# A HANDBOOK OF TEACHING

Department of Mathematics
University of Virginia

# Preface

This handbook, prepared in the summer of 1998, is in fulfillment of a grant supported by the Faculty Senate Initiative to Promote Excellent Teaching. It was authored by three graduate students, Jim Bowling, Terrell Hodge, and Julie Theoret, with the support of faculty members Barbara MacCluer, Kevin McCrimmon, Larry Thomas, and Thann Ward.

In accordance with the grant proposal, this is the first version of a handbook for TAs. It is expected that all TAs will be involved in a continuing revision and adaptation of this handbook, in accordance with the changing needs of undergraduate mathematics instruction. Consequently we encourage you to submit any suggestions or comments to the faculty member serving as the teaching advisor (see 10.2).

While leaning on our own experiences, we also drew (at times heavily) from the sources listed in the references as well as our own experiences. Thus we would like to thank the authors of these works. In addition special thanks also go to Jim Howland, Julie Riddleberger, Joyce Stevens, and the Teaching Resource Center for their assistance. Final thanks go to the aforementioned faculty who initiated the grant and gave us the opportunity to write this handbook.

# Contents

# 1 Introduction

This handbook was designed to serve as a resource for you, as a graduate student teaching assistant (TA) [1], in an effort to better equip you with the tools you need in your transition from student to teacher. We hope that, in fact, this handbook will aid both the experienced TA and the neophyte (and perhaps faculty members as well). The topics discussed are by no means exhaustive in scope, but they represent a significant cross section of the life of teaching in the Department of Mathematics here at UVA. With the exception of Section 2, you may profitably read any section, in any order, as it suits your needs, but we suggest that you review the entire handbook.

# 2 First Things First

Welcome! You have just arrived at UVA and you have many things to think about, especially if you have never been in front of a class before. The beginning of any semester, especially your first, can be a little stressful. You may want to get a jump on things before the semester begins.

The first thing that you should do is find out which course you are TAing. Check for the listing of teaching assignments outside the mailroom. The listing should also include when and where your class will be held. If you are not listed, or there is no listing, contact Julie Riddleberger (see below).

Once you have found out what you are TAing, you can check out the textbook and a solution manual, if available, from Julie. You can find out your office assignment at the same time.

You should also contact the professor or graduate instructor for whom you will be the TA. This will let that person know who you are and that you are serious about your job as their TA. Take note that, at Mr. Jefferson's University, faculty are most often addressed as 'Mr.', 'Ms.', or 'Mrs.', not 'Professor' or 'Doctor'. (Originally teachers and students were all addressed equally by the title "Mr.", but today students are usually called by their first names.) As the first day of class approaches, you should investigate the classroom where you are teaching. Sometimes the Registrar's office mistakenly assigns the Department of Mathematics classrooms that are not suitable for us. It is best to find this out in advance and get the room changed as quickly as possible. Mary Cline (see below) can help you with this.

One of the most important things to remember as you start your life here at UVA – always be nice to the secretaries, and they will be nice to you. Joyce Stevens (KERCHOF 212) handles all payroll issues. Julie Riddleberger (KERCHOF 218) takes care

[1] In this handbook, the abbreviation 'TA' is used in many forms, both as a noun and as a verb. A graduate student who teaches will be referred to as a 'TA'. A TA may be the principal instructor of a class, or may lead a discussion section ('fourth hour', see Section 3.1). In the latter case, a graduate student is often said to 'TA' the fourth hour.

of many issues including textbook sign out and add/drop and ISIS questions. Julie is the graduate secretary, so she should be able to answer most questions you have about your duties and the graduate program here. Mary Cline (KERCHOF 214) takes care of any scheduling problems and room assignments for review sessions and exams. Connie Abell (KERCHOF 216) works the front desk and can act in Mary's place if she is not available.

# 3 As a TA

## 3.1 Fourth Hours: What Are They?

For the most part, the mathematics courses at the University of Virginia meet on a regular Tuesday/Thursday or Monday/Wednesday/Friday schedule. There are some courses however, that have one extra meeting per week. These extra meetings are generally referred to as fourth hours. They are not (in general) optional sessions that the students can choose to attend as needed, but are listed as a required part of the course. Fourth hours meet once a week for 50 minutes. One responsibility that a graduate student at the University may be given is that of leading a fourth hour. A listing of the particular courses that have fourth hours can be found in Section 5 below. The details of leading a fourth hour will be described in the following sections, but in general these extra meetings are used as times when students can ask specific questions concerning homework or other assigned problems. As a fourth hour TA, it will be your responsibility to be prepared to answer these questions. You will not be responsible for organizing the overall course, and you will usually not deliver lectures.

## 3.2 Goals

Certainly, one of the main goals of a fourth hour is to give students an opportunity to see correct solutions to problems that they themselves could not solve. A description of the overall purpose cannot stop there, however. By simply writing correct solutions on the blackboard, a TA offers nothing more than a solutions manual that the students can read on their own. Ultimately, the goal is not simply to provide students with answers to individual problems. The real goal is to help the students develop their own problem-solving skills (see Section 7). To reach this goal, a TA must be prepared to interact with the students. He or she must communicate clearly and be prepared to explain the motivation behind the individual steps that lead to a solution.

## 3.3 Interacting With Faculty

If you are a TA who is leading a fourth hour, keep in mind that you will be leading that fourth hour for a particular course and a particular instructor. Meet with him or

her at the beginning of the semester to clarify what your exact responsibilities will be. Some issues you should discuss are:

- How does the instructor want the fourth hour organized?
- Will there be quizzes during the fourth hour? If so, then who will write them? Who will grade them? Will they be timed?
- Will you, the TA, be involved in writing or grading the exams?

Keep in mind that as a TA you may not have some of the freedom you would as a lecturer for a course. As a result, be careful not to make any decisions concerning the class that may not be yours to make. When in doubt, always check with the actual instructor.

One practical note: Be sure to check your e-mail and mail box frequently during the semester, as these are two main ways in which the instructors maintain contact with their TAs.

### 3.4 Strategy And Structure Of The Fourth Hour

The instructor you are working for may have a specific manner in which he or she wishes the fourth hour to be organized. In some cases though, the instructor will not have a definite opinion, and you will have some freedom in structuring the fourth hour. It will be worth your while to put some thought in to the actual organization as time can be a problem in a fourth hour, particularly when students have a lot of questions.

One strategy that you may find useful is the following: Each week, prior to the fourth hour, have the students inform you of the questions they want you to address during the fourth hour. The students can, for example, e-mail their questions to you or write them on slips of paper and put them in your mail box. You can even set up a web site with an anonymous feedback page which could be used for this purpose (see Section 8.3). Being forewarned will allow you to think about your explanations ahead of time and to make certain they are clear before presenting them to the class. Also, this strategy can help you recognize particular problems that a large number of the students are struggling with. For instance, if you find nine slips of paper in your box, all asking about problem 17 on page 231, then you will know that you need to be ready to talk about that problem at length.

## 4 As a Lecturer

### 4.1 Responsibilities

In addition to leading a fourth hour, graduate students at the University may be assigned to serve as lecturers for certain mathematics courses (see Section 5). Perhaps

the best way to describe some of the details involved in being a lecturer at UVA, is to speak about a specific class and its design.

Math 121 is an introductory calculus course at UVA. Since it fulfills one of the mathematics requirements in the university curriculum, a large number of students enroll in the course each semester. As a result, in any given semester, there may be up to ten or twelve different sections of Math 121. One individual, a TA or a faculty member, is assigned per section, to serve as that section's instructor. One of these instructors, a faculty member, is also assigned to serve as the course coordinator for Math 121. He or she may teach one large class, and thus several sections, and is responsible for overseeing the operation of all the sections collectively. If you are a graduate student who is assigned to serve as a lecturer for Math 121, then you will function as an instructor for one section only (roughly 25 to 35 people) and will work under the direction of the course coordinator.

In general, if you are serving as a lecturer for any course, the set up will be the same as that described above. Mainly, you will be responsible for lecturing to the class on the appropriate material, administering and grading their exams, and determining final student grades. Usually, the course topics and assignments will have already been organized and you will be provided with a complete syllabus for the course. You may be asked to contribute problems to the semester exams, but in general you will not be responsible for writing up or organizing an entire exam.

Note that it is possible to serve as a lecturer for a course that does not have a Course Coordinator (see Math 121S in Section 5). In this case you will be responsible for writing up your own syllabi and exams. However if you feel that you are in need of some guidance in carrying out these tasks, do not hesitate to speak with faculty members or other graduate students who may have taught the course before.

## 4.2 Goals

When you are serving as a lecturer, your main role will be to function as the vehicle through which the course material is communicated to the students. This is a large responsibility, but one that can be enjoyable and rewarding if approached with the right attitude. To play this role effectively, it is necessary to have a clear understanding of what your goals as a lecturer really are. The course function is essentially twofold. In particular, it is your goal to expose the students to the subject and to help them achieve a high level of understanding of the key concepts and ideas that make up the course. In general, your goal is to help the students develop their ability to think analytically when attacking problems (see Section 7). It is your hope that they will learn how to take the mathematical way of thinking and apply it in a useful manner to areas of life beyond mathematics.

