(subject to various public pressures) than at small private ones. This is no laughing matter. Many math instructors will just go along with the chairman's wishes, simply because it is easier than bucking the tide. Others will stand on their right to autonomy in their own classroom.

This is a tough ethical call, and I cannot tell you what is right. You have to live in your department, with the colleagues and the policies that it has. Probably the best advice I can give is that you should find out what the departmental policies are *before* you begin to teach. If you think that you are going to have trouble living with the grading policies, then discuss them with departmental honchos and try to work out a position that everyone can live with.

It seems to be an increasingly common occurrence (see [WIE]) for a student to come to the instructor after the course is completely finished and say, "I got an 'F' in your course. Could we talk about how to raise my grade?" This is like buying a car, signing the papers, making the down payment, driving the car home, and then coming back a week later to see whether you can renegotiate the sale. It makes no sense.

A grade is supposed to be *an evaluation of the work that the student performed during the term.* When the grade is given, the work (or lack of it) is a done deal. The very notion that this is a point for haggling is a genuine travesty—it shows a true misunderstanding of the university's mission.

At a prominent university in St. Louis—not my own—there has developed a new process that is called "grieving". A student who receives a disappointing grade in a class will say "I'm going to grieve this grade." There is a dean who is in charge of such matters, the student makes an appointment with that dean, and then the young scholar puts on a dog and pony show to convince said dean that the grade is unfair. Then the dean changes the grade! Without consulting the instructor of the course!! Sadly, the practice of grieving amounts to an institutionalization of the wretched behavior that I described in the last two paragraphs. The institution in question is funded strictly according to its enrollment, and it takes great strides to see that its customers are happy. While I sympathize with the school's plight, I certainly do not endorse its practices.

2.12 The Syllabus (and the Course Diary)

Every mathematics course should have a syllabus. The teacher should give the course a little thought and planning before classes begin. What is the text? What will be covered? What are the prerequisites? How many exams will there be? How will the grade be determined? What is the instructor's name, office number, phone number, and office hour?

The syllabus should be in outline form—not paragraph form—and display essential information so that it is easy to find. A sample syllabus follows.

2.12

Fall, 1999
Krantz

Math 411
Washington University

Syllabus for Math 411
Real Analysis

Course Description: This is a rigorous course on the foundations of mathematical analysis. Topics to be covered include set theory, logic, the real number system, sequences and series (both of scalars and of functions), compactness, topology of the reals, approximations, differentiation. We will cover at least the first five chapters of the text.

Course Prerequisites: Calculus and linear algebra.

Instructor: Steven G. Krantz

Office: 103, Cupples I

Phone: (314) 935-6712

FAX: (314) 935-6839

Office Hours: To be announced. Consult the course Web page.

Course Web Page: `http://www.math.wustl.edu/~sk/math411`

Math Department Office: 100, Cupples I

Text: *Principles of Mathematical Analysis*, 3rd edition, by Walter Rudin.

Class Meeting Times: MWF 1-2

Classroom: 115, Cupples I

Exams: There will be two midterm exams and a final. Exams will be scheduled by the university. Consult the class Web page or the department office for information.

Quizzes: There will be weekly quizzes. Schedule and format to be announced.

Homework: There will be regular homework assignments and these will be graded. Late homework is not permitted. I will drop your two lowest homework grades to allow for missed assignments.

Grading: The components of the course are weighted as follows:

Homework:	10%
Quizzes:	15%
Midterm I:	20%
Midterm II:	20%
Final:	35%

2.12

This is a "bare bones" example of a course syllabus. It contains the critical information that should be a subset of any syllabus. Your syllabus may contain more information about the course topics, or about the text, or about homework assignments, or about grading.

It is only courteous to provide students with the information that has been indicated. The syllabus is also a paper trail for your course. Try to stick to your syllabus as much as possible. If a student comes to you in the seventh week and says, "I didn't know that there would be two midterms." or "I didn't know that homework was such a big component of the course." then you can point out that these particulars were explained in the syllabus that you distributed on the first day of class and that has been posted all semester long. The syllabus serves as a sort of contract between you and the class. It keeps you honest and it keeps the students honest.

The syllabus should not be a *magnum opus*. In some large calculus classes, especially when there are several such classes being coordinated, instructors may find it useful to list the topic for every class period, relevant pages from the book, and the homework problems that are assigned for each day. That is fine in its place. For most courses, a syllabus of one or two pages is more than sufficient.

Ideally, the syllabus should be available in a stack outside your door, or perhaps in the undergraduate office, all semester long. If you set up a Web page for the course—and this is an excellent idea—then you should post the syllabus (together with all homework assignments, exam times, solution sets, etc.) there. This practice is just good business, like a restaurant posting its menu or a gas station posting its prices. There is admittedly a certain cachet to being completely disorganized and doing everything by the seat of your pants, but it doesn't pay. You end up wasting a lot of time covering your tracks, you create too many potential opportunities for aggravation, and it leaves students with a bad taste in their mouths.

For the same reason that you should have a course syllabus, I would also recommend that you keep a course diary. This device could be several sheets of paper that you tape inside the front of your copy of the text (and you should tape a copy of the syllabus in the same location), or it could be a separate little notebook that you keep together with your text and your grade book. Any time a student requests a makeup exam, or asks for an extension on an assignment, or whenever anything comes up in connection with the course—put it in the diary! When you and the class decide on a date for the midterm, put it in the diary. If you set up a review session, put it in the diary. If you are going to be out of town, and Professor Veeblefetzer has agreed to cover for you, put it in the diary. That is to say, make a dated entry with the item that you need to remember. It is even reasonable to put all appointments with your students in the course diary. That way you'll have a record of all transactions pertaining to the course, and you also will be less likely to forget them.

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It is an important job, and you should endeavor to carry it out with dignity and professionalism.

2.5 Homework

In most lower-division courses, and many upper-division ones, it is by way of the homework that you have the greatest direct interaction with your students. When students waylay you after class or come to your office hour, it is usually to ask you about a homework problem. This is why the exercise sets in a textbook are often the most important part of the book (textbook authors do not seem to have caught on to this observation yet) *and* why it is critical that homework assignments be sensibly constructed.

