CHAPTER 2

Practical Matters

2.0. Chapter Overview

Like many activities in life, fine teaching is composed of many technical components. When everything works properly, then the whole is considerably greater than the sum of its parts. However, if some of the crucial parts are rusty or, worse, non-functional, then the whole will creak and drag and not do a good job of it.

The novice instructor should probably read every section in this chapter. The more experienced instructor may wish to pick out particular sections for concentrated effort.

2.1. Voice

There is nothing more stultifying than a lecture in a reasonably large classroom on a hot day delivered by an oblivious professor mumbling to himself /herself at the front of the room. We are not all actors or comedians or even great public speakers. But we are teachers, and we must convey a body of material. We must capture the class's attention. We must *fill the room.*

If you are unlucky, then you may be assigned to teach in a classroom that works against you. Perhaps visibility is poor for the students in the back, or the acoustics are bad, or the blackboard is substandard. If you are burdened with such a teaching environment, try your best to get it changed. If you cannot, then think hard about how to get the best out of this classroom. If the blackboard is unusable, then consider lecturing with an overhead projector or a computer projector. It may be possible to get a portable SmartBoard (see Section 4.12). If the acoustics are bad, then consider using a microphone. If visibility is poor, then think about changing the seating arrangement. No matter what the liabilities, you must take charge.

Your voice is one of your primary tools. And you must use that tool in part to control the environment in your classroom. The most important presence in the room is not the blackboard, nor the desk, nor the text. It is *you.* You want the students' attention focused on you.

I am not saying that you must lose your dignity, or act silly, or show off. You must learn to use your voice and your eyes and your body and your presence as a tool. If you are going to say something important, then make a meaningful pause beforehand. *Say* that it is important. Repeat the point. Write it down. Give an example. Repeat it again.

You can gain the attention of a large group by lowering your voice. Or by raising it. Or by pausing. One thing is certain: You will not gain the audience's attention by rolling along in an uninflected monotone. Again, I am not suggesting that you undergo a personality change in order to be a sound teacher. What I am

suggesting is that you find ways to talk to them as a *person interacting with people*, rather than as an ill-at-ease, out-to-lunch egghead.

At a well-known university (of good quality!) in southern California they once tried bringing in actors from Hollywood to help professors spice up their delivery. One instructor of an Abnormal Psychology course was advised to use the line, "I never teach about any mental illness until I try it out myself." Such pandering is inappropriate, offensive, and childish. Can you imagine yourself using such patter? Who would want to?

What I am suggesting here is that you take just a little time and contemplate your lecture/classroom style. A lecture or class should be a controlled conversation between you and your audience. It is a trifle one-sided, of course. But there must be cerebral interaction between the teacher and the students. That means that you, the instructor, must grab and maintain the attention of the class. Your behavior in front of the group is a primary tool for keeping the lines of communication open.

When you are talking about a subject that you perceive to be trivial, and when you are nervous, you tend to talk too fast. Novice instructors find themselves barreling through their lectures. You must resist this tendency. If you are really new at the business of teaching, then practice your lectures. Get a friend to listen. In calculus, a fifty minute lecture with three or four good examples and some intermediate explanatory material is probably just about right (I'm thinking here of a lecture on max-min problems, for example). Try to make each class consist of about that much material, and make it fill the hour. If you finish early, that is fine (but it may mean that you talked too fast). You can quit early for that day, or do an extra example, or use the extra time to answer questions.

Part and parcel of the message in the last paragraph is that we instructors also tend to do too much in our heads – we don't write enough on the blackboard. This is a dreadful mistake. Students have a hard enough time keeping up even when you write *everything* on the board. Skipping steps will leave even the good students in the dust. Write out everything. Write it slowly, and write it clearly. But write it.

Don't give the students the impression that you are in a rush. It puts them off, and reflects a bad attitude toward the teaching process. If on Wednesday you plan to explain the chain rule, then do just that. If the chosen topic does not fill the hour, then do an extra example or field questions. Do not race on to the next topic. One idea per class, at the lower-division level, is about right. (Of course if you are teaching a multi-section class at a big university, then it is important to keep pace with the other instructors. This is yet another reason for keeping careful track of your use of time. See also Section 1.6.)

It is something of an oversimplification, but still true, that a portion of the teacher's role is as a cheerleader. You are, by example, trying to persuade the students that this ostensibly difficult material is doable. Part of the secret to success in this process is to have a controlled, relaxed voice, to appear to be at ease, and to be organized. Don't let a small error fluster you. Make it seem as though such a slip can happen to anyone, and that fixing it is akin to tying your shoelaces or pulling up your socks.

