WHAT IS MATH ANXIETY?

(taken from www.mathacademy.com/pr/minitext/anxiety)

famous stage actress was once asked if she had ever suffered from stage-fright, and if so, how she got over it. She laughed at the interviewer's naive assumption that, since she was an accomplished actress *now*, she must not feel that kind of anxiety. She assured him that she has *always* had stage fright, and that she has *never* gotten over it. Instead, she had learned to walk on stage and perform – in spite of it.

Like stage fright, math anxiety can be a disabling condition, causing humiliation, resentment, and even panic. Consider these testimonials from a questionnaire we have given to students in the past several years:

> **When I look at a math problem, my mind goes completely blank. I feel stupid, and I can't remember how to do even the simplest things.**
>
> **I've hated math ever since I was nine years old, when my father grounded me for a week because I couldn't learn my multiplication tables.**
>
> **In math there's always one right answer, and if you can't find it you've failed. That makes me crazy.**
>
> **Math exams terrify me. My palms get sweaty, I breathe too fast, and often I can't even make my eyes focus on the paper. It's worse if I look around, because I'd see everybody else working, and know that I'm the only one who can't do it.**
>
> **I've never been successful in any math class I've ever taken. I never understand what the teacher is saying, so my mind just wanders.**
>
> **Some people can do math – not me!**

What all of these students are expressing is *math anxiety,* a feeling of intense frustration or helplessness about one's ability to do math. What they did not realize is that their feelings about math are common to all of us to some degree. Even the best mathematicians, like the actress mentioned above, are prone to anxiety – even about the very thing they do best and love most.

In this essay we will take a constructive look at math anxiety, its causes, its effects, and at how you as a student can learn to manage this anxiety so that it no longer hinders your study of mathematics. Lastly, we will examine special strategies for studying mathematics, doing homework, and taking exams.

Let us begin by examining some social attitudes towards mathematics that are especially relevant.

SOCIAL CAUSES AND EDUCATIONAL CONTEXTS

magine that you are at a dinner party, seated with many people at a large table. In the course of conversation the person sitting across from you laughingly remarks, "of course, I'm illiterate . . . !" What would you say? Would you laugh along with him or her and confess that you never really learned to read either? Would you expect other people at the table to do so?

Now imagine the same scene, only this time the guest across from you says, "of course, I've never been any good at math . . . !" What happens this time? Naturally, you can expect other people at the table to chime in cheerfully with their own claims to having "never been good at math" – the implicit message being that no *ordinary* person ever is.

The fact is that mathematics has a tarnished reputation in our society. It is commonly accepted that math is difficult, obscure, and of interest only to "certain people," i.e., nerds and geeks – not a flattering characterization. The consequence in many English-speaking countries, and especially in the United States, is that the study of math carries with it a stigma, and people who are talented at math or profess enjoyment of it are often treated as though they are not quite normal. Alarmingly, many school teachers – *even those whose job it is to teach mathematics* – communicate this attitude to their students directly or indirectly, so that young people are invariably exposed to an anti-math bias at an impressionable age.

It comes as a surprise to many people to learn that this attitude is not shared by other societies. In Russian or German culture, for example, mathematics is viewed as an essential part of literacy, and an educated person would be chagrined to confess ignorance of basic mathematics. (It is no accident that both of these countries enjoy a centuries-long tradition of leadership in mathematics.)

Our jaundiced attitude towards mathematics has been greatly exacerbated by the way in which it has been taught since early in this century. For nearly seventy years, teaching methods have relied on a behaviorist model of learning, a paradigm which emphasizes learning-by-rote; that is, memorization and repetition. In mathematics, this meant that a particular type of problem was presented, together with a technique of solution, and these were practiced until sufficiently mastered. The student was then hustled along to the next type of problem, with its technique of solution, and so on. The ideas and concepts which lay behind these techniques were treated as a sideshow, or most often omitted altogether. Someone once described this method of teaching mathematics as inviting students to the most wonderful restaurant in the world – and then forcing them to eat the menu! Little wonder that the learning of mathematics seems to most people a dull and unrewarding enterprise, when the very meat of the subject is boiled down to the gristle before it is served.

This horror story of mathematics education may yet have a happy ending. Reform efforts in the teaching of mathematics have been under way for several years, and many – if not all – teachers of mathematics have conscientiously set about replacing the behaviorist paradigm with methods based on constructivist or other progressive models of learning. As yet, however, there remains no widely accepted teaching methodology for implementing these reform efforts, and it may well be that another generation will pass before all students in the

primary and secondary grades are empowered to discover the range and beauty of mathematical ideas, free of the stigmas engendered by social and educational bias.