Let me stress again that I am not trying to sell you a time-consuming attitude or habit. If you take twenty minutes to compose a homework assignment then you are probably taking too much time. But consider the following precepts:

- Do not make the homework assignment too long.
- Do not make the homework assignment too short.
- Check over the problems you assign to confirm that there are no notational or obvious typographical errors. (Students can waste great amounts of time trying to fathom typos that are trivial to you and me. As a result, they become quite frustrated and angry. Doing this sort of checking shows them that you are on their side.)
- Be sure that the assignment touches on all of the most important topics.
- Be sure that the homework assignment drills the students on the material that you want them to learn and the material that you will be testing them on.
- *Make sure that at least some of the homework problems are graded.*
- Plan ahead. The exams that you give should be based only on material that the students have seen in the classes and in the homework.

If homework does not count and is not graded, then students will not do it. That is a fact. I realize that many of us have neither the time nor the inclination to spend long hours each evening grading homework. Many universities and colleges these days simply do not have the resources to provide enough graders for lower-division courses. But there are compromises that you can make. For example, you can tell the students that, of ten problems on the homework assignment, just three will be graded. But don't tell them which three. This device will force most of the serious students to do *all* the homework problems, but it requires much less grader time to get the grading done.

If the last suggestion will not work for you, then you can give weekly quizzes that you yourself will grade. The amount of your time involved will be little,

and it is a device to force students to keep up with the work. Incidentally, this device also gives you a gentle way to keep your finger on the pulse of the class.

Consider the implementing following policy to help get your students more interested in doing the homework. Students can and do benefit from collaboration, just as we mathematicians do in our research. While you probably do not want to encourage collaboration on exams, you may wish to encourage it on homework. Of course I'm not talking about "I'll copy yours this week and you can copy mine next week." Instead, I'm talking about an intelligent exchange of information among equals.

Some studies have shown that one reason that Oriental students in this country tend to do very well in their mathematics classes (and there are surely many reasons) is that they work in groups. More precisely, they first work hard as individuals. Then they get together and compare results. In short, they collaborate in much the same way that mature mathematicians collaborate. They are willing to say, "I can do this but I cannot do that. What can you contribute?" At the same time, the studies indicate that certain other elements of the student population are either loath to work in groups or are unaware of the benefits of this activity. These strata tend to do poorly in mathematics classes. See [TRE] for details.

Some of the more interesting teaching reform projects, including those from Harvard and Duke, are specifically designed to encourage students to learn mathematics through group activities. Reports on these experiments are encouraging.

If you do decide to encourage group work in your classes, then you will have to make peace between said collaboration and your grading policies. If homework is not collected, then there is no problem and you can separate the good students from the bad through exams and quizzes. If instead homework is collected, then you will have to consider carefully how to tell whose work is whose, or at least how to divide up the credit.

2.6 Office Hours

At most universities the instructor is required to hold three or more office hours per week. Choose three hours that are convenient for you or convenient for the students or both. Monday/Wednesday/Friday at 11:00 A.M. is, on most campuses, one of the most popular times for classes. If you schedule your office hour at that time then many students will not be able to attend. One good strategy is to stagger your office hours, so that they are at different times on different days. Another is to make an office hour from half past the hour to half past the hour, so that a student's class is likely to overlap only half of it rather than all of it.

Of course you cannot select a time for office hours that will please *everyone*, so don't even attempt to do so. Set your office hours, and announce them, and explain to the students that you can make appointments for those who cannot attend the regularly scheduled hours. Such an announcement will not appreciably increase the number of visitations from your students, and it is just good business to set such a policy.

about teaching from a fellow mathematician?

(3) Self-evaluation might consist of the candidate preparing a "Teaching Portfolio". This portfolio would contain an enunciation of the candidate's overall teaching goals, plus a list of particular goals connected with particular courses that the candidate is going to teach. A mentor would review the portfolio regularly with the candidate, and help him assess whether he is achieving his objectives.

(4) Some people are shy, or uncomfortable in front of groups, or are poor speakers. Notable success has been had by having such individuals work with experts from the Communications Studies or Speech Department. While it may be uncomfortable to have a fellow mathematician tell the candidate that his teaching is inadequate, it may be more natural (akin to going to a fitness trainer or a podiatrist) to have the candidate consult with a well-meaning faculty member from another department. And I can tell you that this is a method that works in practice.

(5) I rather like this last method for evaluating teaching, but it is expensive both in terms of time and in terms of money. The idea is that a professional interviewer, perhaps someone with a background in psychology, will interview each student at the end of the course. The interview can be brief—perhaps ten minutes. But the interviewer can ask questions that will draw out the student's concerns. He can also zero in on important points that the student is trying to articulate and help him to develop them. At the end of the interview process, the interviewer will write up an in-depth report on the class, and the instructor, in question.

Once you start thinking creatively about ways to evaluate teaching, you will certainly develop ideas of your own. Bear in mind, as you do so, that the dean has an affection for "Evaluation of the Course Overall" and "Evaluation of the Instructor Overall" because these simple questions give him two numbers. He can quickly assess whether a given candidate cuts the mustard or not. When you devise alternative assessment techniques, be sure that each one results in useful and accurate advice for the teacher being examined and also in a *quick and incisive* take on the candidate's teaching abilities. The dean does not have the time to view videos, or read long position papers. He may not insist on a *number*, but he needs the evaluation to be of the nutshell variety.

2.10 Exams

In this section I will discuss how to compose an exam, how to formulate questions on an exam, how to judge the length of an exam, how to grade the exam, and so forth.

I will also discuss larger issues: **(i)** How much should you tell your students about what is on the exam?, **(ii)** How should you handle student questions about how the exam was graded?, **(iii)** How comprehensive should you make your exam? I will also discuss, in some detail, the question of whether exams should be multiple choice or of the (more traditional) written-out variety.

Let me state my thesis quite plainly. Handwritten exams, in which students write out complete solutions to stated problems, are good. Multiple choice, machine-graded exams are not so good. Of course nothing is black and white. Handwritten exams have their down side and multiple choice exams have their up side. The relevant issues will be developed as the section unfolds.

In most elementary math classes (and many advanced ones) the principal device for determining grades is the examination. These are usually (but not always) given in class, or during a special time slot in the evening. There are a number of points of view about what constitutes a good exam.

Some professors attempt to put together elaborate exam problems, each of which synthesizes several of the concepts introduced in the course. This practice causes me to pose some questions which you should ask yourself frequently when you teach or write: "Who is my audience? Am I trying to teach eighteen year olds or am I trying to impress myself? Am I trying to effect an educational experience? Or am I trying to put together an exam that I can show to my cronies while crowing about how dumb it proves the students to be?"

By contrast, there is the "minimalist" exam. A famous old exam from MIT consisted of the single problem

> You have a pile of warm metal shavings in the shape of a cone. Discuss.