But, as with all advice in this book, you must temper the thoughts in the last paragraph with a dose of realism. If you make the material look easy, then students will infer that it *is* easy. The psychological processes at play here are not completely straightforward. Nobody would be foolish enough to go to an Isaac Stern concert

and come away with the impression that playing the violin is trivial. Yet students attend my calculus classes, watch me solve problems, conclude that the material is easy and that they have it down cold. They then decide that in fact they *don't* need to do any homework problems or read the book, and then they flunk the midterm.

These are the same students who come to me after the exam and say, "I understand all the ideas. The material is absolutely clear when you talk about it in class. But I couldn't do the problems on the exam." How many times have you heard such a statement from your students? I like to tease my students by reminding them that this is like saying, "I really understand how to swim, but every time I get in the water I drown."

On the one hand, you don't want to make straightforward material look difficult. After 300 years, we've got calculus sewn up. There is no topic in the course that is intrinsically difficult. We merely need to train our students to do it. So *do* make each technique look straightforward. But remind the students that *they themselves need to practice.* Do this by telling them so, by giving quizzes, by varying the examples and introducing little surprises. Ask the class questions to make the students turn the ideas over in their own minds. Use your *voice* to encourage, to wheedle, to cajole, to question, to stimulate.

Mathematics instructors in general, whether they are "reformers" or "traditionalists" or "high techers" or "plug-and-chuggers," agree that each student must take each idea in the course and rebuild it in his/her own mind. This is nothing new. Go read Beth and Piaget [**BPI**]—they discuss this notion in detail. An awareness of this concept will help you to shape your teaching methods. If the students cannot understand what you are talking about, then it is unlikely that they will take the ideas home and think about them. If the students watch you state and prove a lot of abstruse theorems, and in the process become terminally depressed, then it is unlikely that they will take the ideas home and analyze them and internalize them. If the students watch you flounder around, unable to complete an example coherently or explain a concept neatly, then it is unlikely that they will take the ideas home and rebuild them in their own minds.

If instead you kindle the students' curiosity, plant in them a desire to learn, show them something they have never seen before and *make them realize that it is something they have never seen before*—and certainly never understood before—then there is a real likelihood that they will leave class turning the new thoughts over in their minds, talk among themselves about it, ask questions, and come back to you with their own ideas. *That* is teaching.

Even if you know how to use your voice well with a small audience, and to capture their attention and get them excited about learning, there are special problems with the large classes that are used in the teaching of calculus (for instance) at many universities. Refer to Section 2.13 for more on this matter.

2.2. Eye Contact

We all know certain people who invariably emerge as the leader of any group conversation. Such people seem to sparkle with wit, erudition, and presence. They usually pick the topic and they usually aim the discussion. They have a sense of humor, and they are intelligent. What is their secret?

It is partly a matter of attention and awareness. The sort of person I am describing has an inborn curiosity; he/she is aware of you, and interested in you,

and genuinely eager to learn about your opinions and experiences and interests. When you ask yourself what makes another person interesting, an honest answer would have to entail that such a person is outer directed, and cares about others.[1]

This is obviously a talent that is partly inborn and partly cultivated. Some of the trick is to show genuine interest in what other people have to say before bounding ahead with what you have to say. Another part is to talk about subjects, and to tell anecdotes, that you know will interest other people. Being charming and witty helps too, but in this section I want to concentrate on more mechanical features of repartee.

Many of the devices that make for an engaging conversationalist also make for an engaging teacher. A review of the last paragraphs, and of the rest of this book, will bear out this assertion. In this section I will discuss the importance of *eye contact.*

Telling a good joke while staring at the floor with your thumb in your ear will not have the same effect as telling the joke while looking at your listener, engaging his/her attention, and reacting to the listener while the listener is reacting to you. A good joke teller has his/her audience starting to chuckle half way through the joke and just dying for the punch line. Getting a good laugh is then a foregone conclusion.

Another aspect of good joke telling—one for which Jack Benny was justifiably noted—is timing. You need to a tell a joke at the right pace, to know when to insert pauses, to know when to raise your voice or lower it, to know when to grimace or smile. Delivery is everything.