Finally, young women continue to face an additional barrier to success in mathematics. Remarkably, even at the start of the 21st century, school-age girls are still discouraged by parents, peers, and teachers with the admonition that mathematics "just isn't something girls do." Before we became teachers, we would have assumed that such attitudes died out a generation ago, but now we know better. Countless of our female students have told how friends, family members, and even their junior and senior high school instructors impressed upon them the undesirability of pursuing the study of mathematics. My own wife (a mathematician) recalls approaching her junior high school geometry teacher after class with a question about what the class was studying. He actually *patted her on the head*, and explained that she "didn't need to know about that stuff." (And, needless to say, he didn't answer her question.)

Sexism such as this is only part of the problem. For all adolescents, but especially for girls, there is concern about how one is viewed by members of the opposite sex – and being a "geek" is not seen as the best strategy. Peer pressure is the mortar in that wall. And parents, often even without knowing it, can facilitate this anxiety and help to discourage their daughters from maintaining an open mind and a natural curiosity towards the study of science and math.

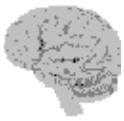
Together these social and educational factors lay the groundwork for many widely believed myths and misconceptions about the study of mathematics. To an examination of these we now turn.

MATH MYTHS AND MISCONCEPTIONS

A host of common but erroneous ideas about mathematics are available to the student who suffers math anxiety. These have the effect of justifying or rationalizing the fear and frustration he or she feels, and when these myths are challenged a student may feel defensive. This is quite natural. However, it must be recognized that loathing of mathematics is an emotional response, and the first step in overcoming it is to appraise one's opinions about math in a spirit of detachment. Consider the five most prevalent math myths, and see what *you* make of them:

MYTH #1: APTITUDE FOR MATH IS INBORN.

This belief is the most natural in the world. After all, some people just *are* more talented at some things (music and athletics come to mind) and to some degree it seems that these talents must be inborn. Indeed, as in any other field of human endeavor, mathematics has had its share of prodigies. Karl Gauss helped his father with bookkeeping as a small child, and the Indian mathematician Ramanujan discovered deep results in mathematics with little formal training. It is easy for students to believe that doing math requires a *math brain*, one in particular which they have not got.



MATH BRAIN

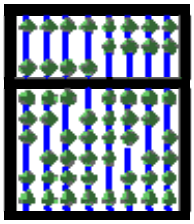
But consider: to generalize from "three spoons, three rocks, three flowers" – to the number "three" – is an extraordinary feat of abstraction, yet every one of us accomplished this when we were mere toddlers! Mathematics is indeed inborn, but it is inborn in all of us. It is a human trait, shared by the entire race. Reasoning with abstract ideas is the province of every child, every woman, every man. Having a special genetic make-up is no more necessary for success in this activity than being Mozart is necessary to humming a tune.

MATH GENES

Ask your math teacher or professor if he or she became a mathematician in consequence of having a special brain. (Be sure to keep a straight face when you do this.) Almost certainly, after the laughter has subsided, it will turn out that a parent or teacher was responsible for helping your instructor discover the beauty in mathematics, and the rewards it holds for the student – and decidedly *not* a special brain. (If you ask my wife, on the other hand, she will tell you it was orneriness; she got sick of being told she couldn't do it.)

MYTH #2: TO BE GOOD AT MATH YOU HAVE TO BE GOOD AT CALCULATING.

Some people count on their fingers. Invariably, they feel somewhat ashamed about it, and try to do it furtively. But this is ridiculous. Why *shouldn't* you count on your fingers? What else is a Chinese abacus, but a sophisticated version of counting on your fingers? Yet people accomplished at using the abacus can out-perform anyone who calculates figures mentally.



Modern mathematics is a science of *ideas*, not an exercise in calculation. It is a standing joke that mathematicians can't do arithmetic reliably, and I often admonish my students to check my calculations on the chalkboard because I'm sure to get them wrong if they don't. There is a serious message in this: being a wiz at figures is not the mark of success in mathematics.

This bears emphasis: a pocket calculator has no knowledge, no insight, no understanding – yet it is better at addition and subtraction than any human will ever be. And who would prefer being a pocket calculator to being human?