There's a conversation stopper. On the other hand, a notable instructor at that same venerable institution for many years formulated final exams as follows

> There are fifteen important concepts in this course. Discuss any thirteen of them, outlining key ideas and providing proofs as time permits.

These types of exams may be suitable for certain students at MIT some of the time. They are not appropriate at most universities today most of the time.

My practice is extreme in yet a third direction. I usually tell my students what will be on the exam. No, I don't write each exam problem on the blackboard during a review session. But if a student asks, "Will we be tested on the chain rule?", I give him an honest answer (with the understanding that if I say "yes" then this should be construed as "maybe"). If the student says "How many problems are on the exam?" then I tell. If a student wants to know how many questions are multiple choice and how many not, I give. To deny this information is just power tripping. It serves no good purpose.

To be honest, 95% of my exam questions (in an elementary course) are straightforward. They offer no surprises. They are similar, but not isomorphic to, homework exercises. With the other 5% I am more fast and loose. I use these as a vehicle to identify the really bright and able students in the class.

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I know good teachers at first class universities who take the straightforward approach one step further. They have a blanket policy in all elementary classes (calculus and linear algebra and ODE, let's say) that *all* exam questions come directly from the homework. Literally. And they announce this on the first day of class and repeatedly throughout the course. It's an interesting policy. They tell the students exactly what will be on the test (in a sense), but on the other hand they really don't. This policy leaves students little room for complaining about the content of exams. On the other hand, it does not challenge them. And it encourages them to memorize (and perhaps to cheat!). Use this policy with caution.

Exam time is when you really have the students' attention. Get as much from it as you can. Drive home the important ideas of the course. Give a thumbnail sketch of the evolution of these ideas a few days before the exam. Such a review helps students to organize their thoughts.

Your exams are one of your most important tools for communicating with your class. The students may be at only half mast during some of your classes. But at exam time they are giving you their full and rapt attention. This is your big chance to tell them what this course is about, and how they are doing in it. There is no sense to use your exams as a device for alienating the class, and there are so many ways in which you can do so. If you are consciously going to give your students a killer exam then you should ask yourself *why* you are doing so. What are you trying to accomplish? Whom are you trying to impress? Consider carefully before you give such an exam. If the class is already dead then giving a hairy exam will pound the final nail into the coffin's lid. If the class is instead on your side, then why make a conscious effort to drive the students away?

Put another way, the purpose of a class is to transmit knowledge and information. Any given class has a dozen or more key ideas in it. That is what the tests should be about. A midterm or final exam in a basic course should not be a repository for ancillary theorems. It should not be a forum for obscure results not covered in class, or touched upon only in passing. An exam should be about the *principal topics* in the course—ones that you have emphasized and illustrated and repeated (*ad nauseum* if necessary). Topics covered on the exam should be ones that the students have heard about in class and seen in the homework (see also Section 1.4 on clarity).

Make sure that the questions you ask elicit the basic information that you seek. If your question about the chain rule turns into an algebraic morass, then it does not test the students about the essential material that they are to have mastered. If your maximum-minimum problem involves arithmetically or algebraically complex expressions that obscure what is going on, then you are not really testing the students as you wish to do. Thus it is important that you, the instructor, work the test problems through in advance. This takes some time, but less time than all the aggravation that ensues if you give a poorly formulated or carelessly prepared exam.

Multiple choice or show the full solution? There are arguments for and against both systems. From the professor's point of view, one argument for multiple choice is that the grading of the exams requires no effort (in many cases it can be done by machine). And the exam is completely objective. But these

reasons are a bit self-serving, and there is another more interesting consideration.

If you give traditional exams on which students write out solutions to the problems, then you usually fall into the malaise when grading of giving a lot of partial credit. Since you are human, you may tend to give even more partial credit on the 75^{th} examination paper than on the 5^{th}. The upshot is that it is actually possible for a student to get through the entire calculus sequence, with a grade of "C" or better, not knowing any particular calculus technique in its entirety. By contrast, it can be argued, the multiple choice exam has the advantage of requiring the student to actually *get to the correct answer* on a number of problems. But there is more to mathematics than just getting the correct answer. So you must consider to what extent your multiple choice exam is exposing students to the wrong value system.

On the other side, it can be argued that multiple choice exams involve a lot of gamesmanship. A student who has not studied, but who is clever, can sometimes get a reasonable grade on such an exam just by guessing shrewdly. (Of course you can offset this feature with negative scores for wrong answers. Also, if you give about ten possible choices for each question, and if the exam is otherwise well constructed, then you can make this eventuality unlikely.) It can also be argued that it is easier for students to cheat on a multiple choice exam.

I think that a more serious point about multiple choice exams is similar to the liability of large lectures. They don't do a good job of engaging the student in the learning process (see Section 3.5). A handwritten exam is a form of discourse between the student and the teacher (Section 3.14). The student writes his thoughts, the teacher evaluates those thoughts, and the student (ideally) learns from the exchange. A multiple choice exam is more like getting money from an Automatic Teller Machine. The job gets done, but no nurturing or growth occurs.

You also have to ask yourself which type of exam really tests the students on what they should be learning. Are they learning problem-solving skills? Are they learning the key ideas? Can they state the theorems? Can they prove them? Do they understand the definitions? Can they reproduce, with comprehension, the important examples? It seems patently clear that a written-out exam can do all of these. A multiple choice exam would be less informative in almost all instances.

A common student complaint about multiple choice exams, and one which I find difficult to gainsay, is that the student can do a problem almost completely correctly but have a small arithmetic slip, with the result that he cannot find the correct choice among those given. If, instead, the exam had allowed the student to submit his full answer for reading by the instructor, then the student would no doubt have received substantial credit. Instructors will argue that students should learn to be accurate. A small arithmetic slip will cause the bridge to fall down or the brain surgery to go awry. I imagine that the same professors would not expect their next scholarly papers to be refereed with this thought in mind.

Perhaps especially critical these days is that multiple choice exams do not appear to be a good vehicle for training students to do multi-step word problems. This is one aspect of mathematical training in which American students lag behind students in Japan and other countries. A well-crafted written-out exam

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can walk the student through six or more steps, beginning at square one and ending with the solution of some really interesting problem or phenomenon. This can be done with a multiple choice exam too, but it is much trickier to pull it off.

If I am teaching a large class (200 students or more) in which a hand-graded exam is infeasible, then I find it useful to compose my exams as follows: If there are twelve problems on the exam then ten of them are multiple choice and two are "short answer". The short answer problems are of the sort that I can grade instantly—just by glancing at them.