Giving a good lecture or class is serious business, and is not the same as telling a joke. But many of the moves are the same. If you want to hold your audience's attention then you must look at your audience. You must engage not one person but all. You must learn to use your body as a tool. Step forward and back. Force the eyes of the audience to follow you. A good lecturer speaks to individuals in the audience, to grouplets in the audience, and to the whole audience. Like a movie camera, you must zoom in and zoom out to get the effects that you wish to achieve. A ninety minute movie filmed at the same constant focal length would be dreadfully boring. Ditto for a lecture.

Some people are very shy about establishing eye contact. It is a device that you must consciously cultivate. The end result is worth it. The teacher who can establish eye contact is also the teacher who is confident, who is well prepared, and who conducts a good class.

2.3. Blackboard Technique

Make sure your blackboards are clean before you begin. Take extra time to erase the old stuff thoroughly.

Write neatly. Write either in very plain longhand or print. Be sure that your handwriting is large enough. Be sure that it is dark enough. Endeavor to write straight across the blackboard in a horizontal line. Proceed in a linear fashion. Don't have a lot of insertions, arrows, and diagonally written asides.

Don't put too much material on each board. The ideas stand out more vividly if they are not hemmed in by a lot of adjacent material. In particular, it is difficult

[1] A boring person is one who talks about himself. An interesting person is one who talks about you.

for students to pay attention when the teacher fills the board with long line after long line of print. An excellent guitarist once said that the silences in his music were at least as important as the notes. When you are laying material out on a blackboard, the same can be said of the blank spaces.

Some people find it useful to divide the blackboard into boxes. This practice makes it easier for the lecturer to organize what he/she is writing, and also makes it *much, much easier* for the students in the audience to organize the material in their minds and in their notes.

Label your equations so that you can refer to them verbally. Draw sketches neatly. Use horizontal and vertical lines to set off related bodies of material.

You can control your output more accurately by keeping the length of each line short. Think of the blackboard as being divided into several boxes and write your lecture by putting one idea in each box. To repeat: If necessary, *actually divide the blackboard into boxes.*

If the classroom has sliding blackboards, think ahead about how to use them so that the most (and most recent) material is visible at one time. For those combinatorial theorists among you, or those experts on the game of NIM, this should be fun.

If you are right-handed, consider writing first on the right-hand blackboard and then working left. The reason? That way you are never standing in front of what you've written. Good teaching consists in large part of a lot of little details like this. You shouldn't be pathological about these details, but if you are aware that they are there then you will pick up on them.

Every now and then during your presentation, you should stand aside and pause. Don't say *anything.* This gives you an opportunity to collect your thoughts and catch your breath. You can verify the accuracy of what you have written. It gives the students an opportunity to catch up and to ponder what they've heard. They may decide to formulate questions. If instead you are barging ahead at full speed for the entire hour, then students never have a moment to think about what they are hearing. They cannot interact with you because you are not interacting with them.

Try to think ahead. Material that needs to be kept—and not erased—should be written (probably in a box) on a blackboard to the far left or far right where it is out of the way but can be referred to easily. You may wish to reserve another box on the blackboard for asides or remarks. Some instructors put material that needs to be seen for the entire hour on an overhead slide. This frees up all the blackboards, and keeps those important equations or definitions front and center.

These ideas are another facet of the precept that you know the material cold so that you can concentrate on your delivery. Just as an actor knows his/her lines cold so that he/she can make bold entrances and exits, and not trip over his/her feet, so you must be able to focus a significant portion of your brain on the *conveying of the information.*

If your lesson will involve one or more difficult figures then practice them on a sheet of paper in advance. Remember that you are a mathematical role model for the students. If you make it appear that it is difficult for *you* to draw a hyperboloid of one sheet, then how are the students supposed to be able to do it? Of course you can prepare the figure ahead of time on an overhead slide (or even photocopy

it straight out of a book, or straight from `Mathematica` or `Maple`, onto a transparency). This solves the problem of having a nice figure to show the students. It does not solve the problem of *showing the students how to draw the figure.* As a result, it puts a barrier between them and the ultimate goal of learning how to *read* the graph. If necessary, consult a colleague who is artistically adept for tips on how to draw difficult figures.

You will find students quite resistive to learning to graph—especially in three dimensions. I learned a useful teaching device when last I taught multi-variable calculus, and it became clear to me when I was showing my students how to graph. That device is *persistence.* I made it clear to them that anything that gave them a pain in the neck was going to appear repeatedly in subsequent work. For example, almost all of them did rather poorly on the graphing portion of the first midterm. So I gave them several followup quizzes to help them hone their graphing skills. After each quiz they all gave me their "Is that finally the end of graphing?" look. But after examining their work I said, "Nope; not good enough yet." And on we went. Over and over again I graphed functions in three dimensions. I went through every step. And I did it *at the blackboard,* just as I expected them to do it with pencil and paper. Graphing appeared again on the final. And I *told* them that it would so appear. In fact I told them that the best way to study for the final was to find everything on the first two midterms that they hated, and that this material would certainly be on the final. They believed me, and it worked.