## 4.3 Interaction With Faculty

As a lecturer, you will generally have more freedom than you would as a TA in carrying out your duties. Keep in mind, though, that if you are working under a course coordinator, you might not be the ultimate authority. If the course for which you are lecturing is coordinated, then meet with the coordinator at the beginning of the semester. It will be helpful to address issues such as the following:

- As a graduate student lecturer, what are your responsibilities regarding the writing of the quizzes and semester exams?
- Will you grade your own exams or will it be a collective effort?
- What decisions do you have the freedom to make, without speaking with the course coordinator first? Specifically address issues like make-up exams and withdrawals, attendance policy, and grading policies.

If you are not working with a course that is coordinated, then feel free to ask for advice or guidance. Again, do not hesitate to approach someone who has taught the course before (see Section 10.2).

## 4.4 Interaction With Other TAs and Undergraduates

In the past, TAs who served as the instructor for a course with a fourth hour would be assigned other TA's to conduct the fourth hour. Thus you, as the instructor, may have the additional responsibility of guiding another TA. In this case, the Golden Rule of "Do unto others as you would have them do unto you" especially applies. Before the semester begins, decide what role you would like your TA to play. For example, will you want your TA to:

- give complete, or only partial solutions to problems, or simply just hints?
- to work only problems which are similar, but not assigned?
- to give quizzes?
- to grade quizzes or homework?
- to help you prepare and/or grade exams?

Keep in mind, when contemplating which duties you would like your TA to take on, what is commonly done for that type of course, or what other instructors plan to do, including the possibility that the role of the fourth hour instructor may be dictated by the course coordinator. Of course, you may wish to try something different.

Remember that your fourth hour instructor is another graduate student like yourself. Thus, he or she may be incredibly busy with his or her own schedule and work, and

be grateful to you for clearly delineating the duties you expect of him or her. On the other hand, since your fourth hour instructor is also your peer, he or she may also have his or her own ideas about the course, and resent you stepping up with your best laid plans, and no thought about the TA's own ideas. In either case, you should meet with your TA before the semester begins. Having considered the role you would like your TA to play, you will be prepared to to consider the other TA's thoughts on the matter; let him or her know from the outset that you are interested in his or her input, and that you would like to discuss this in your first meeting.

As soon as possible, provide for your TA a copy of the class roster and a syllabus. Decide upon a means by which you will contact each other, whether it be by e-mail, by department mail box, or by weekly meetings. Of course, you can get together informally as well, but be sure that your TA knows when you will provide, or decide together upon, the material to be covered each week. Give your TA as much advance warning as you can. (YOU wouldn't want to be stuck preparing 50 problems with two hours notice!)

Work together with your TA to assess the progress of your class. If the students had a lot of questions about a particular type of example, warn your TA. Ask your TA to pass on to you his or her observations about the class – a TA may realize that students have difficulties with a topic, or that an example you believed you covered well made little sense to them. Sometimes TA's hear comments which students might not make directly to you as the lecturer, but which may be able to help you to improve your lecture style, such as the fact that students find the pace to be too slow or too fast, or your handwriting to be difficult to decipher. Perhaps your TA may also be informed by the students that your last lecture was really thorough and the students are well-prepared! (Just in case you might be privy to this wonderful news, however, have a suggestion handy for your TA in case the students really don't have questions.) Use information given to you by your TA discretely, so as to avoid putting your TA in the precarious position of appearing to be a tattle-tale, but do work with your TA to maximize class feedback.

If possible, set up office hours so that yours and your TA's do not overlap, giving students more opportunities to find help. Be sure to make clear to students and to your TA if or when questions should be directed to you alone (as in the case of an exam, say). If you will use a problem-solving method or approach which differs significantly from that in the text, be sure to let your TA know (and ask your TA to do the same) so that you can maintain consistency. It can be needlessly frustrating for a confused student to find that the TA's approach and yours differ.

This does not, and should not, preclude the possibility that you and your TA may wish to appeal to different ideas, but you and your TA should first stand on common ground so that you may then recognize the path less taken, and inform the student of this as you go. Indeed, the opportunity for a principal instructor and a fourth hour instructor to appeal to differing aspects of a single student's understanding or mood, as well as different characteristics of the class as a whole, is one plus of having distinct people serve as lecturers and fourth hour leaders for the same section of a class. Another

advantage is the chance to work with another TA to develop your teaching skills and/or to perhaps try out new ideas with respect to pedagogy. As the principal lecturer, you should be wary of loading your TA with too much responsibility, but sharing the work of assessing the class, whether by feedback from your TA, or by asking your TA to make up/grade quizzes or grade homework can provide both you and your class with an added element of feedback, and an opportunity for the TA to hone his or her skills. Don't forget also the possibility of passing on tricks of the trade to less experienced TAs as one of your duties, as well as a joy, of having another TA as the fourth hour instructor.

In the future it is likely that a single TA may run both the lecture sessions and the fourth hour. This option holds its own advantages, including: greater ease of scheduling, the greater flexibility inherent in having three or four sessions per week, instead of two or three (a mistake on Wednesday might be noted on Thursday), the ability to establish a rapport more quickly with the class due also to meeting more often each week, and the possibility of saving time by not needing to maintain contact with and prepare material for another TA. If possible, you might opt to try a class both ways, with and without a separate TA for a fourth hour.

Finally, as the instructor for a class, you may have an undergraduate to act as a grader for your class. The availability of graders has varied widely from year to year, semester to semester, and class to class, due largely to funding and to differences in enrollment (for example, a lot fewer people register for Calculus 131 in the spring than in the fall, and larger sections usually are first in line to receive those graders which are available). In some cases, the course coordinator of a large number of sections may meet with the graders as a whole to discuss grading policies and establish uniform guidelines. In this case, your responsibility consists primarily of contacting the grader, establishing a policy on homework collection and return, informing the grader which problems are to be graded and for what point totals, and being sure to let the grader know if you will be deviating from any of the instructions or usual policies. In order for homework to be timely and thus most useful as a feedback mechanism for the class, try to arrange it with your grader so that you can return homework to the class within a week after it has been submitted. You may wish to set up a brief weekly meeting with your grader to answer any questions he or she has, and to raise any issues which may have come to mind after looking over the grader's work. This is especially true the beginning of a semester. If there are no initial concerns, often faculty and graduate students will simply leave homework in their mathematics department mailboxes for the graders to pick up and return. Consult with the course coordinator to determine the extent of the grader's responsibility to you and to the course coordinator. If you are teaching a coordinated course, but no mention of the topic of graders is made by the coordinator, be sure to raise the issue yourself to ensure that uniformity of grading does not become an issue later.

If there is no overarching course policy with respect to direction of graders, then along with the considerations above, you will have to decide upon and provide your

grader with specific guidelines with respect to grading. By "specific", we mean here that you should tell your grader how to assess points for a problem and a set in general, including, for example,

- how much needs to be written out to consitute a complete solution to a given problem (e.g., indicate whether numbers alone are ok, or whether sentences should be used),
- whether neatness should be counted: if it is very messy, should the grader slog through it, or perhaps give it some fraction of credit,
- whether late homework is acceptable, and if so, how many points are to be counted off,
- what constitutes completeness of an assignment, especially if only a few of the assigned problems are to be graded.

Think long and hard before deciding on how much you wish your grader to grade: he or she may be grading for the first time, and is under the pressure of a full course load. Graders are expected to work a fixed number of hours per week (this may be just two to three hours per week) and are paid on this basis. A good way to encourage students to do problems without overloading your grader (or yourself, if you are grading your own homework) is to make it a policy that you will grade only a fraction of the problems (three to five is often a sufficient number) due each week, but do not inform the students before turning in the work which problems will in fact be graded. In assigning the problems to be graded (if these are not already chosen by the course coordinator) keep in mind that some problems may have solutions in the back of the textbook. Be sure to provide the grader with homework solutions, whether written by you or drawn from a solutions manual.

As in the case of working with another TA as your fourth hour instructor, be sure your grader knows where and when to reach you, and when and where to expect the homework. Also fix who will keep the record of the homework grades; you might give the grader a book in which to keep them, or ask the grader to record them each week on a copy of the roster (which you have, of course, provided as soon as possible anyway) to be included with the week's returned homework, or ask the grader to use a spreadsheet program and give you a copy of the file. Your grader is not a slave: show him or her the same consideration you would to another TA or a faculty member. Pass on any techniques or ideas you have developed to facilitate your own grading, and be considerate when making suggestions to the grader. As a last point, you might keep in mind that the weeks of exams for your students are also often exam weeks for you grader, so you might consider doing a bit of the grading yourself, or somehow lightening the load for the grader, but at the least, don't overwhelm your grader then.