The students in large classes that I have taught are comfortable with an exam that is primarily multiple choice. But they appreciate the personal touch suggested by a couple of short-answer problems that are graded by hand.

It seems to me that in a small class (60 students or fewer) the professor can write a traditional exam requiring full answers to questions and then spend some time grading the papers carefully. In this context you can not only attend to the grading yourself but you can make constructive comments. These comments can be brief, and they can be encouraging. The serious students do read them, and do benefit from them.

I have presented arguments in favor of machine-graded multiple choice exams and also arguments against them. Once again, I shall be prescriptive: Hand-graded exams are better. They keep you in touch with how the class is doing as a whole, and also with individuals in the class. They give you the opportunity to discern what topics require additional coverage in class. Your comments on the exam are a useful part of the teaching process. If it is at all feasible, even in a class of eighty or more students, endeavor to give traditional hand-graded exams (or at least an exam that has a hand-graded component).

It is tempting, especially for new instructors, to hold review sessions for exams. This is a way of making yourself feel generous, it is easier than doing something more productive, and it will make the students grateful. But it also makes exams seem more onerous than they really are. (If you do decide to hold a review session anyway, then read Section 2.16 on problem sessions.) And it makes the students who cannot attend the review session feel as though they are at a serious disadvantage. I find it more useful to write a practice exam that I distribute a week in advance of the real test. About two days before the test I post solutions to the practice problems (either on the class Web page or on a bulletin board or both). Of course there is always the danger that students will think that first reading the practice problems and then reading your solutions will constitute studying for the exam. I always caution the students strenuously against this trap. No system is perfect.

Tests that are too long, or too involved, do not work. Your exam should contain a reasonable number of questions of reasonable length, and they should not be inter-linked. If problems are interconnected, and if a student makes a critical error in one of these, then all of the related problems are affected. If test problems are too involved then students can panic, mismanage their time, and turn in a performance that does not at all reflect their true abilities.

Master teacher Tom Banchoff [BAN] recommends the following technique for dealing with student panic on exams. He gives regular, 50 minute, in-class

exams—as we all do. But each student has the option of going home and reworking the exam at leisure to show what he really knows. Banchoff takes both performances into account when he does the end-of-term grading.

By the same token, it is sometimes appropriate to give a "take-home" exam. You will have to decide whether the particular class you are teaching can be trusted with such an exam. And then you will have to lay down some ground rules. Open book or closed? Timed or not? Can consult other people or not? A take-home exam gives the students an opportunity to really show what they can do. But it has many unmanaged aspects that can lead to trouble.

It is very easy to misjudge a test that you write. A problem that seems trivial at first blush may have complex arithmetic or algebra hidden in it. Thus *you must personally work the test out completely before you give it to your class.* An exam that you can do in twenty minutes—with all solutions written out neatly—is probably about right for a 50 minute exam for a class of freshmen. If it takes you 40 minutes, and you find yourself laboring over the algebra or arithmetic, then obviously this is not a suitable 50 minute exam for freshmen.

The point value of each exam question should be clearly exhibited on the exam. The total number of possible points on the exam should be displayed. It is tempting to make difficult problems worth a lot of points and trivial problems worth very few. But of course the end result, since many students will not do well on the hard problems, is that the class average is pushed down. On the other hand, you don't want to make the easy problems worth a lot of points and the hard ones worth just a few—this sends entirely the wrong message to the class about what is important. So you must strike a balance.

It is a useful device to break difficult exam questions up into steps. This practice helps the weaker students to get started, and to display what portion of the material they actually know. It also makes the exam easier to grade, and increases the consistency of your grading.

When you are grading exams, it is important to be as consistent as you can be. Begin by writing out the solution to each problem. Break the solution into pieces and assign a point value to each part. Thus, in a maximum-minimum problem, setting it up might be worth 3 points, doing the calculations another 3, and enunciating the answer another 3. One spare point for overall analysis makes a total of ten. Some instructors like to be even more precise than this. Refer to Section 2.14 for the concept of "horizontal" grading for insuring uniformity.

Remember that some students, the day the test is returned to them, will come to you with questions about how their individual exams were graded. In some cases, they will come with a friend and ask why two similar solutions were graded differently. If you are systematic, then you can handle such transactions with dispatch.

Should you write your exams out in longhand (with a pen), or should you word-process or TEX the exams? The obvious advantage of word-processing or TEXing an exam is that it is then lovely to view, all the characters are legible, there is virtually no chance that a student will misconstrue a problem for having misread what you wrote, and the exam has a professional appearance. Many mathematics departments keep an archive of all exams (especially finals, but sometimes even midterms) in order to handle student complaints, to give

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guidance to future new instructors, to keep tabs on the faculty, and generally to have a paper trail of what is going on in the department. Clearly a file full of carefully typeset or word-processed exams gives a much better impression than a file full of hastily scrawled longhand exams. But there is a flip side to this picture.

Writing an exam on a computer entails special formatting problems. It is difficult with a word-processor, and agonizing with TEX, to render an exam in the usual format—with a lot of indenting, alignment, vertical spaces, hang-indented material for point values and numeration, running heads, and so forth. It is also extremely easy to introduce inadvertent mathematical (and other) errors when keyboarding an exam. If figures or annotations or other pixilations are needed then you will likely be tempted to throw your keyboard out the window. Whereas writing an exam by hand could take an hour, it often happens that writing an exam on a computer could take several hours. Thus many an instructor—including yours truly—finds himself writing his exam with a *pen* by *hand.* When I do so, I make strenuous efforts to write neatly and clearly. I proofread meticulously. And I save a lot of time.

In this instance I am not going to make a crisp recommendation. Word-processed or typewritten exams are formally more attractive, and look more professional. But they are time-consuming to write and prone to error. Proceed with caution.

Now back to the trenches. When teaching a big class, it is best to generate some statistics about each exam that you give. When you hand an exam back to 200 people and someone asks, "What is the average?" or "What is the cutoff for an 'A'?" then you had better have an answer ready. The alternative is chaos. Therefore consider calculating the mean, the mode, and the median (if you don't know these words then look them up). Calculate the standard deviation and use it as a guide in setting up your grading curve. Draw a histogram. When you are explaining to a student how the exam was graded, such statistics are a great help.

Incidentally, hand exams back at the *end* of the class period. For if you return them at the beginning of the hour then students will spend the period reading the exam and comparing grades rather than listening to your lecture.