If you cannot organize the steps of a maximum-minimum problem, then can you really expect the students to do so? In the best of all possible worlds, the students' work is but a pale shadow of your own. So your work should be the platonic ideal. Sometimes, in presenting an example or solving a problem at the blackboard, you may inadvertently gloss from one step to another. Or you might make a straightforward presentation look like a bag of tricks. Or you may do some of the steps in your head. This practice is very confusing for students, especially the ones who lack confidence. By organizing the solution in a step-by-step format you can avoid these slips.[2]

After you have filled a board, it should be neat enough and clear enough that you could snap a digital snapshot and read the presentation from the screen on your camera. In particular, you should not lecture by writing a few words, erasing those, and then writing some more words on top of the erased old words. Students cannot follow such a palimpsest. I cannot emphasize this point too strongly: Write from left to right and from top to bottom. *Do not erase.* When the first box is filled, proceed to the second. *Do not erase.* Only when all blackboards are full should you go back and begin erasing. Students must be given time to stare at what they've just seen as well as what is currently being written. Keep as much material as possible visible at all times.

BUT: When it is time to erase, be sure to erase thoroughly. It is well worth spending a few extra moments being sure that the blackboard is sparkling clean before you begin a new block of material. If you endeavor to write over a sloppily erased blackboard, then your writing will be obscure at best. Everything will look fuzzy. This is really a psychological issue. Of course the students can squint and strain and figure out what you are writing (even if it is a virtually unreadable

[2]When I solve a maximum-minimum problem, I have eight steps that I *always* follow. Every time I do an example I carefully enunciate each of the steps.

melange of overwrites), but it bums them out to have to do so. Try to make their job as easy as possible.

Do not stand in front of what you are writing. Either stretch out your arm and write to the side or step aside frequently. Read aloud to the class as you write. Make the mathematics happen before their eyes and *be sure that they can see everything.* Every once in a while, pause and step aside to catch your breath and to let them catch up.

Here is a common error that is made even by the most seasoned professionals. Imagine that you do an example that begins with the phrase "Find the local maxima and minima of the function ..." And so forth. Say that you've worked the example. Now suppose that the next example begins with the same phrase. It is a dreadful mistake to erase all but that first phrase and begin the new example on the fly, as it were.

Why is this a mistake?—it *seems* perfectly logical. But the students are taking notes! How can they keep up when you pull a stunt like this? *Slow yourself down.* Write the words again. If a student gets two sentences behind then he/she may as well be two paragraphs behind. Give frequent respites for catch up.

And now a coda: How much of what you are saying should you write? In my experience, the answer is "As much as possible." When you are transmitting sophisticated technical ideas verbally, students have trouble keeping up. Many of them are not native English speakers. They need a little help. Write down everything except asides (actually, some asides are worth recording as well). Say the words as you write them. This is also a device for slowing yourself down. Most of us tend to talk far too fast—at least about mathematics. Slowing yourself down and writing deliberately will help you to keep your handwriting clear and will make the lesson as a whole appear to be neat and clean. If the *appearance* is neat and clean then perhaps the *ideas* are neat and clean—at least that's what you want the students to think.

The flip side of the last paragraph is that the tendency to talk too rapidly may cause you to write too rapidly (and therefore sloppily). Thus periodically checking the quality of your handwriting on the blackboard can serve as a means of telling whether either your verbal or written delivery is too speedy.

Let me reiterate one of my most fundamental precepts. There is a real psychological barrier for the instructor to overcome when learning blackboard technique, and voice control. When we understand very deeply what we are talking about, then it all seems quite trivial. We can convince ourselves rather easily—at least at a subconscious level—that it is embarrassing to stand in front of a group and enunciate whatever mundane material is the topic of the day. Thus we are inclined to race through it, both verbally and in the way that we render it on the blackboard. *Be conscious of this trap and do not fall into it.* I have never been criticized for being too clear, whether I was giving a calculus lecture to freshmen or a seminar lecture at the Mathematisches Forschungsinstitut Oberwolfach. *Slow down.* Be deliberate. Enunciate. Explain.

