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.

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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.

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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

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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

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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

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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

would hang on my every word. I would be inundated with brilliant questions and dazzling student work. My life would be bliss." Baloney. I know people who teach at Harvard, and I know people who teach at Tennessee Tech. Every school has its share of bright and eager students as well as its share of duds. Some schools may have a preponderance of students who cannot add fractions, while other schools may have a preponderance of students who are too arrogant to listen to anything that you have to say. A good teacher learns to grow where he is planted.

3.6 Math Anxiety

About twenty-five years ago the phenomenon of "Math Anxiety" was identified and described—by well-meaning people, educators endeavoring to explain why some people have more trouble learning math than others (see [TOB] and [KOW] for both history and concept). We don't hear much about math anxiety in math departments because such departments are full of people who don't have it. Math anxiety is an inability by an otherwise intelligent person to cope with quantification and, more generally, with mathematics. Frequently the outward symptoms of math anxiety are physiological rather than psychological. When confronted by a math problem, the sufferer has sweaty palms, is nauseous, has heart palpitations, and experiences paralysis of thought. Oft-cited examples of math anxiety are the successful business person who cannot calculate a tip, or the brilliant musician who cannot balance a checkbook. This quick description does not begin to describe the torment that those suffering from math anxiety actually experience.

What sets mathematics apart from many other activities in life is that it is unforgiving. Most people are not talented speakers or conversationalists, but comfort themselves with the notion that at least they can get their ideas across. Many people cannot spell, but rationalize that the reader can figure out what was meant (or else they rely on a spell-checker). But if you are doing a math problem and it is not right then it is wrong. Period.

Learning elementary mathematics is about as difficult as learning to play *Malagueña* on the guitar. But there is terrific peer support for learning to play the guitar well. There is precious little such support (especially among college students) for learning mathematics. If the student also has a mathematics teacher who is a dreary old poop and if the textbook is unreadable, then a comfortable cop-out is for the student to say that he has math anxiety. His friends won't challenge him on this assertion. In fact they may be empathetic. Thus the term "math anxiety" is sometimes misused. It can be applied carelessly to people who do not have it.

The literature—in psychology and education journals—on math anxiety is copious. The more scholarly articles are careful to separate math anxiety from general anxiety and from "math avoidance". Some people who claim to have math anxiety have been treated successfully with a combination of relaxation techniques and remedial mathematics review.

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It would be heartless to say to a manic depressive, "Just cheer up," or to say to a drug addict, "Just say no." Likewise, it is heartless to tell a person who thinks he has math anxiety that in fact he is wrong—he is just a lazy bum. At the same time, mathematics instructors are not trained to treat math anxiety, any more than they are trained to treat nervous disorders or paranoia. If a student told you that he had dyslexia, then you certainly would not try to treat it yourself; nor would you tell the student that he just didn't have the right attitude, and should work harder. Likewise, if one of your students complains of math anxiety, you should take the matter seriously and realize that you are not qualified to handle it. Refer that student to a professional. Most every campus has one.

Never forget that you are a powerful figure in your students' lives. This fact carries with it a great deal of responsibility. If you were a follower of Dr. Kervorkian,[3] then you might take a troubled student in hand and say, "I know you are doing poorly in your math class. You must be in a great deal of pain, and suffering from shame. I have a solution for you—it's rather permanent, but it's painless." Chuckle if you will, but this is no joke. Problems of the psyche can be severe and dangerous. If a student comes to you with psychological problems then make sure that he gets help from someone who is qualified to administer that help.

Unfortunately, at some schools the "math anxiety" thing has gotten way out of hand. There are good universities where a student may be excused from a mathematics or statistics course (one that is *required* for his major) by simply declaring himself to be math phobic, or possessed of math anxiety. It is a sad state of affairs, but there is nothing that we math teachers can do about it. Because you and I are, by nature, good at mathematics, and because we do not suffer from math anxiety, it is difficult for us to empathize with people who suffer from this malady. It is really best to let those who know the literature, know the symptoms, and know the treatments to handle students who have this form of stress. Do not hesitate to refer your students to the appropriate counselor when the situation so dictates.

3.7 How Do Students Learn?

Psychologists, sociologists, education theorists, and anthropologists have debated the nature of the learning mechanism for decades. There is no general agreement on how students learn. See [ASI] for a modern discussion of some of the issues. This is a question on which serious scholars will spend their entire careers—and still not reach definitive conclusions. My only intent here is to share with you a few personal perceptions.

It is my opinion that the very best students tend to teach themselves. The instructor points out signposts for such a student, and then the student's native intellect takes over.

[3] Dr. Jack Kervorkian is the physician who has garnered considerable notoriety for assisting the suicides of severely ill people.

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

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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.

Familiarize yourself with your university's policies.