This myth is largely due to the methods of teaching discussed above, which emphasize finding solutions by rote. Indeed, many people suppose that a professional mathematician's research involves something like doing long division to more and more decimal places, an image that makes mathematicians smile sadly. New mathematical ideas – the object of research – are precisely that. Ideas. And ideas are something we can all relate to. That's what makes us *people* to begin with.

MYTH #3: MATH REQUIRES LOGIC, NOT CREATIVITY.

The grain of truth in this myth is that, of course, math does require logic. But what does this mean? It means that we want things to make sense. We don't want our equations to assert that 1 is equal to 2.

This is no different from any other field of human endeavor, in which we want our results and propositions to be meaningful – and they can't be meaningful if they do not jive with the principles of logic that are common to all mankind. Mathematics is somewhat unique in that it has elevated ordinary logic almost to the level of an art form, but this is because logic itself is a kind of structure – an *idea* – and mathematics is concerned with precisely that sort of thing.

But it is simply a mistake to suppose that logic is what mathematics is *about*, or that being a mathematician means being uncreative or unintuitive, for exactly the opposite is the case. The great mathematicians, indeed, are poets in their soul.

How can we best illustrate this? Consider the ancient Greeks, such as Pythagoras, who first brought mathematics to the level of an abstract study of ideas.

They noticed something truly astounding: that the musical tones most pleasing to the ear are those achieved by dividing a plucked string into ratios of integers. For instance, the musical interval of a "fifth" is achieved by plucking a taut string whilst pressing the finger against it at a distance exactly four-fifths along its total length. From such insights, the Pythagoreans developed an elaborate and beautiful theory of the nature of physical reality, one based on number. And to them we owe an immense debt, for to whom does not music bring joy? Yet no one could argue that music is a cold, unfeeling enterprise of mere logic and calculation.

If you remain unconvinced, take a stroll through the Mathematical Art of M.C. Escher. Here is the creative legacy of an artist with no advanced training in math, but whose works consciously celebrate mathematical ideas, in a way that slips them across the transom of our self-conscious anxiety, presenting them afresh to our wondering eyes.

MYTH #4: IN MATH, WHAT'S IMPORTANT IS GETTING THE RIGHT ANSWER.

If you are building a bridge, getting the right answer counts for a lot, no doubt. Nobody wants a bridge that tumbles down during rush hour because someone forgot to carry the 2 in the 10's place! But are you building bridges, or studying mathematics? Even if you are studying math so that you *can* build bridges, what matters right now is *understanding the concepts* that allow bridges to hang magically in the air – not whether you always remember to carry the 2.

That you be methodical and complete in your work is important to your math instructor, and it should be important to you as well. This is just a matter of doing what you are doing as well as you can do it – good mental and moral hygiene for any activity. But if any instructor has given you the notion that "the right answer" is what counts most, put it out of your head at once. Nobody overly fussy about how his or her bootlace is tied will ever stroll at ease through Platonic Realms.

MYTH #5: MEN ARE NATURALLY BETTER THAN WOMEN AT MATHEMATICAL THINKING.

If there is even a ghost of a remnant of a suspicion in your mind about gender making a whit's difference in students' mathematics aptitude, slay the beast at once. Special vigilance is required when it comes to this myth, because it can find insidious ways to affect one's attitude without ever drawing attention to itself. For instance, I've had female students confide to me that – although of course they do not believe in a gender gap when it comes to *ability* – still it seems to them a little *unfeminine* to be good at math. There is no basis for such a belief, and in fact a sociological study several years ago found that female

mathematicians are, on average, slightly *more* feminine than their non-mathematician counterparts.

Sadly, the legacy of generations of gender bias, like our legacy of racial bias, continues to shade many people's outlooks, often without their even being aware of it. It is every student's, parent's, and educator's duty to be on the lookout for this error of thought, and to combat it with reason and understanding wherever and however it may surface.

Across the centuries, from Hypatia to Amalie Nöther to thousands of contemporary women in school and university math departments around the globe, female mathematicians have been and remain full partners in creating the rich tapestry of mathematics. For outstanding web sites with information about historical and contemporary women in mathematics, check the subject index in the "biography" section of the Math Links Library.

TAKING POSSESSION OF MATH ANXIETY

ven though all of us suffer from math anxiety to some degree – just as anyone feels at least a *little* nervous when speaking to an audience – for some of us it is a serious problem, a burden that interferes with our lives, preventing us from achieving our goals. The first step, and the one without which no further progress is possible, is to recognize that math anxiety is an emotional response. (In fact, severe math anxiety is a *learned* emotional response.) As with any strong emotional reaction, there are constructive and unconstructive ways to manage math anxiety. Unconstructive (and even damaging) ways include rationalization, suppression, and denial.