Many of us, at the beginning of the class, rattle on verbally at some length before we finally persuade ourselves that we had better start writing something on the board. Please don't do this. Start writing the material from the very outset. If you want the students to notice it, and write it down, and get it straight, then you had better set the example by writing it.

When I taught at UCLA we had a chair who was frequently engaged in delicate negotiations on international phone calls with nonnative English speakers. One instance was a case of trying to help a Russian mathematician expatriate. The chair would take copious notes during the phone conversation, so that he could later consult with his executive committee about the situation. But he was a very nervous sort of guy, and he usually found that he could not read his notes. Literally! So he could not report on his phone conversations and his negotations usually ended up being ineffective.

You do *not* want your teaching to be like what I described in the last paragraph. You must *force* yourself to write boldly and clearly. Usually it is best to print rather than to use longhand. You should write large and as plainly as possible. Put plenty of space between the words and between the lines. Slow yourself down and make it come out right. It should be possible for a student to take a digital photo of your blackboard (with his/her phone, for example) and take it home and read it.

Writing material neatly and slowly is a subtle way of telling the students that this material is important. If you are taking the trouble to write it down deliberately, then it must be worth writing deliberately. Conversely, if you scribble some incoherent gibberish, or scribble nothing at all, then what signal are you sending to the students?

2.4. 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 (many 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.
- Generally speaking, the homework problems should resonate with the material you present in class. If you lecture on A and give homework on B and test the students on C you will really create a world of hurt. Be consistent.
- *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.[3] 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.

Today there are Internet alternatives to traditional homework. One that is freely available is `WeBWorK` from the University of Rochester. This is an Online homework system that gives students instant feedback on the quality of their work. In some of my classes the for-credit homework assignments are done on `WeBWorK`. In other classes I use `WeBWorK` as a supplement to the traditional hardcopy homework. See Section 4.9 for more on `WebWork` and similar tools.

Consider implementing the 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 Asian 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

[3]The famous math teacher Ray Redheffer used to give *two* homework assignments in each class meeting. He told the students that he would be collecting one of them next time, but he would not tell them which one.

you will have to consider carefully how to tell whose work is whose, or at least how to divide up the credit.

2.5. Office Hours

At most universities the instructor is required to hold two or more office hours per week.[4] 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.

Promise students that you will be there during your office hour. And be there. Students should be made to understand that they need not wait for a natural or personal disaster in order to come to your office hour. It is perfectly all right for a student to come to your office hour and say "I don't get problem 6." or "The chain rule makes no sense to me."

During your office hour, you will usually not be overwhelmed with students (except perhaps just before an exam). In fact it is a general rule of thumb that, the larger the class, the smaller the percentage of students who will come to your office hour. But those who do show up will appreciate your attentions. Of the hours that you have designated, you can spend some of them catching up on your correspondence, making up the next homework assignment, or reading the *Notices* or the *Monthly* or the *Mathematical Intelligencer*.

If you have sufficient space in your office, it is a good idea to have a table and a couple of chairs set up in a special part of the office—*away from your desk and your papers and books and personal artifacts*—where you will consult with students. What is the reason for this affectation? First of all, you don't want students inadvertently walking away with your papers or your correspondence. Second, you don't want them spilling coffee on your latest manuscript or your new book that you purchased at great expense from Marcel Dekker. Third, students are by nature careless. They may put their feet on your desk or use your telephone or grab your fountain pen. Rather than appear to be an old fuddy-duddy and constantly be scolding, it is so much easier to have a special venue in which to "hold court."

When a student comes to my office expressing befuddlement over a particular type of problem, I have a powerful and decisive weapon that I unleash. I begin by asking, "Do you have a half hour or so?" If the answer is "Yes", then I sit the student down and say, "Try a problem of the kind you are having trouble with. When you get stuck, tell me." Of course the student invariably gets stuck, and I

[4] I also know of schools—good schools—where teaching is the main activity and professors are expected to have their office doors open all day long. And the students really take advantage of this largesse.

give him/her a little help. I might need to intervene three or four times during the first problem that the student does for me. But the second problem may require only two interventions, and the third only one. By the time the fourth problem rolls around, the student's newfound confidence is irrepressible, and the transaction is a great success. The student goes away pleased and happy that he/she has now mastered a heretofore mystifying mathematical idea. Of course I always tell the student, "If you get home, and you find that you are still confused, then come back and we'll do this again."