Hand back exams just as soon as possible after the exam is given—in the next class period if possible. If you procrastinate, and do not return the exams to students for a couple of weeks or, worse, until right before the next exam, then much of the didactic value of the exam will be lost. Students will have put that material on the back burner while they are learning new material, and their overall interest in the exam and its contents will have waned. If you can return exams in the very next class, then you can bring that portion of the course to closure and move confidently into the next body of material that you must teach your students.

It seems natural to spend the class period following an exam actually working the exam at the board. Let me tell you decisively that this is not a good use of time. First, students resent your implicit statement that "Look at me—unlike you, I can do the exam quickly and easily." Second, what each student really cares about is how *he* performed on the exam. If a student did a problem

incorrectly, it is possible that he will want to see you give the correct solution. Otherwise interest is minimal. Best is to make the written-out exam solutions available to all class members (in a posted copy, or in a hard copy that you distribute in class, or on the Web). Always insist that, before a student comes to you to complain about how a problem is graded, the student must first read your solution. You cannot imagine how much time and travail this practice will save.

You also need to get on with the course you are teaching. Make it clear to the students that you welcome their comments about the exam. Make yourself available during office hours, and even have extra office hours for discussing the exams if appropriate. But don't waste valuable class time hashing over an exam that has been taken and graded. Such an exam is basically a dead issue, and it is time to move on.

Generally speaking, it is best to try to deal with specific student questions about the way a specific person's exam was graded in a private, one-on-one fashion. You should never handle such complaints in front of a class. It is also a bad idea to handle them in front of a group of six after class. This is a personal matter. Treat it like an appointment with a physician. See also Section 2.11 on grading.

2.11 Grading

The pot of gold at the end of the rainbow, from the student's point of view, is the grade at the end of the course. Grading is a multi-parameter problem. The students want to be treated fairly, yet they want to to feel that the course has substance. They want to be enlightened, yet they want (to some degree) to be delighted, to be entertained. They want to respect you (the instructor), but they want to be your friend. There are a variety of devices for making your grading scheme palatable (without being essentially more lenient) to students. What is the most evenhanded and efficient way to determine grades?

I have used a number of grading schemes successfully, and some unsuccessfully. I would like to record a few of the former here—merely for the reader's delectation. My main goal in formulating my grading policies is to make the greatest number of students feel that they have been treated fairly (and, not incidentally, to reduce student complaints). This does not mean that I am a lenient grader, nor that I give away grades for no special reason.

Always tell students on the first day of class, and in your syllabus (see Section 2.12), how you will grade the course. You want this to be a matter of public record. If students complain about your grading practices, and there will occasionally be some who do, then you have your public statements to fall back on. And don't lie. If you say that you will grade according to a certain scheme—with exams worth so much and homework worth so much and so forth—then do so. If you say in your syllabus that you will grade on a curve, then do so. If you say in the syllabus that you have an absolute grading method (90% is an "A", 80% is a "B", etc.), then stick to that.

You may wish to consider in advance how you will handle students who are

2.11

distraught about their midterm grades. One method that usually works for me in borderline cases is to say to the complaining student, "If these few points really make a difference in your course grade at the end of the semester then let's discuss it at that time." This arrangement usually makes everyone happy, and very few students will take you up on the offer.

If a student comes to complain about a grade, then show the student some courtesy. If you cannot come up with a cogent reason for the way that you graded an exam or a problem, then that is *your fault*. Rethink your grading practices. Never fall back on your august position as your first line of defense. You show the student absolutely no respect by saying, "that's the way I graded your test and I'm the boss." That is not how you would wish to be treated. You can always turn a session of "Why was this test graded this way?" into a favorable transaction. What does it cost you to give the student a few extra points if the points are merited?

However *never* penalize a student for being honest. If the student comes to you and says, "You added up my points incorrectly. I should have received an 87 instead of a 90." then just send the student home with a little praise for being so perceptive. Tell the student that if you ever inadvertently give him too few points then he should feel free to approach you at that time as well.

It is tempting, especially when you are a new instructor, to endeavor to take an "organic" approach toward grading. Students are very receptive to the instructor who says, "I try to grade on a subjective system. If your strong grades are on the midterm exams, then I downplay the homework and the final. If your work shows improvement, then I take that into account when I determine your grade. I try to emphasize everyone's strengths. I am your friend." This approach works well in the short run. It is a good opiate—for you as well as for the students.

One weakness of the organic grading method is that it is intrinsically unfair. A student who does his homework with friends (and who therefore, despite his own personal lack of understanding, gets good homework grades), but who takes his exams alone (and gets poor exam grades because of his lack of true understanding) could still garner an "A" or "B" in the course.

Perhaps a more pragmatic and immediate liability of the "organic" grading method is that, if a student complains about his course grade, then you have nothing to fall back on. You cannot show him your calculations and you cannot show where his score fits on a histogram. The trouble with an intuitive methodology is that you cannot explain it or defend it. Even though it sounds a trifle cold, you are much better off with an objective system of grading. In the end, everyone is more comfortable with a dispassionate approach. And, in the rare event that you have to defend yourself to the chairman, or to an angry parent, or to the dean, or even to a colleague, you will be prepared.

One device that I have used in large calculus classes (see also Section 2.14 for additional thoughts on grading in large classes) is the following: I tell students that I determine their grade by weighting their midterms as 50% of the grade, the final as 30% of the grade, and the homework as 20% of the grade (for example). But the *caveat* that I throw in is that anyone who gets an "A" on the final gets an "A" in the course. This assumes, of course, that the final exam is

comprehensive. Thus if a student comes to me during the term and is distraught about his homework grade or his midterm grade, then I can simply enjoin that student to do well on the final. In fact not many students pull their grade up with the final exam (never more than 5%) and this simple device helps to keep morale high.

As with many items in this book, I offer the last tentatively. I have had some of the brighter students complain about this policy: "Why should some jerk who didn't work all semester be able to pull off an 'A' at the last minute just by cramming?" I patiently explain that it is virtually impossible for such a "jerk" to pull off such a miracle, that the purpose of the policy is to help and to offer encouragement to students who have been struggling, or for whom this is the first difficult math class. It also sends the important message to students that what is important is that, by the end of the semester, they ultimately master the material. Some faculty have told me that the skewed value system that the just-described policy implies is sending a counterproductive message to the students. My primary motive in formulating the policy was to give the students hope, and to quell their misgivings and their fears; and not least I wanted to minimize their complaints. In a substantial course—say real analysis—in which it takes time for the students to internalize the ideas, this policy helps students to show (integrated over time) what they have ultimately learned.