By "rationalization," we mean finding reasons why it is okay and perhaps even inevitable – and therefore justified – for you to have this reaction. The myths discussed above are examples of rationalizations, and while they may make you feel better (or at least less bad) about having math anxiety, they will do nothing to lessen it or to help you get it under control. Therefore, rationalization is unconstructive.

By "suppression" is meant having awareness of the anxiety – but trying very, very hard *not* to feel it. I have found that this is very commonly attempted by students, and it is usually accompanied by some pretty severe self-criticism. Students feel that they shouldn't feel this anxiety, that it's a weakness which they should overcome, by brute force if necessary. When this effort doesn't succeed (as invariably it doesn't) the self-criticism becomes ever harsher, leading to a deep sense of frustration and often a severe loss of self-esteem – particularly if the stakes for a student are high, as when his or her career or personal goals are riding on a successful outcome in a math class, or when parental disapproval is a factor. Consequently, suppression of math anxiety is not only unconstructive, but can actually be damaging.

Finally, there is denial. People using this approach probably aren't likely to see this essay, much less read it, for they carefully construct their lives so as to avoid all mathematics as much as possible. They choose college majors, and later careers, that don't require any math, and let the bank or their spouse balance the checkbook. This approach has the advantage that feelings of frustration and anxiety about math are mostly avoided. However, their lives are drastically constrained, for in our society fewer than 25% of all careers are, so-to-speak, "math-free," and thus their choices of personal and professional goals are severely limited. (Most of these math-free jobs, incidentally, are low-status and low-pay.)

People in denial about mathematics miss out on something else too, for the student of mathematics learns to see aspects of the structure and beauty of our world that can be seen in no other way, and to which the "innumerate" necessarily remain forever blind. It would be a lot like never hearing music, or never seeing colors. (I understand that some people have these disabilities – but they didn't *choose* to have them.)

Okay, so what is the constructive way to manage math anxiety? I call it "taking possession." It involves making as conscious as possible the sources of math anxiety in one' own life, accepting those feelings without self-criticism, and then learning strategies for disarming math anxiety's influence on one's future study of mathematics. (These strategies are explored in depth in the next section.)

Begin by understanding that your feelings of math anxiety are not uncommon, and that they definitely do not indicate that there is anything wrong with you or inferior about your ability to learn math. For some this can be hard to accept, but it is worth trying to accept – since after all it happens to be true. This can be made easier by exploring your own "math-history." Think back across your career as a math student, and identify those experiences which have contributed most to your feelings of frustration about math. For some this will be a memory of a humiliating experience in school, such as being made to stand at the blackboard and embarrassed in front of one's peers. For others it may involve interaction with a parent. Whatever the principle episodes are, recall them as vividly as you are able to. Then, write them down. This is important. After you have written the episode on a sheet(s) of paper, write down your reaction to the episode, both at the time and how it makes you feel to recall it now. (Do this for each episode if there is more than one.)

After you have completed this exercise, take a fresh sheet of paper and try to sum up in a few words what your feelings about math are at this point in your life, together with the reason or reasons you wish to succeed at math. This too is important. Not until after we lay out for ourselves in a conscious and deliberate way what our feelings and desires are towards mathematics, will it become possible to *take possession* of our feelings of math anxiety and become free to implement strategies for coping with those feelings.

At this point it can be enormously helpful to share your memories, feelings, and goals with others. In a math class I teach for arts majors, I hand out a questionnaire early in the semester asking students to do exactly what is described above. After they have spent about twenty minutes writing down their recollections and goals, I lead them in a classroom discussion on math anxiety. This process of dialogue and sharing – though it may seem just a bit on the goopy side – invariably brings out of each student his or her own barriers to math, often helping these students become completely conscious of these barriers for the first time. Just as important, it helps all my students understand that the negative experiences they have had, and their reactions to them, are shared one way or another by almost everyone else in the room.

If you do not have the opportunity to engage in a group discussion in a classroom setting, find friends or relatives whom you trust to respect your feelings, and induce them to talk about their own experiences of math anxiety and to listen to yours.

Once you have taken possession of your math anxiety in this way, you will be ready to implement the strategies outlined below.

STRATEGIES FOR STUDYING MATHEMATICS

 athematics has features that set it apart from almost any other scholastic discipline. On the one hand, correctly manipulating the notation to calculate solutions is a skill that is achieved through practice. On the other hand, such skills are really only the surface of mathematics, as an understanding of the concepts is needed, as well. Consequently, the contemplation and comprehension of mathematical *ideas* must be our ultimate goal.

