how much work can be set.

It should go without saying that you need to make sure that you do not set questions which the students cannot answer because the lecturer has not covered that topic yet. You should also not set a question which you have not worked through yourself in advance: it might have an error in it or some hidden difficulty which makes it inappropriate at this stage.

Past Tripos questions are a favourite source for supervision work, both for lecturers and supervisors. However, these questions need to be approached with care. Firstly, they are certainly not suitable in the early stages of the course, where something more straightforward and introductory is needed. Secondly, courses change over time and so an old Tripos question may no longer be appropriate to the present course. There are distinct advantages to doing some Tripos or Tripos-style questions, especially towards the end of the course, as these give the students confidence that they are in a position to tackle the examination, including giving a feel for the amount of material that can be

included in an answer. Past Tripos questions can also form a very useful basis for work to be done over the Christmas and Easter Vacations.

In marking written work you need to identify clearly where any errors have been made and indicate what the correct solution is. It is important to make clear and helpful written comments on the students' work - not simply put a cross by their solution or answer. It is also important not to be dogmatic about the "correct solution". There are usually more than one way to approach a problem and you should not criticise the students for not adopting your favoured approach. By all means point out alternatives, but make it clear that they are just that.

The supervision itself

You should have obtained some clues from their written work as to how well the students are coping with the course, and should be prepared to cover areas which are clearly causing them problems. The expectation is that you will go over the solutions to the questions with which the students have found difficulty. Often, going through these explanations is a convenient way of bringing in different aspects of the subject which you want to draw to their attention to. For example, you may wish to comment on the approximations or principles which underlie the approach to a certain problem.

Another way of introducing extra material is to pose further questions as you go along; this is also a good way of getting some interaction with the students and getting them to say something. The students will certainly expect you to go through the problems with them, and if you do not do this they will justifiably have cause for complaint. On the other hand, a supervision cannot just be a Tripos-cramming exercise in which you show the students how to solve problems efficiently. You should be able to use your discussion of the problems as a jumping-off point for widening the discussion and bringing in extra points. The educational value of a supervision is greatly enhanced by bringing in this extra dimension.

You need also to give the students the opportunity to explore their own idea, to ask questions or to seek from you explanations and clarification of topics they do not understand. Allow them the chance to interrupt you, even if you find it interrupts your beautifully prepared argument. Do not deflect their questions or they may not have the confidence to ask again. Some students come with a clear idea of what they want to ask. Others invent things on the spot when asked "is there anything you want to ask about", others leaf through their notes looking for something to ask about! You need to develop a sense of whether or not a "question" is genuine. You should do your best to offer explanation and clarification during the supervision, but if there is something you feel uncertain about do not hesitate to defer discussion of this to a subsequent occasion. None of us can be omniscient: you will gain far more respect from your pupils by presenting a clear explanation next week than an unconvincing or even wrong one this week.

Particular difficulties that a student has identified can also be addressed by you giving specific guidance as to books which they could consult for help: references to specific books and chapters in them or to some of the increasingly useful forms of computer-aided learning that are available on the University network will be most helpful. You need also to be prepared for the student not to understand your explanation, and to give them the chance to say so. Be ready to repeat the explanation or to offer an alternative: above all be tolerant of their inability to follow you. If you are hostile or resentful when they say that they do not understand they will say that they understand

even when they do not, and then the chance for them to gain from the supervision is lost. However, do not be afraid to ask a suitable question which probes their understanding.

Undoubtedly the hardest thing in a supervision is to establish a two-way interaction between the students and the supervisor. It is all too easy for the supervisor to slip into giving a monologue. While the students may find this useful, especially if you are helping their understanding, it is not really the intention of small group teaching. One of the great benefits of a good supervision is that the students have experience in articulating scientific ideas and explaining their thinking; this is invaluable experience which they will not get elsewhere. Once you get to know the abilities of the students you are supervising you can ask them questions which you think are tailored to their ability, challenging and stretching their abilities on an individual basis. Above all, your supervision pupils should quickly realise that they are expected to think and work during the supervision, as well as you.

One thing that often inhibits students participation in a supervision is their feeling that the supervisor is making a judgement on them. This is, of course, not the case; there are no Tripos marks awarded on the basis of supervisions! The supervisor needs to establish an atmosphere in which the students feel secure enough to expose their weaknesses; there is no pretence that this is easy to achieve. If, as a supervisor, you are prepared to admit to the students that you found such and such a problem or concept difficult the first time you met it you will go a long way to helping them be honest about their weaknesses. Your aim is to gain the students trust and confidence, and you are unlikely to do this by being aloof or defensive in your manner. One aim of the supervision is to show how we all continue to learn and to explore ideas together.

When things go wrong

Two situations which arise in supervisions can be particularly difficult to deal with. The first is when the students have done, and done well, all the work set and claim to have no further points they want to discuss or need clarification on. Experience is that they are probably deluding themselves. A supervisor always needs to be prepared with more material and more demanding questions so as to be able to really probe the students' understanding and to raise or broaden the level of any discussion. This needs to be handled carefully, as it is all too easy in such a situation for the students to feel that their time is being wasted by the introduction of irrelevant material. Unseen Tripos questions can be a help in this situation.

The second situation which requires careful handling is when the students apparently are unable to tackle the work at all and seem completely lost. Of course there is always the possibility that this is a result of idleness on their part. Assuming that it is not the case, the key thing in these situations is to build up the students' confidence that they can do the work - exasperated sighing and derisive comments from the supervisor that the work is trivial will not help in this situation. You should explore their background knowledge and understanding, emphasising the key points and ideas; check that they have reasonable lecture notes and some good books to work from. Once the base seems secure, start to show how the simpler problems should be approached and do some solutions for them. You should proceed in small steps through a problem, leading them through the solution with a series of straightforward questions; the aim is to build confidence. In these situations, it helps to get them to do the same problems again, perhaps even some that you have gone through in the supervision - again as a confidence building exercise. Be prepared also to give hints as to how to approach the work, and keep the amount moderate.