# 5 Courses

The following is a list of all the courses you may responsible for teaching or TAing:

- **MATH 103 - Precalculus** Students who take this course are typically first-year undergraduates who need preparation for calculus and precalculus applications in other courses. It is a three credit course. MATH 103 classes typically have less than 20 students. It is usually not coordinated. Graduate students are instructors for this course, and may be in charge of preparing the exams. The aim of this course is to prepare students for calculus as well as for mathematics applications in courses such as business, economics, chemistry, biology, sociology, geology, environmental science, medicine, and physics.

- **MATH 111 - Finite Math and Probability** Students who take this course are typically pre-commerce students and students fulfilling the natural science requirement. It is a three credit course. MATH 111 classes typically have fewer than 25 students. It may be coordinated with graduate students as instructors, who may be expected to prepare the exams for the course. This course introduces elementary concepts in probability using cards, dice, etc... Students also learn about matrices and some of their applications. Some sections require the students to use Maple.

- **MATH 112 - Introduction to Statistics** Students who take this course are mainly first and second-year undergraduates with interests in pre-commerce, liberal arts, biology, and social science. MATH 112 is a requirement for admission into the Commerce School. It is a three credit course that is heavily coordinated and has graduate students as instructors. MATH 112 classes are usually quite full with between 30-35 students. The course covers the main ideas of descriptive statistics, statistical experimental design, and statistical inference as well as providing an introduction to probability. Homework requires the use of Minitab or Excel for selected problems.

- **MATH 121 - Applied Calculus I** The student body is mainly first-year undergraduates who are not math or science majors. MATH 121 fulfills a course requirement for entrance into the Commerce School. Pre-medical and social science students often take this course. It is a four credit course that includes a fourth hour. It is usually coordinated, with graduate students as instructors and TAs. MATH 121 can have up to 35 students, depending on the time of day the class is offered. MATH 121 serves as an introduction to calculus (basic topics in differentiation and integration) with an emphasis on applications in the social sciences.

- **MATH 121S - Applied Calculus** This is a special calculus course especially for students with no prior calculus experience. The students who take this course

are typically first-years with instructor permission. Students in the Transition Program have first priority. This class usually has no more than 20 students. MATH 121S is not coordinated and not connected to the other MATH 121 classes. Only one section is offered each semester. It is four credit course. In recent years it has been taught by a senior graduate student with another graduate student for a TA. Sometimes the graduate instructor opts to do his or her own fourth hour. The instructor of MATH 121S has much more freedom and flexibility to cater to the special needs of the students. The instructor prepares the syllabus, homework assignments, and writes all the tests, including the final exam.

- **MATH 122 - Applied Calculus II** MATH 122 is the logical sequel of MATH 121 with students (mainly first-years) coming from MATH 121 or calculus in high school. It is a three credit course with no fourth hour and up to 35 students in each class. It is a coordinated course. Graduate students are instructors for this course. The course begins with a review of the basic MATH 121 material, goes into multivariable calculus, and touches upon sequences and series.

- **MATH 131 - Calculus I** This calculus course is designed for math and science majors. The students are typically first-year undergraduates with prior calculus experience, although previous experience with calculus is not a prerequisite. It is a four credit course with graduate students acting as TAs for the fourth hours. On rare occasion, a senior graduate student will serve as an instructor. The fourth hours typically have less than 30 students. MATH 131 is coordinated. It serves as an introduction to calculus with applications in the physical sciences and is required of all math majors, in lieu of A.P. credit.

- **MATH 132 - Calculus II** MATH 132 is the logical sequel to MATH 131 with the same type of first and second-year students. It is a coordinated four credit course with graduate students acting as the TAs for the fourth hours. The fourth hours typically have fewer than 30 students. MATH 132 begins with techniques of integration, and continues with applications such as work, center of mass, volumes, and arc length. Sequences, series, conic sections, and polar coordinates are also covered.

- **MATH 132A - Calculus II** This course, taken mainly by first and second-year undergraduates, is designed for students coming from MATH 121, MATH 122 or students having instructor permission. Students taking MATH 121 and/or 122 are typically not prepared for 200-level math classes. MATH 132A acts as a transition for students who only took MATH 121 and/or MATH 122. There is only one section of MATH 132A taught per semester. It is a five credit course and graduate students serve only as TAs. The course tends to have fewer than 25 students. MATH 132A covers topics from MATH 132 and selected topics that were not addressed in MATH 121, including the calculus of trigonometric functions.

- **MATH 221 - Calculus III** MATH 221 is multivariable calculus and obviously requires MATH 132 or AP credit. The students are typically first and second-years who are potential math, science, and economics majors. MATH 221 is required for math majors. It is a four credit course with graduate students only as TAs. This course is usually not coordinated, but does operate from a common syllabus. The fourth hours tend to be full, with 30 to 35 students. MATH 221 deals with differentiation and integration in multidimensional space. The course begins with vectors and ends with (at least a discussion of) the theorems of Green, Gauss, and Stokes. Some sections require that the students use Maple.

- **MATH 225 - Ordinary Differential Equations** This course is for undergraduates, mainly second and third-years, who are majoring in math or science. It is required for math majors. It is a four credit course with graduate students serving only as TAs. MATH 225 is typically not coordinated with rather full sections with 30 to 35 students. The course teaches the techniques for solving certain differential equations and discusses how differential equations can be used for mathematical modeling. Students are also introduced to matrices and the calculation of eigenvalues and eigenvectors. Some sections require that the students use Maple.

- **MATH 306 - Algorithms** This course is designed for undergraduates (of all levels) with math knowledge at the MATH 132 level and a year of programming experience. Graduate students can take this course under the number 506. They are graded separately. This course tends to be very small and there is only one section offered. A specially trained graduate student TAs this course. The main topic is analysis of algorithms, including an introduction to fundamental data structures. There are weekly programming assignments in $C^{++}$ and a final project at the end of the semester.

- **Applied Math Courses - APMA** The Math Department has recently taken on the task of teaching several applied math courses for the School of Engineering and Applied Science. These courses, which shall only be mentioned briefly, include:

  - **APMA 101** $\sim$ **MATH 131**
  - **APMA 102** $\sim$ **MATH 132**
  - **APMA 103** $\sim$ **MATH 132**
  - **APMA 205** $\sim$ **MATH 221**
  - **APMA 206** $\sim$ **MATH 225**
  - **APMA 310** $\sim$ **MATH 311** Introduction to Mathematical Probability

  The logistics of this arrangement are not fully understood to date. Graduate students will most likely be called upon to grade and hold help sessions, but may

also be fourth hour TAs. The most likely candidate for graduate assistance is APMA 310.

- **Graduate Courses**
  - **MATH 731 - Real Analysis**
  - **MATH 732 - Complex Analysis**
  - **MATH 751 and MATH 752 - Algebra**

  These courses (or their equivalents) are core sequences required of all graduate students in the Department of Mathematics. Each has a fourth hour which is run by a senior TA (usually in his/her fourth year) who has been selected by the faculty. The duties vary depending upon the faculty member who is teaching each course.

# 6 Everyday Teaching

## 6.1 Administrative

### 6.1.1 Organizing The Course

Before the semester begins, you should make sure that you have considered some important issues and/or questions.

1. Make sure you are aware of the basic skills and knowledge that students entering into the course are expected to have. If you suspect that a student is not "up to speed", then it is your responsibility to let them know.

2. What concepts and skills are the students expected to master (see Section 5) as a result of the course? Make sure that you have a firm overall understanding of what the students are supposed to be learning.

3. Decide on policies, noting that many may be determined by the general syllabus of a coordinated course. Will late homework be accepted? Will make-up quizzes be given? How will attendance factor in to the grading? etc. Have your policies in place by the beginning of the semester. Waiting to answer these questions until they arise can lead to inconsistency which can damage your relationship with the students. For this reason, your policies should be described in the syllabus (see Section 6.1.2), and communicated clearly to your class.

### 6.1.2 Syllabus

As a graduate student, whether you are a TA or a lecturer, a syllabus for the course will most often be provided, including a semester schedule for the course and a listing of

homework assignments. However, you should still give the students your own "syllabus" containing any relevant information not already included. Provide the students with:

- Your name
- Location of your office
- Your office phone number and/or e-mail address
- Your office hours (see Section 6.1.3)
- Any information regarding course policies that may not be covered in the general course syllabus provided by the course coordinator (if applicable).
- Any personal information that you deem appropriate. This might include a statement about your teaching philosophy, or your expectations of your students. If you elect to use e-mail or the web to keep in contact with your students, you might give them a cutoff time by which they should contact you in order to ensure you receive their mail before class.

Note that graduate students can be assigned to serve as instructors for courses that do not have a course coordinator. Even in these situations, old syllabi are often available. Check with more senior TAs, or ask the teaching advisor (see Section 10.2).

### 6.1.3 Office Hours

Whether you are a TA or a lecturer, you should set aside some regular weekly hours and designate them as times when students can come to your office with any questions. Two to three hours is a common amount to assign to office hours, but this can vary, depending upon the class or coordinator. In some cases, for example, you may be asked to spend one hour in a help room open to all students of a particular class, and then be expected to set aside one other additional hour for your own section. In any case, put these scheduled hours in the syllabus (see Section 6.1.2) and make sure that you are in your office during those times. Encourage your students to come, and let them know that you are more than willing to help them learn the material, even outside of class.