In view of mathematics' unique character, the successful student must devise a special set of strategies for accomplishing academic goals, including strategies for lecture taking, homework, and exams. We will examine each of these in turn. Keep in mind that these strategies are *suggestions*, not laws for everyone, and each student must find for him or herself the best way to implement these ideas.

TAKING LECTURES

Math teachers are a mixed bag, no question, and it's easy to criticize, especially when the criticism is justified. If your own math teacher really connects with you, really helps you understand, terrific – be sure to let him or her know. But if not, there are a couple of things you will want to keep in mind.

Think what the teacher's job entails. First, a textbook must be chosen, a syllabus prepared, and the material being taught (which your teacher may or may not have worked with in some time) completely mastered. This is before you ever step into class on that first day. Second, for every lecture, there is at least an hour's preparation, writing down lecture notes, thinking about how best to present the material, and so on. This is on top of the time spent grading student work, which can only be done after the instructor works the exercises for him or herself. Finally, think about the anxiety you feel about speaking to an audience, and about your own math anxiety, and then imagine what a math teacher must do: manage both kinds of anxiety simultaneously. It would be wonderful if every instructor were a brilliant lecturer. But even the least brilliant deserves consideration for the difficulty of the job.

The second thing to keep in mind is that getting the most out of a lecture is *your* job. Many students suppose that writing furiously to get down everything the instructor puts on the board is the best they can do. Unfortunately, you cannot both write the details and focus on the ideas at the same time. Consequently, you will have to find a balance. Particularly if the instructor is lecturing from a set text, it may be that almost everything he or she puts on the board is in the text, so in effect it's written down for you already. In this case, make *some* note of the instructor's ideas and commentary and methods, but make *understanding the lecture* your primary focus. One of the best things you can do to enhance the value of a lecture is to review the relevant parts of the textbook *before* the lecture. Then your notes, instead of becoming yet another copy of information you paid for when you bought the book, can be an adjunct set of insights and commentary that will help you when it comes time to study on your own.

Finally, remember that your success is your instructor's success too. He or she wants you to achieve your goals. So develop a rapport with the instructor, letting him or her know when you are feeling lost and requesting help. Don't wait until after the lecture – raise your hand or your voice the minute the instructor begins to discuss an idea or procedure that you are unable to follow. Use any help labs or office hours that are available. If you are determined to succeed and your instructor knows it, then he or she will be just as determined to help you.

SELF STUDY AND HOMEWORK

There you are, just you and the textbook and maybe some lecture notes, alone in the glare of your desk lamp. It's a tense moment. Like most students, you turn to the exercises and see what happens. Pretty soon you are slogging away, turning frequently to the solutions in the back of the book to check whether you have a clue. If you're lucky, it goes mostly smoothly, and you mark the problems that won't come right so that you can ask about them in class. If you're *not* so lucky, you get bogged down, stuck on this problem or that, while the hours slide by like agonized glaciers, and you miss your favorite TV show, and you think of all the homework for your other classes that you haven't got to yet, and you begin to visualize burning your textbook . . . except that the stupid thing cost you 80 bucks . . .

Let's start over. There you are, just you and the textbook and maybe some lecture notes, alone in the glare of your desk lamp. Relax. What are you here for? For whom are you doing this homework? Your teacher? Your parents? No, homework is for you, and you alone. It is your opportunity to learn, and to begin to gain mastery – and *that* is what you are here for. Not a grade – knowledge.

Presumably, your instructor has just lectured the material, but have you read the material in the textbook yourself yet? You haven't? Then do so. Reading the textbook is something practically no student does, yet it can make a world of difference in how difficult the material seems to you.

When reading a textbook, remember that it is not a novel, nor indeed like any other kind of book. Written math is *dense*. Each paragraph – sometimes even each line – contains deep ideas, which may require a novel way of thinking to understand. It may take you 20 minutes or longer just to absorb and understand a single page. That is normal.

Read it with blank paper available and a pencil in your hand. Work through the examples yourself, until you thoroughly understand each step. Writing things down is far more effective than highlighting or underlining. Read the footnotes. After you have done these things, *then* you are ready to look at the exercises. (NB: If you are reading a college-level text, it may be helpful to familiarize yourself with the Latin terms and Greek letters commonly used in mathematics.)