Sometimes you must change a student's grade—either on an exam or in a course. Perhaps you made a clerical error in recording the grade, or you made an error in grading a problem, or you were the victim of any number of other human frailties. Do not be afraid to change a grade when it is merited. *However*: You do not want to develop the reputation among students as an instructor with whom grades can be negotiated. I've had this rep, and I don't know how I got it. But there was a time when, the day after an exam, 85% of my students lined up outside my office to take turns slugging it out with me—point by point and problem by problem—over their exam grade. I felt at times as though I should buy stock in the Kleenex Company. This process is unpleasant and (can be) degrading both for you and for the student. Doing a careful job of grading in the first place, and posting carefully written solutions for students to see, can help to assuage much of student discomfort with grades.

Make the student read your (posted) solution before you agree to talk about the grading of a problem. Many times I, as an inexperienced instructor, have spent fifteen minutes haggling with a student over a problem only to realize that the student had not read the correct solution. Once he read it, his objections faded away.

No matter how fair and ethical and "right" your grading methods may be, the way you grade may run afoul of departmental policies. I know many a mathematician who has painstakingly prepared a grading curve for his calculus course and submitted his grades to the department, only to have the Chairman or the Director of Undergraduate Studies call him on the carpet for not following the "approved departmental grading curve". The usual party line is, "In this department, we recommend that you give 20% 'A's, 30% 'B's, 40% 'C's, and 10% 'D's. We discourage 'F's." Of course these specific figures are manufactured, but the scenario occurs all the time—probably more often at large state institutions

I once taught a junior/senior level real analysis course. One student's primary interest was chemistry, but he was studying for an advanced degree in statistics, and this in turn required that he take real analysis. Fine. He was a bright and hard-working student, and I couldn't help but like him. One day I gave a rigorous definition of "continuous function" and he raised his hand and said, "That's not what I think of as a continuous function." A part of me wanted to beat him over the head. But he was coming from a different world, and he had posed a serious comment that demanded a serious answer. I was really on the spot. I had to *defend* my definition. I certainly learned from this dialogue. And I have, as a result of this experience, become more open to such questions. I would encourage you to do the same.

My message is this: Learn to be patient. Students will ask you to repeat terms. Students will ask you "non-mathematical" questions. Students might seem less able, or less well prepared, than those in your country. But they are bright and they are willing. You must learn to work with them. *After* you have learned how the American education system works, and what the students are like, you will find that your colleagues are receptive to your thoughts about its shortcomings. Before you have made this acquaintance, you are working in a vacuum and you should keep your own counsel.

In some countries it is the style of the university professor to stand at a lectern in the front of the room and to read the textbook to the class. Questions are considered to be a rude Americanism. An extreme example of a teaching style that is virtually orthogonal to what we Americans know is one that has been attributed to the celebrated Hungarian analyst F. Riesz. He would come to class accompanied by an Assistant Professor and an Associate Professor. The Associate Professor would read Riesz's famous text aloud to the class. The Assistant Professor would write the words on the blackboard. Riesz would stand front and center with his hands clasped behind his back and nod sagely.

My point is that in the United States, for better or for worse, we have our own way of doing things. The style here is to indulge in discourse with the class. Some professors make the discourse largely unilateral. That is, they lecture. Other professors encourage more interchange between the students and the teacher. Reading this book will help you to become acquainted with the traditional methods, and some of the newer methods, of teaching in this country.

4.2 Late Work

Late work is a nagging problem. The easiest solution to the "Can I hand just this one assignment in late?" dilemma is to "Just say 'no'." But what of the student who has a *really good excuse*? What if there has been a death in the family or some other crisis that the student cannot avoid?

The trouble with making one exception is that it tends to snowball at an exponential rate to N exceptions. In a large class this can be catastrophic. One possible solution is to tell the students that, when you calculate their cumulative homework grade, you will drop their two worst grades. That means that any student can miss one or two homework assignments with essentially no penalty.

It's a remarkably simple solution to an otherwise difficult problem.

There are a number of other possible answers to the late homework problem. You can downgrade late assignments, or you can assign extra work. You can just forget the missing assignment and base the student's course grade on the remaining course work. The point is that you should think about this matter in advance, and formulate a policy that you will use consistently. A choice of incorrect policy toward late work could lead to a lot of extra effort and/or aggravation for you. Don't be afraid to ask a more experienced colleague for help in this matter.

4.3 Cheating

Cheating is a big, and probably unsolvable, problem. Academic dishonesty is demoralizing for the teacher and for the non-cheating students. Honest students react to cheating with emotions that range from outrage to pity to melancholy. What is the point of studying so hard if cheaters can get good grades through skulduggery? And the cheaters' inflated grades affect the grading curve, which in turn affects everyone. On the whole, cheating is a moral outrage—for both instructor and student alike.

You will find it difficult to deal with the sort of students who cheat, for they may be dishonest with themselves and with others in a number of aspects of their lives. You want to be firm and fair and just all at the same time. But you *must* deal with them, and you must do so directly and firmly. As with late work and other difficulties, you must have a clear and consistent policy to apply to cheaters. Fortunately (see below), the university may have already formulated such a policy for you.

You may wish to set a moral tone against cheating by making an announcement on the first day of class. For large lectures, this may be especially important. Declare that you consider cheating to be an egregious offense—against yourself, against the other members of the class, and against the university. While you admit to the class that you may not be able to catch all cheaters, you assure the students that anyone caught cheating will be punished to the full extent of the law—*including expulsion from the university when appropriate.*

Be forewarned: Most American universities have set policies about handling cheaters. You are not free to act as you please when you catch a miscreant. In particular, there are due process procedures set up (to protect the rights of the accused cheater) that you must follow if you wish to punish a cheater. You do not necessarily have the right to tear up the student's exam, to give the student an "F", or to mete out other retribution. Check with the director of undergraduate studies in your department to determine the proper course of action when handling a suspected cheater.

One rule of thumb is that you should not be lenient with cheaters. Cheating cuts at the very fiber of what university education is about. When you catch a cheater, you must send a strong message that this behavior is intolerable.

At one Ivy League university, entering students are required to sign an oath that they will adhere to the university's Honor Code. Part of the honor code is

that, at the start of any exam, the professor will record on the blackboard the statement "I pledge my honor that I have neither given nor received information during this exam." Each student is to copy the pledge verbatim onto his exam sheet and then sign it. The instructor is then required to leave the room for the entire duration of the exam. He may, if he wishes, return briefly in the middle of the exam to answer questions. The critical part of the honor code that the student signs at the outset of his education is that he pledges not to cheat and he also pledges to turn in any other student whom he observes cheating. Since the instructor must leave the room at exam time, we see that the entire onus of catching cheaters is placed on the students themselves!