### 6.1.4 Quiz Writing

Quizzes are a good way to gauge student progress during the semester. The semester exams can certainly identify individuals who are struggling, but quizzes, in general, are easier to deal with and can be administered quickly either during the fourth hour or during class. However, in writing up quizzes, one should keep in mind some simple guidelines:

- Make quizzes relatively brief. In general, the students should be able to complete them within 10 or 15 minutes.

- Quiz problems, for the most part, should test student understanding of the essential concepts. A deep and difficult problem will not be of assistance in evaluating a student's understanding of the basics.

- Always work the quiz through yourself before administering it to the students. This will help you catch any mistakes and will let you know when a quiz has become too long or too challenging. Consider asking other TAs to look the quiz over as well.

- Grade the quizzes soon after administering them. This will help you to quickly determine whether or not the students are grasping the material.

#### 6.1.5 Exams

Since most courses are coordinated, you, as a TA, will not usually be expected to write up an entire exam for a specific course. However, you may frequently be asked to contribute problems to exams, and for some courses, you may indeed be responsible for preparing exams (see Section 5). Whatever the case may be, the following guidelines can be helpful in constructing and administering an exam.

- Give the students sufficiently detailed information about material on the exam, enough to enable them to profitably prepare for it. While they should not be given the actual exam problems ahead of time, they do deserve to know what it is that they will be tested on. Ideally, this will correspond to the content and focus of your lectures, quizzes, etc.

- Decide ahead of time how you will answer questions of a specific nature, such as "Will the chain rule be on the test?" The degree of specificity of your answer may depend upon your teaching philosophy and the course, but be consistent and as truthful as possible when giving your answers. If you do not wish to go into the specifics of the contents of the test, because, for example, you believe that it is important for the students to use the upcoming exam as a motivating factor for sifting through the material and weighing the importance of various pieces on their own, then tell them so. Don't withhold information simply for a kick or to feel powerful.

- Keep in mind that the purpose of an exam is to test the student's understanding of the material. While one or two tricky problems can help identify the best students, an abundance of difficult questions only serves to lower the grades and discourage the students.

- Make the problems independent of one another. Solving problem 8 should not depend directly on solving problem 7. (Even making 7(b) depend on 7(a) can lead to problems of apportioning partial credit for students who do 7(a) wrong!)
- Clearly display the point values next to each problem.
- Work out the test in full yourself, before administering it. An exam that takes you 10 or 15 minutes will likely take most students 50 minutes or more.
- Consider breaking up difficult questions into several parts. This helps the student and makes grading easier.
- Prepare the solutions on paper or post on a website so as to make these available to the students, after the exam has been returned. In coordinated courses, there will often be a course-wide answer key posted on the web and on reserve in the library.
- Deal with student questions concerning grading or fairness of problems outside of class.

### 6.1.6 Grading

In general, the majority of a student's energy will be spent in concern over the grade he or she is receiving in the course. As a result, it is crucial that you thoroughly consider the issue of grading and the details it involves. Here are some guidelines that can be helpful as you do this. These ideas should also be kept in mind should you be in a position to supervise a grader (see Section 4.4).

- BE CONSISTENT and PROMPT. Aim to return homework in a week or less.
- When grading individual assignments or exams, grade "horizontally" and not "vertically". For instance, grade problem number 1 on every student's exam and then continue with problem number 2 in the same fashion. This will be of particular help in maintaining consistency.
- Always be able to justify the grades you have given. Do not resort to "Because I said so." Make it clear to students why points have been taken off. This is best done by writing down comments on the homework papers. If you are grading a large number of papers and the errors are fairly common and uniform, providing a solution key which notes the particular errors and corresponding points taken off can be one way to cut down on grading time, while still providing students with sufficient information.
- Be considerate and listen to any student complaints. If you make a mistake then own up to it and rectify the situation.

- Let the students know how their final grade will be determined. Give explicit information in the syllabus on what the exams, quiz scores, homework averages, attendance, and class participation contribute to the overall average.

- Maintain some flexibility, if possible. For example, leave yourself the room to reward a student who performs exceptionally well on a comprehensive final, after having a mediocre semester. However, when teaching a very tightly coordinated course such as Math 112, you may be required to follow a grading scale rigidly, so be careful not to make any promises to the class which you cannot keep.

- Some classes may hold "grading parties", at which everyone involved in teaching or TAing the class gathers to go over exams, with people assigned to grade a fixed problem or page. Know whether this is the case for your section, before you set off to grade your own exams on your own (see Section 4.3).

## 6.2 In the Classroom

### 6.2.1 Atmosphere And Attitude

The atmosphere of the classroom and the attitude of the instructor can directly determine the level of student interest and participation. In a fourth hour as well as a lecture class, you as a TA should seek to create an environment in which the class is ready and willing to be involved. Let the students know that you are not there to simply give out information. You are there to interact with them in an effort to help them understand and master the material. Students should also hear from you that they are expected to do their part, too. If they appear in class unprepared, you will be unable to take full advantage of the brief hours you have with them each week. It is worth reminding your students (especially first year students) that they are expected to log in two to four hours for every hour in class they share with you.

The atmosphere of the class should not be so relaxed that it prevents the students from taking the subject seriously. However, neither should it be so formal that the students are afraid to ask questions about material they do not understand. Communicate to the class that questions are encouraged and are not a sign of "weakness". It is only by asking questions that the students can gain an understanding of the concepts that confuse them.

Whether you are a TA or a lecturer, the students will look to you as an example. Your attitude towards them and towards the course material will determine how they feel about you and about the class. Be respectful of the subject and of the individual students. If you criticize the course and show little patience with the students, then expect them to return the favor. Take your responsiblity as a TA or lecturer seriously and the students will take their roles seriously as well.

### 6.2.2 Voice

Clear and coherent verbal communication is essential to being an effective teacher. Here are some important points to keep in mind as you address the class during a fourth hour or lecture.

- Speak loudly and clearly. If the students cannot hear or understand the words you are saying, then learning is hopeless.
- Vary the tone and pitch of your voice. Monotonicity cures insomnia.
- Be careful not to speak too quickly.
- If you consider a specific point to be important, then repeat it, repeat it, repeat it.
- Pause periodically, and give students a chance to catch up in their notes. It is difficult for them to listen and write simultaneously.

### 6.2.3 Eye Contact

Good eye contact is essential if you want the students to feel that they are active participants in the class and not just observers. Some specifics to keep in mind concerning eye contact are:

- Face the students when addressing them. Refrain from the "talking to the blackboard" method.
- Vary your focus. Look directly at individuals, broaden to groups, and the class as a whole. As S. Krantz (see [2], p. 31) writes, "A ninety minute movie, filmed at the same focal length, would be dreadfully boring. Ditto for a lecture."
- When a student is asking a question, look directly at him or her.
- If making eye contact is difficult for you, then you must work to make it easier. While this may be uncomfortable, you will find it worth your while as your ability to maintain eye contact improves.

### 6.2.4 Body Language

In considering the factors that determine an instructor's effectiveness, it is important not to forget the role that body language and appearance play. There are only a few simple points to remember when considering these important issues.

- Dress neatly and attractively. You do want to be comfortable, but make sure that your attire and appearance convey the message that the course is to be approached with a certain amount of seriousness and respect.

- Stand up straight when addressing the class.
- Be on time. Set an example for your students in this regard.
- Appear confident. The best way to achieve this is to prepare thoroughly for the material that will be covered. If the students can see that you have studied and are familiar with the relevant topics and problems, then they will have more confidence in your ability to clearly explain these ideas to them.

### 6.2.5 Blackboard Technique

The blackboard is still an essential tool in any mathematics classroom. It is constantly being used to display information and to illustrate examples. It stands to reason then, that knowing how to use it effectively is invaluable. Below are some helpful tips on using the blackboard, taken from [2].

- Write neatly in legible longhand or print.
- Write large and be sure that the marks are dark enough to be seen.
- Proceed in a linear fashion. Do not use a lot of arrows or insertions.
- Limit the amount of material on the board at one time, and avoid cluttering it with information.
- Label equations so that you can refer to them verbally.
- Draw sketches neatly. Practice them ahead of time if necessary.
- If right handed, you could even try proceeding from the right side of the board to the left, so as to avoid standing in front of something you have just written.
- Be organized. In taking notes, students will imitate what you write on the board.
- Never do a new problem by simply erasing parts of an old one.
- Be sure to allow the students time to copy what is needed. It is difficult to listen and write simultaneously.
- Read what you are writing to the class.
- Write down a lot of what you say; include the key ideas as a minimum.
- Making frequent use of the blackboard not only helps clarify things for the students, but it prevents you from covering too quickly, material you think to be simple.