Supervisions are difficult to conduct if the group you have is very mis-matched in apparent ability of preparation. If this seems to be the case, you should consult the Director of Studies who engaged you and see if that College's groups can be rearranged. You should be aware, however, that the students can be rather offended by such a rearrangement. An all too common problem in a supervision is when one student dominates the group by always answering your questions, volunteering ideas and generally not letting anyone get a word in. One approach to this is to make it quite clear that you are directing a question or enquiry at a particular person, rather than to the group as a whole. Tactfully, or at times bluntly, you will have to ensure that one person does not dominate. It can be very harmful to the confidence of the others in the group if one person is apparently (and it is often only apparently, not actually) so much more confident with the work.

Feedback

Many students find it difficult to cope with the fact that they cannot do all the work and do it perfectly. At school or college they will have been used to being at the top of the set and to finding the work relatively easy; some will have been able to maintain this position despite doing little work outside lesson time! It is important, therefore, to let the students know that even though you have covered their work with comments and corrections that this is by no means unusual. The work is hard, and very few are going to be able to do it all perfectly. In providing the students with feedback on a week by week basis you need to make sure that they understand how they are doing relative to the norm for the course.

You are expected to write a brief on-line report on [CamCORS](#) for each student a week or so before the end of the term; reports are also your claim for payment, so there is plenty of incentive to fill them in. It is essential to keep notes on each student as you go along so that your report can be accurate rather than based on an impression of the most recent supervision. Your report is addressed primarily to the student: it needs to be frank, giving praise where it is due for effort, participation and achievement, and pointing out perceived areas of weakness or where more effort is needed. There is no point in being "nice" just for the sake of it; only an honest appraisal is of use.

Generally these reports are used by the College to keep a track of the students' progress; in the event that a student is unable to take an examination, due to illness for example, the reports may be used by the College as part of a case for the student to be allowed to stay in the University.

Students will see these reports. If you have concerns that you do not wish the student to see, then you will need to contact the Director of Studies directly: his or her email address is¹ available on CamCORS.

You should immediately inform the Director of Studies who hired you if you have serious concerns about a particular student; don't leave it until the end of Term. Persistent failure to hand in work, missing supervisions without good cause or constantly rearranging and postponing supervisions should all be reported to the Director of Studies. Also, if you detect signs of stress or anxiety in the students, you should once again pass this information on. You need to remember that as the supervisor you probably see the student more often than the Director of Studies does, so you are in a

¹ You will need a CamCORS account in order to complete Supervision Reports. Accounts need to be approved by a College, or, if supervisions are organised by the Department, by the Departmental Teaching Office.

better position to pick up on warning signs. The source of any information on a student which you passed to a Director of Studies will be treated in confidence if you so request.

All students also have a College Tutor who is responsible for their overall welfare. You may receive communications from College Tutors regarding the students you are supervising, or you may be asked for cooperation and extra sympathy with students who are having particular difficulties. Again, information exchanged with a Tutor will usually be in strict confidence.

Most Colleges now have formal systems for monitoring the effectiveness of supervisors. Usually, the students are asked to rate their supervisors for their effectiveness as teachers, communicators and so on. Poor feedback from students is likely to result in a supervisor being called to account by the relevant Director of Studies. The most frequent complaints made against supervisors are their failure to mark work, the difficulty in contacting them and the constant cancellation or rearrangement of supervisions.

Behaviour

The relationship between a supervisor and students is not a very formal one, but never the less it is important to understand that from the point of view of the students the supervisor is a person with authority and, to an extent, power over them. The relationship needs to take this into account. Social interaction between supervisors and their students is on the whole a good thing and Colleges are keen to encourage integration between undergraduates and researchers. However, a supervisor needs to be aware that the students they are supervising may find it uncomfortable to be in a social situation with their supervisor, simply because of the teacher-pupil relationship on which the interaction is based. Generally it will be easier, and on the whole more appropriate, for a supervisor to invite a group of students to some social function, rather than to make individual invitations.

A supervisor must not think that supervising a group of students gives the right to intrude into the students' social or personal life. By showing a general interest and concern for the students you are supervising you are likely to be more effective as a teacher and role model.

Conclusion

Effective supervising is undoubtedly hard work and needs a significant commitment of time and energy on your part. The rewards, in seeing those you are supervising learn and grow in understanding and confidence are well worth the effort. When it works well, supervision is very stimulating and enjoyable for all concerned: it is a truly unique and much prized part of teaching at Cambridge.

Summary

The elements of a good supervision:

Preparation: understand the material, the way it is being presented and the approach taken by the lecturer.

Written work: carefully select appropriate problems for the students, mark their work carefully.

Tailor your supervision: taking cues from their written work, explore the subject with the students, adjust your approach to match their level; leave time for them to ask questions; encourage the weaker ones and help to boost their confidence; stretch and challenge the stronger students.

Don't give another lecture: supervision is a two-way process. Don't be afraid to admit that you don't know, or that you found something difficult.

Feedback: keep Directors of Studies informed if there are problems; make your end of term reports accurate and honest; expect feedback and criticism of your performance.

Practice makes perfect: your first supervisions will not be perfect, and even after your hundredth there will still be room for improvement; be open to fresh ideas for different ways to approach your supervisions.

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