An interesting policy, and one that would not work at every institution. A notable feature of making each student copy and sign the pledge on his exam is the following. If he is planning to cheat, then the university is forcing him to lie as well. Having served on university committees that adjudicate cheating, my experience with students is that they are disinclined to rat out their peers. Most people want to be told what to do most of the time, and the students whom I have known prefer there to be an authority figure who will identify and deal with cheaters. This means you, so you had better figure out how to do it.

The best defense against cheaters is offense. Give your exams in a large room. Space the students far apart. Check picture ID's to make sure that students have not sent in ringers (substitutes) to take the exam for them. Patrol the room. Avoid turning the exam into a power trip situation. Just maintain control.

Another aspect of cheating is plagiarism. Plagiarism is not as likely to arise in a mathematics class as in, say, a history class. But you should be aware of what it is and how to deal with it. Plagiarism is the appropriation of another person's words or ideas. It is too large to treat in any detail here, but see [MLA] and the Web site

`http://www.cas.ilstu.edu/English/145web/DprtInfo/Plag.html`

One advantage from your point of view is that you do not have to handle plagiarism in real time. You have the plagiarist's work, together with the putative source material, in front of you. You may consider it carefully, show it to colleagues, ask your undergraduate director how to proceed. The best policy is not to attempt to act alone.

One could easily write another book about techniques to catch cheaters. In some departments, exams are photocopied (or at least a sample of them is photocopied) before they are returned to students. This is to dissuade a student from altering a graded exam and then coming back to the instructor to request more points. Some departments (such as my own) use elaborate statistical procedures to detect unnatural correlations among students' answers on multiple choice exams. (A student caught by means of such a mathematical technique finds it quite difficult to defend himself!) Many other devices are available.

The point is that it is worth spending a few moments thinking about how you will handle cheaters. There are many pitfalls to be avoided—in particular, you must respect the accused cheater's rights as specified in your university's code of conduct. There is nothing very pretty about a situation involving cheating.

Just remember that you are not free to act on your own. Become acquainted with your university's procedures.

4.4 Incompletes

The profession of teaching, while certainly a stimulating and rewarding one, is littered with nasty little details. One of these is the "incomplete". The theoretical purpose of an incomplete is to provide a vehicle for handling certain problem situations. Perhaps a student *has* completed a substantial amount of material in the course, but has been ill or has suffered a death in the family or some other setback. He needs to defer completion of the course work until the next term. The professor fills out an "Incomplete Form", and records the student's term grade as an "I" or "Incomplete", to formalize the understanding that the student will complete the work at some pre-specified future time. Many universities find it convenient to let professors administer incompletes as they see fit. As a result, there is much inconsistency and abuse.

Frankly, I've given a lot of incompletes in my life and very few of them were ever completed. Students get busy with the next semester's work, and never get around to things past. In fact I did not complete the only incomplete that I ever took as a student. It is also unfortunately the case that certain students will simply blow off a course and then ask for an incomplete at the end of the term. Often it is easier for you as the instructor to just grant the incomplete, given that an otherwise undisciplined student is not likely to complete it (the grade then usually, but not always, reverts to an "F"). You may very well wonder what is the point of engaging in a long interview with such a student to determine whether the incomplete is merited.

All this having been said, it is probably best, as with all matters in teaching that impinge on fairness, to have a uniform policy for handling incompletes. But think this through. Are you going to require that the student provide *proof* of his excuse? This sounds reasonable, but what if the student says, "My mother is dying of cancer." or "My grandmother just died and I cannot concentrate on my work." I know professors who will demand a letter from the physician or the undertaker, but this strikes me as a bit extreme. It could also prove to be uncomfortable or embarrassing for all concerned.

One convenient way to handle the request for an incomplete is to instruct the student to approach a professor teaching the same course the following term. The student should ask whether he can audit the course, having his work graded. The new professor of course will *not* submit an official grade for this student (after all, the student is not registered in his class). Instead, he will transmit the resulting grade to you. You then fill out a form to remove the student's Incomplete grade and replace it with that letter grade. This is clean and simple, and it works. You certainly don't want to have to re-teach some or all of the course for the benefit of just one student.

You are the academic analogue of a middle management executive in the business world. Executives exist, presumably, because they are smart enough to handle exceptional circumstances. Teaching is loaded with all of the sorts

of exceptions that are connected with dealing with *people*. I have used the "incomplete" here as but one example of the problems and potential enigmas that can arise. Your department probably has set policies, or at least guidelines, for handling incompletes. Become acquainted with the routine procedures before you give your first "I".

4.5 Frustration

One of the most commonly heard complaints of college mathematics instructors, especially experienced instructors, is this: "Math 297 is a prerequisite for the course that I am teaching yet the students don't seem to know anything from Math 297." A variant of this is "My calculus students cannot[1] add fractions" or "My calculus students don't know how to expand $(a+b)^2$.".

Indeed, these are valid complaints. It is also valid to complain about the high cost of living, or about death and taxes. The peccadillos described in the first paragraph are facts of life and we as math instructors must deal with them. The truth is that we instructors think about math all day long, every day. We see the entire curriculum as a piece. For the experienced math instructor, there are no seams and creases between linear algebra, calculus, differential equations, and so forth. We swim effortlessly through the ideas, using whatever tools are needed. (By the way, if this doesn't exactly describe you then don't panic—I'm using a bit of poetic license here.) Students are different. They think about math when they are in the math classroom and (one hopes) for a few designated hours outside the classroom, but they are not inured in the subject.

So what is the point? It is simple. If you are in the second week of freshman calculus and you need to add two algebraic expressions that are fractions, then gently remind the students how to do it. If you need to expand the expression $(a+b)^2$, then say, "You remember how this works—right?" After a few gentle reminders, most of the students fall into the flow and they *will* remember how it goes.

Take a break and watch the "Tonight Show" or "Late Night". Listen to the monologue. If the host is going to crack a joke about someone slightly less famous than Bill Clinton, then he gently reminds the audience who it is that he is talking about. It's just good sense. These television hosts can be even less sure of how well informed their audiences are than we can be in our math classes. They guarantee that their viewers will *understand* by providing a bridge.