Remember that your lectures and presentations of examples should balance the material in the textbook, not regurgitate it. If you find it difficult devise your own examples, check out other textbooks in the library, ask to borrow some from other faculty and TAs, or even dig out your own undergraduate texts, if you have them still. When reading the day's paper or magazines, keep your eyes open for examples you might adapt for your class.

### 6.2.6 Inductive vs. Deductive Reasoning

One quick but important point to make concerning teaching in the classroom is the following: In general, students will grasp the concepts more easily if the material is presented in an inductive manner. Specifically, as a lecturer, you should begin with particular examples when illustrating an idea. Start simple and then generalize to the more difficult. Attempting to present an all encompassing general idea initially can overwhelm the class.

### 6.2.7 Applications

Eventually, a student will ask you "What is all this stuff good for?", or "When does this stuff ever get used in the real world?" When this does occur, it is your responsibility to have an answer ready for them. Have some specific examples, on reserve, that demonstrate how to apply the concepts you are studying to real world situations. Look through some alternate sources for examples, or ask a more experienced instructor. The students need not take it on faith that the subject is useful. Show them explicitly how it is used.

# 7 Problem-Solving

As a student of mathematics, you have been engaged for years in problem-solving. As a TA, you encounter yet another problem: How do you teach *others* to solve problems? Simply parading your worked solutions before a crowd of calculus students will not, in general, contribute much toward their development of problem-solving skills, unless the students have already attempted those exercises and know where they have difficulties. Conducting a fourth hour, you hope the latter is the case, but you cannot rely on it. As an instructor employing the lecture style, you will often work exercises at the board as examples for the students to emulate, but then possibly discover after class, or the next day, or the next exam, that the students are unable to complete similar problems, or worse, have no idea even where to begin.

The passivity inherent in this common approach to teaching ("Watch me and I'll do it") has been deemed, by some studies, to be a key factor in in the poor mathematics performance of American students in comparison with Asian and European peers. For many of us, personal experience has shown us that we learn little when we watch,

disengaged, as someone else winds through a problem or lecture. How else, then, are we to learn and to teach?

For some instructors, the answer is to vary teaching styles, moving away from the lecture style to incorporate more 'active learning' strategies. (For example, see [4].) Others contest that the lecture method is still the most tried and true, and should not be abandoned until further data regarding other methods is available (see, for example, [2]). In either case, it is apparent that students must be involved and engaged, though this is an easy point to forget when facing 5 or 25 or 50 students with only 50 or 25 or 5 minutes left to cover certain concepts.

Theoretically, a person who is truly interested in solving a problem will find a way to do so. However, it is probably rash to conclude from this that your only challenge in teaching problem-solving to students is to motivate them to attempt problems. In his classic work *How To Solve It* [3], outlined a strategy for problem solving based on the "conduct which comes naturally to any person who is seriously concerned with his problem and has some common sense." The goal of Polya's book is to articulate the thought processes which characterize a good problem-solver, keeping in mind that common sense is itself also something learned, and often learned by imitation and practice. So, our discussion comes back to the very idea of imitation and repetition, but with this difference: we can profitably make use of the method of providing examples and of considering their solutions in order to help our students to develop skills by which they can, themselves, analyze and attack problems. With this in mind, we lift from Polya a sketch of his method. (This sketch, by the way, appears in the front of the later printings of *How To Solve It.*) It consists of four parts:

1. Understanding the problem
2. Devising a plan
3. Carrying out the plan
4. Looking back

## 7.1 Understanding the problem

First, you have to *understand* the problem.

- What is the unknown? What are the data? What is the condition?
- Is it possible to satisfy the condition? Is the condition sufficient to determine the unknown? Or is it insufficient? Or redundant? Or contradictory?
- Draw a figure. Introduce suitable notation.
- Separate the various parts of the condition. Can you write them down?

## 7.2 Devising a plan

Find the connection between the unknown and the data. You may be obliged to consider auxiliary problems if an immediate connection cannot be found. You should eventually obtain a *plan* of the solution.

- Have you seen it before? Or have you seen the problem in a slightly different form?
- Do you know a related problem? Do you know a theorem that could be useful?
- Look at the unknown! And try to think of a familiar problem having the same or a similar unknown.
- Here is a problem related to yours and solved before. Could you use it? Could you use its result? Could you use its method? Should you introduce some auxiliary element in order to make its use possible?
- Could you restate the problem? Could you restate it still differently? Go back to definitions.
- If you cannot solve the proposed problem, try to solve first some related problem. Could you imagine a more accessible related problem? A more general problem? A more special problem? An analogous problem? Could you solve a part of the problem? Keep only a part of the condition, drop the other part; how far is the unknown then determined, how can it vary? Could you derive something useful from the data? Could you think of other data appropriate to determine the unknown? Could you change the unknown or the data, or both if necessary, so that the new unknown and the data are nearer to each other?
- Did you use all the data? Did you use the whole condition? Have you taken into account all essential notions involved in the problem?

## 7.3 Carrying out the plan

*Carry out* your plan.

- Carrying out your plan of the solution, check each step.
- Can you see clearly that the step is correct?
- Can you prove that it is correct?

## 7.4 Looking back

*Examine* the solution obtained.

- Can you check the result? Can you check the argument?
- Can you derive the result differently? Can you see it at a glance?
- Can you use the result, or the method, for some other problem?

Check Polya's (quite readable) book for a further discussion of this plan, including applications to some concrete problems. To summarize and complete this section, we quote, once again, from Polya ([3], p. 5): "The teacher who wishes to develop his students' ability to do problems must instill in them some interest for problems into their minds and give them plenty of opportunity for imitation and practice. If the teacher wishes to develop in his students the mental operations which correspond to the questions and suggestions of our list, he puts these questions and suggestions to the students as often as he can do so naturally. Moreoever, when the teacher solves a problem before the class, he should dramatize his ideas a little and should put to himself the same questions which he uses when helping the students. Thanks to such guidance, the student will eventually discover the right use of these questions and suggestions, and doing so he will acquire something that is more important than the knowledge of any particular mathematical fact."

# 8 Technology

## 8.1 ITC

ITC stands for Information Technology and Communication. ITC's mission is to "provide and promote the information technology and communication bridge between the University community and its goals."

ITC is responsible for various computer labs around grounds and is available to answer any questions you may have with computing issues. The ITC Help Desk is located in WILSON 235. The hours are 8:00am to 5:00pm Mon.-Fri. The phone number is 4-3731. Walk-ins are welcome. You can also email any technology questions to "consult@virginia.edu".

If you would like to know more information about ITC the URL "http://www.virginia.edu/lib-itc.html" brings you to a site with many ITC links. You can also access this site by accessing and going to **Libraries and Information Technology** off of UVA's main web site. The link **ITCWeb** should provide you with some great information.

ITC is also responsible for a great program to aid instructors here at UVA. It is called the Instructional Toolkit. See Section 8.3 for more information.

## 8.2 Various Labs on Grounds

The following is a list of some of the computer labs open to the general UVA population with one exception. The list is by no means exhaustive. For a more thorough list follow the links **ITC Computing Facilities and Software - Computer Labs** off **ITCWeb**.

- **KERCHOF 201 and 128** There are two computer labs in KERCHOF in addition to the computers provided in each office. The various computers have Windows 95 or Windows 97, including Microsoft Word and Excel. They also have Maple, Minitab, and Scientific Word. Some faculty like to use Maple for their courses. Math 112 requires the use of Minitab and Excel. Refer to Section 5 for more information. These computers are used for math faculty, graduate students, and selected undergraduates only. They are not for the general student population.
- **BRYAN HALL - Room 235** This lab has Maple, Minitab, Windows 95 and more.
- **CLEMONS LIBRARY - Fourth Floor** This lab has Maple, Minitab, Windows '97 and more.
- **OLSSON HALL - Room 018** This lab has Maple, Minitab, Windows '97 and more.
- **THORNTON HALL - Catlin Stacks** This lab has Maple, Minitab, Windows '97 and more.

## 8.3 Instructional Toolkit

The UVA Faculty Instructional Toolkit was designed by ITC to help faculty create and manage websites for their classes. The Toolkit also allows instructors to create an e-mail distribution list of all students registered in their classes. This provides an easy way to access the whole class and keep them up-to-date on important issues. You can use the Toolkit for just the e-mail list and suppress the website options. The URL is *http://toolkit.virginia.edu*. You can also access this site off **ITCWeb** by following the links **Specialized Support - Instruction - The U. Va. Faculty Instructional Toolkit**.

The best way to learn more about the Instructional Toolkit is to visit the website and play around. Before you can create a class home page using the Toolkit, you will need a userid, password, and the schedule number for the course that you are teaching. You can use your e-mail userid, but you may have to use a different password because the Toolkit is sometimes picky about what it will accept as a valid password. To get the schedule number for your course, you can look on the posted teaching list (see Section 2),

or you can look at the Course Offering Directory (COD) online. The COD can be found off of the Registrar's home page at *http://www.virginia.edu/ regist/oregpage/cod.html*. Just go to the **Arts and Sciences** link. There you will find a list of all classes that are offered by the College of Arts and Sciences, including all the math classes. The COD will give you the appropriate schedule number and let you know how many students are currently enrolled in your class. Now you are ready to create your own class home page.