On days when your office hour is not crowded, and you only have a couple of customers, I highly recommend that you try this teaching technique. It's good business, and it always produces satisfied customers. Word gets around in the class that the professor is not such a bad guy after all. Perhaps, as a result, a few other students will drop by for help.

You want to convey to students that the office hour is a particular time that you have set aside for them. If you consult with students while sitting at your desk and glancing at your mail, or scribbling notes for an upcoming seminar, or reading your email, or answering phone calls, then you in fact will *not* convince them of your dedication. Instead, if you hold court in the special part of your office that you have set aside for consultations, then your students will understand that this time is theirs. If you really want to do it right, then let your voice mail pick up on your phone calls during your office hour. For those sixty minutes, give yourself to your students.

The office hour is your opportunity to get to know at least some of your students personally. Of course I do not mean by this that you should get involved in their *personal lives*. Problems about their love lives or their parents or their social diseases should be referred to the professional counselors that are on the staff of every college. What I mean is that you should take the opportunity to get to know some of your students as people, and to let them get to know you as well.

This activity has several beneficial side effects, both for you and for them. When you are lecturing, you can have certain individuals in the room in mind as you formulate your remarks. You can make reference (*without* mentioning any names) to questions that came up during office hour. It is reassuring to the average student (the type that *does not* go to office hour) to know that conscientious students (the type that *do* go to office hour) have some of the same questions that they have.

This point is in fact worth developing. Some components of teaching may be compared with certain aspects of psychotherapy. One big feature of therapy—certainly an aspect that is exploited by popular psychology and self-help books—is to assure the patient that he/she is not alone. There are thousands of people with exactly the same problems, suffering in just the same ways. And they have been treated successfully.

Just so, when you teach you must give both tacit and explicit reassurances to students that their questions and confusions are not theirs alone. An eighteen-year-old is scared to death that he/she is the only person in the room who doesn't understand why the numerator in the quotient rule has the form that it has—or why it does not seem to be symmetric in its arguments. Such a student would not dare ask about it in front of a room full of his/her peers. The student may not even be sure how to articulate the question, so surely will not want to flounder about in

front of the entire class. At the same time the student may be afraid to come to your office hour and, alone but in *your* august presence, ask for a clarification.

Thus you must signal to students that questions are a good thing. When a student asks a question in class that might be of general interest, I not only repeat it but I often state that I am glad this question was raised. I carefully record the question on the blackboard. Several people have visited me privately, I add, and asked variants of the same question. If there is a question that should be asked but has not been, then I ask it myself. I say that if this point is unclear to them (the students) then they should come see me in my office hour and get it straightened out. You don't need to give away door prizes to drum up business at your office hour. However, it is psychologically important for students to know that you are available, whether they actually come to see you or not.

I have said repeatedly in this book that persistence is an important attribute for the successful teacher. Another such attribute is patience. If a student finds the nerve to ask a question in class or during office hour—*even if it is a question that I have answered before*, in fact *even if I have answered it several times before*—then I treat the questioner with respect and I pay due homage to the question and I answer it. I *never* say, "I've already answered that question. Go home and read your notes." Such a rejoinder would be counterproductive, and would discourage further question-asking in class.

I often announce to my classes that students may drop by my office even when it is not my office hour. If I am not busy, I'll be happy to talk to them. In practice, this charity does not appreciably increase the flow of business. There are always students who strictly respect your designated office hour and there are always those who drop by whenever they please. But making an announcement of this nature is one of those little details that contribute to a favorable student attitude. For it sends a signal to the class that you care, and that you truly want to help them learn mathematics. If you do make such an announcement, be courteous to those who take you up on it. If you are busy and must send the student away, do so with respect and suggest another time for the student to return.

I once had a colleague who, whenever a student would show up at his door, would crawl under his desk until the student went away. This is certainly a memorable way to deal with students, but not one that I would recommend. When a student comes to your office, make him/her feel welcome. Act as though you are happy that he/she cared to dropped by. Endeavor to adopt the same cheery tone that you would assume if a good friend paid a surprise visit. Such an action on your part will put the student at ease, and will make the transaction go smoothly and productively.

The office hour is a way to step out of your role as instructor and let the students know that you are a person. It is a way to become acquainted with some of your students. Any good public speaker "works the audience" before his/her speech. Holding your office hour is one way to work the audience. You will also get a feeling during the office hour for how the class is doing, what problems and concerns have arisen, how the pace is working. It is wrong, and self-defeating, to view your office hour as a dreary duty. It is a teaching tool that you should use wisely.