Contrast these recommendations with the following rather common alternative. The professor needs to add two fractional algebraic expressions, so he just barrels through it (rapidly and without comment, as one would do for a colleague). After a few moments some hands are raised, some hesitant questions are asked, and it soon becomes clear that many students are lost. The professor says, "What is the matter with you people? This is high school stuff. Am I a

[1]The Bank of America in Westwood Village, Los Angeles used to regularly place an advertisement in the UCLA student paper each spring. The purpose of the ad was to encourage members of the latest graduating class to consider a career with B of A. The ad read in part "applicants must be able to add fractions." So it is not just math teachers who are plagued by this problem.

It is no fun having to deal with issues of racism or sexism or sexual harassment or misogyny. A complaint lodged against you is, in effect, an attack on your character and your integrity. So be aware that these areas are a potential problem for all of us. Behave accordingly. If you are called on the carpet for any of these matters, then do not become defensive. Show respect for the complainant. Get help from your department head or from your dean of human resources. This is serious business.

4.11 Begging and Pleading

Some students will come to you with unreasonable requests. They will tell you, after doing poorly on an exam, that if they do not pass this test—or this course—with a certain grade then they cannot continue in the pre-medical program, or the microbiology program. Of course you, as professor, can verify rather quickly whether this claim is true. But it does not matter. If the test was so important to the student then the student should have studied harder. The student should have come to your office hours for help before the test. If the student's homework was weak then the student should have seen the writing on the wall. Be cautious of these pleas. While you do not want to be heartless and unsympathetic, you also do not want to find yourself gradually being drawn into an ever more complicated morass of tricky moral dilemmas (see [WIE], and also Section 2.11, for a rather hard-nosed view of this sort of student negotiation).

Students are sometimes *unable* to see the writing on the wall. A student will come to me and ask why he got a grade of "D" in a certain course. I will look at his record and say, "Well, you got a 'D' on the first midterm, a 'D' on the second midterm, a 'D' on the homework, and a 'D' on the final. So a grade of 'D' seemed to be in order." Amazingly, this line of reasoning never occurred to the student (no, I am not making this up). So I have to be patient and explain how the world works. It is a little like explaining the birds and the bees to a slow child; but somebody has to do it.

A desperate student will offer you all sorts of inducements to change grades. Discretion prevents me from enumerating what some of these may be, but they range from the pecuniary to the personal. *You must brush off these attempted bribes with the disdain that they deserve.* If you act as though you are considering and then rejecting them, then you are looking for trouble.

It really is true that if you look and/or act like a student then students will find you more approachable. They will more readily come to you with propositions that they wouldn't consider broaching with a more detached faculty member. In short, younger faculty are more vulnerable. This is one reason for dressing differently from students and maintaining a slight distance. Again, this may sound cold. But I speak here from hard personal experience.

As has been mentioned in Section 4.10 and elsewhere, you must be sensitive to sexual harassment issues. Sexual harassment is not a pretty subject, but acting receptive—even mildly so—to any proffered inducements is only looking for trouble.

4.11

Sometimes a student—who has done poorly on an exam—will ask to be allowed to take the test again. You simply cannot allow this type of favoritism. For one thing, it is unfair to the other students. Second, if the others find out then they will become angry—and justifiably so. You *can* give the student a second try off the record and go over the test afterwards with the student. This artifice can be a device for giving the student some encouragement. You might tell the student, "I can see from this unofficial exam that you know the material better than your official exam suggests. If you do well on the final then you can still probably get a grade of 'B'." However you must engage in this charity sparingly, if for no other reason than it can use up large chunks of your time. Also, it is too easily misinterpreted.

A favorite student response to a poor test grade is, "I did very well on the homework but my test grade does not reflect what I know." Of course some students may "choke", or panic, on a test. As a student, I have done so myself. But unfortunately many students do their homework by copying examples from the text, or the lecture—merely changing the appropriate numbers. This leads to a minimum of understanding. You must stress to your students that, when they study for a test, they should reach proficiency *without* recourse to the book or notes. If the book and notes are necessary, then the technique has not been mastered. For interest's sake, refer to Tom Banchoff's technique, described in Section 2.10, for handling students who choke on a test.

One of the most common student remarks is, "I really understand the material but I cannot do the problems." A variant is, "I can do the problems on the homework but I cannot do the problems on the test." Consider if you will these analogous statements: "I really understand how to swim but every time I get in the water I drown." and "Playing the piano sure looks easy when Arthur Rubinstein does it. I wonder why I cannot do it?"

If you are a good teacher, then you will make the material look easy, or at least straightforward. Thus you can lull students into a false sense of security. You must continually warn them of the importance of mastering the material *themselves*—and of *practicing*. And this point leads to the second ludicrous statement recorded above. The fact that a student can do the homework problems is meaningless *unless* the student can do them cold, and with the book closed.

This last observation seems so obvious that it hardly bears mention. But recall that this is a book about the obvious, and this point bears not only mention but repeated mention. Many students view the learning process as a passive one—something like getting a massage. You must constantly remind them that this attitude will not do. You can remind them by just telling them. Or you can remind them by giving pop quizzes. Or you can remind them by giving an exam and watching them flunk. But, one way or the other, you must attempt to break through this psychological impasse.

In a related vein, many students think that

(i) studying

and

(ii) just sitting in front of the book

are one and the same thing. We all know that studying requires discipline, tenacity, and hard work. It is not something that just happens to you. It is instead something that you *make happen*. Helping your students to understand this point begins with being conscious of the problem yourself.

It is an observed fact that most students—but especially freshmen and sophomores—have no idea how to study. David Bressoud (see his Appendix to the book) recently conducted a survey in which he asked students in large calculus lectures how they studied. What he learned is that the student conception of "studying" is to attempt to do the assigned homework problems by emulating a cognate example from either the text or the class hour. This is certainly a meaningful activity, but it is only a minuscule portion of what true studying is. It is worthwhile to consider how you, as a mathematics instructor, can force the students to read the text and to turn the ideas over in their own minds. Some instructors have required their students to keep journals recording the development of ideas in the course. Lab activities—really tightly constructed ones that force the students to reinvent the ideas for themselves—are another way to accomplish this goal. Group discussion is a third method.

In my opinion, most students want to be told what to do. Your job as teacher is to tell them. Don't make them guess what are the important topics in your class. Tell them. Don't make them guess what they will be tested on. Tell them. Don't make them guess how to study for an exam. Tell them. Don't make them guess what are the pitfalls in studying. Tell them. Is there any reason not to do this? Would you rather deal with the begging and the pleading?