From the main Toolkit page, you have the option to **Create a New Class Home Page**. You will be asked for a userid and password. You will have to verify any new password. You will then be asked for the schedule number, semester, and year of your class. You will also be asked whether or not you want to hide your class home page. If you keep the home page hidden, then your students do not have access to it via the web. Some instructors prefer to use the Toolkit only for the options not requiring a visible home page. You can change this option later on, so you may want to keep your class home page hidden until to have played around with the Toolkit and figured out all that it can do for you. Once you have submitted this information, you can go ahead and look at all the options available, or come back another time.

After the initial creation of your class home page, anytime that you access the Toolkit, you will go to **Manage an Existing Class Home Page**. You need to remember the password that you used to create the home page. The Toolkit allows you to do a lot of great things, but most of them require that you not have the class home page hidden.

With a visible home page, the general information is automatically loaded into the home page according to the schedule number, although you can edit it if you wish. You can create a syllabus, although this is usually not necessary (see Section 5). You can also post announcements and put assignments on your page.

The most useful tools that the Instructional Toolkit provides is the class roll and e-mail tools and the anonymous feedback tool. The Toolkit allows you to instantaneously update your class roll to see who is currently in your class. This is useful during the add/drop period at the beginning of the semester. With your class roll updated, you can have the Toolkit create an e-mail distribution list of your entire class. Every time you update the class roll, the e-mail list is updated as well. With one simple address, you can e-mail your entire class. It is a great way to let all your students know about any pertinent information as it arises. The above tools do not require a visible home page. The anonymous feedback tool, which does require a visible home page, allows your students to submit comments, anonymously, about the class. This allows students to feel comfortable about giving feedback or making constructive criticisms, without fear of any consequences. Note that if you would like to keep your class home page hidden, but would still like to give your students the ability to submit anonymous feedback, please refer to Section 10.1.

Lastly the Toolkit gives instructors the option of submitting the final grades via computer. You will have to verify your social security number. There is a general

overview of how the submission process works, and, at the end of the semester, you can practice with a test submission before trying the real thing.

All in all, the Instructional Toolkit is a great way to aid instructors in the organization of their courses. You should note that the tools described in this section can only be used by the course's primary instructor, not a fourth hour TA.

# 9 Outside Agencies

Outside of the classes you TA or lecture, most of your contacts will be with the faculty, staff, and other graduate students of the Department of Mathematics. On occasion, however, in your capacity as a teacher, you may need to be in contact with some other agencies or divisions of the university. This section includes a brief description of the most likely candidates, with respect to the circumstances under which these encounters may arise.

## 9.1 The Athletic Department

A student athlete whose game schedule will require him/her to miss class or scheduled exam times is expected, by the Department of Athletics, to take a copy of his/her schedule to the instructor of each class in which he/she is enrolled sometime fairly soon after the semester begins. Student athletes are also asked to remind an instructor the week of any conflict. On occasion, a student might not know long in advance if he/she will be gone on a particular day (for example, the selection of football team members who will travel for a given week's game are made only that week), but student athletes should not be making first contact with an instructor *after* missing a class or exam due to team travel. Instructors are asked not to penalize student athletes for absences due to their schedules as athletes, but the specifics of handling the consequences (say, a student misses a quiz) are left to the instructor and student to work out.

If you are running the fourth hour for a class, you might check with the principal instructor to see if any athletes have submitted schedules which will involve your session. If so, or if you are grading for the class and the student may miss some assignments, discuss with the instructor how to handle this.

If you have any questions regarding student athletes and academics, you can contact Cynthia Cardosi or Kathryn Jarvis, Academic Coordinators in the Academic Advising Office of the Department of Athletics, at 982-5300. Currently, Kathryn Jarvis works with the football team, while Cynthia Cardosi advises all other teams.

## 9.2 Learning Needs and Evaluation Center (LNEC)

Although the LNEC provides a range of services for students, the most likely reason you will encounter them, as an instructor, is by a student who has been certified as having a learning disability or learning need. In accordance with such law as the

Americans with Disabilities Act, students who have certified disabilities, are entitled to various accommodations. These depend on the student. By now, most of us are familiar with the idea that a blind person might be alloted a note-taker, or a deaf person an interpreter, for example. However, you may have students with less obvious disabilities, such as dyslexia, for example. For such students the LNEC may propose that they receive more time for taking tests, or the opportunity to be alone in a classroom, among other devices.

A student who has been determined by the LNEC to have a learning disability should bring to you information from the LNEC regarding measures to be taken to accommodate the disability. Be aware that such students may not wish to advertise their status, and so may ask, at the end of a class, to speak to you in private without specifying the reason. The matter of the student's status should remain between you, the student, and the LNEC.

As an instructor, you *must* follow the measures proposed for a given student by the LNEC. The LNEC can help in carrying out these accommodations. For example, the LNEC can provide a separate room for a test-taking student, or administer an exam for which a student has been allotted extra time. As the instructor, though, you will have to decide how to handle some of the difficulties which arise: If you must give double time on an exam that begins at 7:00 P.M., will you stay up until 1:00 A.M.? Will you ask the student to return the next day? Will you send the student to the LNEC with a copy of the exam?

In order to respect the student's privacy, and not to rouse the ire of a small class which is unaware of the student's disability, you might consider taking certain measures. For example, in the test-taking situation above, you might opt to have the student take the exam during the regular time, collecting all exams at the cut-off time, but setting aside the one exam for the student to complete afterwards, or at another time. This is just one possible approach and example, but whatever the needs of the student, be sure to settle on a policy in advance, and be certain the student understands that policy.

For more information, or if you suspect a student may have some learning disability, contact the Learning Needs and Evaluation Center at 983-5180.

## 9.3 Dean of Students/Dean of Arts and Sciences

You may be contacted by the Office of the Dean of Students or that of Arts and Sciences (by letter, say), in the case a student in your classes falls seriously ill or suffers experiences sufficiently traumatic to require his/her absence from classes or even the University. The nature of the notification, and any suggestions made with respect to handling the difficulty, will depend upon the circumstances of the student, but should be considered to be confidential.

## 9.4 Honor Committee

As a University of Virginia student, you should already be aware of the existence of the Honor Code. There are a few aspects of its employment and enforcement which have a direct bearing on your role as a TA or instructor.

Impress upon your students that you take the code seriously by requiring them to sign the Honor Pledge[2] (to 'pledge') where appropriate, as on exams (if students are allowed to work together on homework, it may not be pledged). Harried students, or those just trying to be cute, may simply sign "Pledge". Discourage this practice. Although there is disagreement among students and faculty about the effectiveness of the code and the degree to which it is honored, it is still the 'law'. Students are, indeed, found guilty of cheating and other offenses, and are, under the current single-sanction policy, subsequently expelled from the university. Requiring the students to sign the pledge is a regular reminder of the agreement which they made, in choosing the University of Virginia, to honor the code, and the consequences of breaking it. As a practical matter, should you ever need to initiate an investigation of a suspected breach of the Honor Code, you will also want to have clear evidence regarding the extent to which the matter was covered by the Honor Code. For example, as above, students might be encouraged to work together on homework, but be required to work exams without the input of any other source. Make it clear to your students which work is pledged and which is not.

Due to the presence of the Honor Code, students might not expect to be proctored during exams; you might choose to wait nearby or even in the room in order for students to ask you questions, but consider the tenets of the Honor Code in making your choice. Again, there is ongoing debate among teachers about the practice of removing oneself from the room (with the big question being that of cheating); discuss this issue with other TAs and faculty members.

As an instructor, if you find you have grounds for cheating, you must decide whether to request to initiate an investigation by the Honor Committee. Depending on the nature of the infraction, some faculty and TAs choose to confront the suspected cheater and/or handle the situation without taking the matter to the Honor Committee. You might wish to consult with other faculty and TAs about this matter. According to the official guidelines of the Honor System, "Any individual who suspects that an honor violation may have occurred should confer with an Honor Advisor before taking any action." The names of current Honor Advisors are available from the University Directory.

A student who has committed a violation of the Honor Code may elect to make a conscientous retraction. This involves contacting an Honor Advisor and preparing a written statement addressing the act and admission of guilt; in order to be valid, the

[2] The Honor Pledge,"I swear, upon my honor as a student at the University of Virginia, that I have neither given nor received aid on this ——" (assignment, exam, quiz, etc.), is posted in most classrooms.

process must be initiated before the student gains any knowledge that he/she might be suspected by someone else of committing an honor offense. Since the retraction must be signed by all parties involved in the dishonorable act, you, as a TA or instructor, might be approached by a student seeking to complete the process of making such a retraction, and thus should be aware of this facet of the Honor System.

For further information, contact an Honor Advisor or Honor Committee member, or consult the booklet *"On my honor..." : Philosophy and Guidelines of the Honor System*, available from Honor Committee, 4th Floor, Newcomb Hall. Information is also available from their website *http://www.student.virginia.edu/∼honor*.

# 10 Resources

Included below are a few resources available to aid you in the process of learning the ropes at UVA and in developing your own teaching style.

## 10.1 Teaching Resource Center (TRC)

Located just off the Lawn in Hotel D, 24 East Range, the TRC is chock full of books, videos, clippings, and friendly folks glad to steer you in the right direction, whether you arrive with questions general or specific, or simply just want to take a look at their resources. A list of some of the books the TRC library owns is included below in Section 10.3, but the center offers much more.

Twice a year, at the beginning of each semester, the TRC conducts free Teaching Workshops. The fall workshop is designed especially for new faculty members and teaching assistants, but open to everyone. Starting in 1998, there will be separate programs for faculty and TAs. The topics of the sessions vary somewhat, but include titles such as "Difficult Classroom Situations," "Teaching Problem-Solving Sessions," and "Facilitating Classroom Discussions." While not every session is directly applicable to the teaching of mathematics, the TRC is now striving to include programs geared separately to the humanities and to the sciences, often offering concurrent sessions. Especially in your first year or two, these sessions are a terrific way to get acquainted with the life of teaching here at UVA, as well a rare chance to meet TAs in other fields. (Students on Department of Education Traineeships will usually be required to attend some or all of the sessions as part of the pedagogical training in the Traineeship program.) The spring Teaching Workshops often include topics of interest to even seasoned teachers; one recent spring workshop was focused on the use of technology in teaching and in the classroom, for example. Look for flyers or announcements regarding the workshops to be posted in the department; make inquiries if you don't see any!

During the course of the year, the TRC runs a number of smaller sessions and brown-bag lunch discussions on timely, even controversial topics, as well as on perennial favorites. Consider requesting to be added to their e-mail list in order to receive noti-

fication of these upcoming events: send a request to subscribe to *trc-uva@virginia.edu*. You can also subscribe to their newsletter *Teaching Concerns*.

The TRC has also designed some programs to allow you to improve your teaching. In addition to the Teaching Workshops, the TRC can help you obtain a mid-semester evaluation by videotaping your class, or by allowing a TRC staff member to conduct an in-class observation or a TAP (Teaching Analysis Poll) of your students. A TAP is conducted by a trained consultant who visits the class in the instructor's absence, and facilitates a discussion on how the course is working and suggestions for improvement. The consensus opinions are then relayed to the instructor by the consultant. TAPs are usually done by mid-semester to allow time to incorporate into the course any information gained. Flyers detailing these procedures may be obtained from the TRC; information is also available from the TRC website *http://www.virginia.edu/∼trc* by selecting **Consultations**. Due to the success of these methods, the Department of Mathematics itself may, in the future, require these of all TAs.

Looking ahead to the future, consider attending the TRC's annual workshop (usually held in May) on preparing a teaching portfolio. A teaching portfolio is designed to document your teaching proficiency and help you create a plan for further improvement. Take note that some faculty and TAs in the Department of Mathematics have already attended this workshop and prepared their portfolios, so examples are available; check with the teaching advisor (see Section 10.2) about the availability of these. Books and articles describing the teaching portfolio, as well other samples of them by university faculty and TAs are also available at the TRC. The maintenance of such a portfolio by TAs may also soon be required by the Department of Mathematics as well.

The TRC, in conjuction with the Department of Computer Science, enables instructors to set up an anonymous feedback system on the web. The TRC has samples of these anonymous feedback forms, which can be accessed from their website by clicking on **Sample Feedback Forms**. You can choose one of these samples, or design your own. For some perspectives on using an anonymous feedback page, check out the Spring 1998 copy of *Teaching Concerns*, available from the TRC or from **Teaching Publications** on their website.

Feel free to contact the TRC at 982-2815. Beyond cruising their website, you can also send specific teaching-related questions via e-mail to *trc-uva@virginia.edu*. The short walk to the Center, just to browse the bookshelf in the snug, wood-panelled rooms of Hotel D, also makes for a worthwhile excuse to step out of the department and away from homework for a few (precious) minutes.

## 10.2 Professors and Other TAs

Discussions of ways to improve teaching are becoming more common in university mathematics departments all over, and the department here at UVA is no exception. In the past, the philosophy adopted by the department towards the training of TA's was that "experience makes the best teacher". TAs were expected to analyze their experi-

ences in the classroom and compare their findings with those of other TAs. Although this expectation has not changed, the assumption that this will constitute the only means by which TAs learn to teach has. This shift in attitude towards the training of both faculty and TAs was reflected on a university-wide scale by the establishment of the Teaching Resource Center in 1990 (see Section 10.1). At about the same time, the Department of Mathematics was awarded a grant by the U.S. Department of Education to institute traineeships, designed to enhance the preparation of graduate students as future teachers.

The existence of these traineeships does not constitute the only means by which the department is seeking to promote the development of teaching skills. Beginning in the fall of 1998, all first and second year TAs (not just those Department of Education Traineeships) will be required to take MATH 700, a seminar on college teaching to be taught by the teaching advisor (see below). A major component of the course will be classroom observations by the teaching advisor of each enrolled TA. These visits will be followed up by individual meetings between the teaching advisor and TA, and by the preparation by the latter of written comments on the observed classes. The seminar will also meet periodically through the semester for discussions of current educational issues in mathematics. There will be occassional guest speakers. TAs enrolled in MATH 700 will also begin to create teaching portfolios (see Section 10.1). The seminar will include a workshop on constructing teaching portfolios. As part of MATH 700, TAs will be strongly encouraged to make us of the TRC's TAP program (again, see Section 10.1).

Another recent addition to the Department of Mathematics is the position of the teaching advisor, currently being held by Professor MacCluer. Other faculty members involved in the grants from the Department of Education, supporting the Department's current programs designed to enhance the training of TAs as teachers, are Professors McCrimmon, Pitt, Thomas, and Ward. All would be glad to consider your questions or concerns regarding teaching and the department.

Another resource is the ombudsman. Each year a faculty member in the Department of Mathematics is designated as the departmental ombudsman. When students have concerns about the conduct of a class, believing it to be unfair or improper in some way, they may contact the ombudsman to discuss their concerns. Usually the first attempt at a resolution of any problem will be to ask the student to communicate directly with the instructor. The ombudsman can facilitate this meeting if necessary. Problems which cannot be satisfactorily resolved at this level may, if necessary, be referred on to the course coordinator (if applicable) or the department chair. You might wish to contact the ombudsman if you and a student of yours, or possibly a fellow TA, a course coordinator, or another faculty member encounter difficulties which you cannot resolve yourselves.

In searching for information or insights, don't overlook other TAs. Certainly, the authors of this handbook would be happy to assist you in any way they can, but most any TA would also welcome your questions. New renovations to Kerchof Hall, including the creation of a large common room, will make it easier to meet other TAs and faculty.

In any case, don't hesitate, when in the computer room or in the department office, to throw out a question. Though some of us senior TAs may have forgotten the details surrounding our confusion of our early days, none of us has forgotten the sense of being confused and even a bit lonely, so ask away!

The staff of the mathematics department is also quite accommodating, often knowing just who to turn to if further information is needed. See Section 2.

### 10.3 Books, Etc.

This list is designed to provide a few jumping-off points into the great pool of research and writing about teaching. Items marked '(TRC)' are available from the Teaching Resource Center (see Section 10.1); otherwise unmarked entries are available from various libraries (usually the Mathematics Library) at UVA, and can be located by checking the library catalog, VIRGO.

M. Barnett and M. Linder, Editors,*Teaching at the University of Virginia: A Handbook for Faculty and Teaching Assistants* (TRC)

S. G. Krantz, *Techniques of Problem Solving*, on order for the Mathematics Library

S. G. Krantz, *Teaching Mathematics: A Personal Perspective*

G. Polya, *How to Solve It*

M. Silberman, *Active Learning: 101 Strategies to Teach Any Subject* (TRC)

J. Banner and H. Cannon, *The Elements of Teaching* (TRC)

W. McKeachie, *Teaching Tips* (TRC)

R. Allen and T. Reuter, *Teaching Assistant Strategies: An Introduction to College Teaching* (TRC)

K. Elbe, *The Craft of Teaching* (TRC)

B. Erickson and D. Strommer, *Teaching College Freshmen*(TRC)

*Mathematics Magazine* (published by the MAA)

## 11 When You Don't Want to Teach

Many, if not most, graduate students who choose to attend the University of Virginia have based their selection, at least in part, on the availability of financial support made possible by the opportunity to serve as a teaching assistant. For some, this is purely a

practical matter of funding, while for others, the choice to be a TA is also motivated by their interests in teaching itself. We hope that you are deeply excited (if apprehensive) about the opportunity to teach. In any case, if you are reading this handbook, you have chosen to be a TA, so the purpose of this section is not to provide you with insider information about fellowship opportunities which would relieve you of your teaching responsibilities. Instead, we intend to to address the situation in which even the most devoted teacher among you may, sooner or later, find yourself: a time when you just don't want to teach.

Each person has good and bad days, so there is nothing uncommon about feeling reluctant to teach on a given day. The contents of the rest of this handbook can help quell the nervousness and confusion that accompanies a lack of preparation, or lack of understanding about one's role as a TA. If you find you are eager, or at least willing to teach, but wary of doing so, try to isolate the cause of your anxiety by asking yourself if you are prepared, if you are nervous about speaking, and the like. Use the lists of topics in this handbook for a guide. Talk with other TAs and professors, or just anyone who knows you and will listen sympathetically. If you find some general notion strikes a chord continue trying to narrow the focus of your questioning See if you can isolate the aspect that truly disturbs you. If you can reduce your more general worries to particulars then you can seek specific strategies for remedying them. Hopefully, again, the material in this handbook will be helpful here. If you are unsuccessful in this quest, ask for suggestions from others, or consider having yourself videotaped while teaching (see Section 10.1).

If, on the other hand, you find you are consistently ambivalent about your teaching, or even angered by the need to do so, you might consider the following short list of foundational reasons why teaching is good for you, which we will discuss in turn.

1. Learning mathematics
2. Teaching as a set of transferable skills
3. Enhancing employability
4. Joy of giving

Although the culture of mathematics has earned a reputation as the province of loners, a second glance shows that more than mere vanity drives mathematicians to seek out like-minded fellows. To pursue mathematics is to engage in discovery or creation (depending on your philosophy), and that process thrives in the give and take of exchanges between living people. The very notion of 'giving a proof' necessitates the presence of an audience to validate the argument: not even the brightest stars will be attributed with a solution until someone else finds the proposed proof to be consistent. Seasoned professionals still seek out others on which to try out their ideas.

In light of this, the act of teaching provides you, the TA, with the opportunity to solidify your own knowledge of a subject. If you find you are not so well-versed in the

area (perhaps you are TAing for Calculus III, and you haven't seen Stokes' Theorem since you were a freshman or sophomore), this opportunity is fairly obvious. However, even if you believe you are fully familiar with all of the material of, say, Calculus 121, the act of organizing and preparing presentations on this material for an (external) audience will add clarity to, as well as bring new insights into, the subject you are teaching. Even if you are certain that you know the material forwards, backwards, and hanging upside down from a helicopter, keeping an open mind will still allow you to gain in your own understanding. Here, you might consider Polya's recommendations for building on previous knowledge (see Section 7). You might also speak with members of the department such as Mr. Ward, who prepares and teaches from a new set of notes for each graduate class he conducts, no matter how many times he has held that class before, for the very reason that he can always find something new by doing so.

Moving beyond the value of teaching for the insight into mathematics which it brings to the teacher, there is the usefulness of developing the set of skills which allow you to effectively motivate and effectively communicate a topic, both to groups and to individuals. As indicated above, such skills are immensely useful to a mathematician, but their value does not end with the bounds of the ivory tower. Michael Ashcraft, a manager of a large Target store, has said that, "Most people in sales are would-be teachers." Instruction occurs in the workplace outside academia in the form of professional presentations, management, training and development; replace 'student' by 'employee,' and teaching skills such as evaluation of students and organization and supervision of work translate into workplace skills in the setting of business and industry. If you are not interested in a career in academia, you should take special note of the transferable nature of these skills. Even if you begin your studies convinced of your desire to become a teacher but have a change of heart later, the usefulness of the skills you may acquire by being a TA does not evaporate with your change of plans.

Whether you pursue a career in academia or out, the experience of TAing allows you to argue, in your resume and in job interviews, that you have professional experience. The tight nature of the job market in academia, in particular, makes this no small matter. Letters to the Editor in the AMS notices have included angry pieces by professors at top flight schools whose best students were not getting jobs, and by students of all makes and models who have suddenly discovered that their credentials are too similar to everyone else's. While TAing , of course, provides no guarantee you will find a teaching job, it may give you an extra edge. Keep this in mind when you organize and plan your problem sessions or lectures: the greater autonomy you display, the more solid the footing you have for making the case later that you are experienced. For example, numerous graduate students in the U.S. have done some grading at one point or another, but many graduate students never serve as principal lecturer of a course. Of those who have been lecturers, many have been constrained to follow the syllabus and course design of a tenured faculty member. You may consider, if possible, teaching a course for which you may have more of the responsibilities for organizing the material. Or, take the opportunity to participate in the myriad details involved in

running a course-coordinated section : attempt to arrange it so that you may write, or contribute to the writing of exams, or argue for preparing your own quizzes, or request to be involved in the process of producing the general syllabus. In short, take an active stance, and thereby make the best of an opportunity to distinguish yourself come job application time. In line with the earlier comments regarding the transferability of teaching skills, these actions can benefit you no matter what the nature of work for which you eventually apply. Taking an active stance can also counter the malaise which can befall most anyone who simply 'follows directions' for too long.

As a last, but not least, aspect of our list of reasons why teaching is good for you, there is the marvelous opportunity to foster, in other students, some of the love for the subject and its possibilities which has led you to pursue mathematics at the graduate level. It is a tremendous feeling to step into a classroom to face those desks, so like those in which you yourself sat for years, with the realization that you are in a position to pass on that which came to you. (This role reversal provides an especially nice balance to the knowledge that, as a graduate student, you are still slated to face a number of years seated at a desk!)

No matter what the source of your reluctance to teach, do remember this maxim: Do not let it influence your relationship with your students. If you don't want to be in the classroom, the students will know it, so out of respect for them and for yourself, locate the source of your reluctance, and make peace with it. Never tell your students that you don't want to be there, or that you think you shouldn't have to teach. Never cancel class just because you don't feel like holding it that day. These are your problems, not the students', and they should not be made theirs. If illness or serious worries will limit your ability to be an effective teacher that day, and you feel you must make a remark, do so with a light touch and in passing, such as, "Please let me know if you cannot hear me in the back; I fear my throat is a bit sore today, so I might unconsciously speak more quietly."

Finally, if you find you dread teaching, that you understand the points made above but you cannot seem to care, that numerous conversations with others seem to bring no relief, but you AREN'T suffering from depression, keep in mind that this pursuit may not be for everyone. Sometimes students decide to leave with a master's degree after trying out the program. Some people realize they just really don't like to teach. This is fine. It is commendable to realize what you want and don't want, and to act on it. However, if you remain in the program as a TA, have the self-discipline and respect enough for your students, as well as the whole process of formal education, to act as a responsible and effective teacher.

# 12 Professionalism

Being a TA is a job. As a part of this job you must exhibit honesty, maturity, and fairness. One way to show maturity and to separate yourself from the students is to look presentable when you teach. A suit or dress is not necessary, but cut-off jeans

might not be the best choice (see Section 6.2.4).

Be careful about becoming too "chummy" with your students. Socializing with them could undermine your authority and impartiality (or at least appear that way to the students). Students coming to visit with you at all hours of the day can easily keep you from your work. Try not to give students advice about personal matters.

Confidentiality is an important part of the student-teacher relationship. Use discretion when speaking about a student by name with a colleague. On occasion you may need to refer to a student by name when talking to an association dean (see Section 9.3), or when speaking with a course coordinator or TA running the fourth hour for your class. In general, however, you should respect a students' privacy and refrain from identifying students when commenting on performance of the members of your class with others.

Discretion should be used when discussing math courses or personnel. Never bad mouth a colleague or even a textbook. This undermines the department. If you are giving a student advice about other math courses, stick to the facts.

As an instructor, you must pay special attention to discrimination. Sexism and racism are very serious issues. You should take great care with what you say, how you act, and who you call on in class. It is obvious that you should never touch a student. Even an innocent pat on the shoulder can be misconstrued. You should also be aware of how some students may interpret exam questions or examples that you use in class. "The spirit of the law is that if someone feels offended then they are offended" ([2], p. 67). With respect to this matter, don't wait until you run into trouble in a class that you teach. If you have any questions or concerns, talk to the associate chair or the department chair.

Keeping all of the above issues in mind should help make your experience in the classroom more comfortable for you and your students.

# References


[1] K. Lewis, Editor, *Teaching Pedagogy to Teaching Assistants*, Center for Teaching Effectiveness, University of Texas at Austin.

[2] S. G. Krantz, *Teaching Mathematics: A Personal Perspective*, American Mathematical Society, 1993.

[3] G. Polya, *How To Solve It*, Princeton University Press, Princeton, New Jersey, 1973.

[4] M. Silberman, *Active Learning: 101 Strategies to Teach Any Subject*, Boston-Allyn-Bacon, 1996.

[5] J. Thoma, Editor, *The Physics TA's Guide to the Galaxy*, Department of Physics, University of Virginia, 1994.

[6] *Teaching Mathematics*, Department of Mathematics Handbook, University of Virginia (preliminary version).

[7] *Undergraduate Mathematics and Statistics*, Department of Mathematics, University of Virginia, 1997.