Many instructors (but not all) encourage their students to work together on homework problems. Modern learning theories emphasize the value of doing this, and I find that students who collaborate can develop a synergy among themselves which supports their learning, helping them to learn more, more quickly, and more lastingly. Find out how your instructor feels about this, and if it is permitted find others in class who are interested in studying together. You will still want to put in plenty of time for self-study, but a couple of hours a week spent studying with others may

be very valuable to you.

WORKING PROBLEMS

Most problem sets are designed so that the first few problems are rote, and look just like the examples in the book. Gradually, they begin to stretch you a bit, testing your comprehension and your ability to synthesize ideas. Take them one at a time. If you get completely stuck on one, skip it for now. But come back to it. Give yourself time, for your subconscious mind will gradually formulate ideas about how to work the exercise, and it will present these notions to your conscious mind when it is ready.

As an experienced math instructor, it is my sad duty to report that about a third of the students in any given class, on any given assignment, will look the exercises over, and conclude that they don't know how to do it. They then tell themselves, "I can't do something I don't understand," and close the book. Consequence: no homework gets done.

About another third will look the exercises over, decide that they pretty much get it, and tell themselves, "I don't need to do the homework, because I already understand it," and close the book. Consequence: no homework gets done.

Don't let this be you. If you've pretty much already got it, great. Now turn to the hard exercises (whether they were assigned or not), and test how thorough your understanding really is. If you are unable to do them with ease, then you need to go back to the more routine exercises and work on your skills. On the other hand, if you feel you cannot do the homework because you don't understand it, then go back in the textbook to where you do understand, and work forward from there. Pick the easiest exercises, and work at them. Compare them to the examples. Work through the examples. Try doing the exercises the same way the examples were done. In short, *work* at it. You will learn mathematics this way – and in no other way.

STORY PROBLEMS

Everybody complains about story problems, sometimes even the instructor. One is tempted to feel that math is hard enough without some sadist turning it into wordy, dense, hard-to-understand story problems. But again, ask yourself: "Why am I studying math? Is it so that I'll always know how to factor a quadratic equation?" Hardly. The study of math is meant to give you power over the real world. And the real world doesn't present you with textbook equations, it presents you with story problems. Your boss doesn't tell you to solve for x, he tells you, "We need a new supplier for flapdoodles. Bob's Flapdoodle Emporium wholesales them at $129 per gross, but charges $1.25 per ton per mile for shipping. Sally's Flapdoodle Express wholesales them at $143 per gross, but ships at a flat rate of $85 per ton. Figure out how each of these will impact our marginal cost, and report to me this afternoon."
The real world. Personally, I love story problems – because if you can work a story problem, you know you really understand the math. It helps to have a strategy, so you might want to check out the Solving Story Problems article in the PRIME sometime soon.

TAKING EXAMS

For many students, this is the very crucible of math anxiety. Math exams represent a do-or-die challenge that can inflame all one's doubts and frustrations. It is frankly not possible to eliminate all the anxiety you may feel about exams, but here are some techniques and strategies that will dramatically improve your test-taking experience.

1. **Don't cram.** The brain is in many ways just like a muscle. It must be exercised regularly to be strong, and if you place too much stress on it then it won't function at its peak until it has had time to rest and recover. You wouldn't prepare for a big race by staying up and running all night. Instead, you would probably do a light work-out, permit yourself some recreation such as seeing a movie or reading a book, and turn-in early. The same principle applies here. If you have been studying regularly, you already know what you need to know, and if you have put off studying until now it is too late to do much about it. There is nothing you will gain in the few hours before the exam, desperately trying to absorb the material, that will make up for not being fresh and alert at exam time.

2. **Have breakfast on exam day.** The brain consumes a surprisingly large number of calories, and if you haven't made available the nutrients it needs it will not work at full capacity. Get up early enough so that you can eat a proper meal (but not a huge one) at least two hours before the exam. This will ensure that your stomach has finished with the meal before your brain makes a demand on the blood supply.

3. **When you get the exam, look it over thoroughly.** Read each question, noting whether it has several parts and its overall weight in the exam. Begin working only *after* you have read every question. This way you will always have a sense of the exam as a whole. (Remember to look on the backs of pages.) If there are some questions that you feel you know immediately how to do, then do these first. (Some students have told me they save the easiest ones for last because they are sure they can do them. This is a mistake. Save the *hardest* ones for last.)

4. **Don't panic.** It is extremely common to get the exam, look at the questions, and feel that you can't work a single problem. You see everyone else working, and become certain you are doomed. Some students will sit for an hour in this condition, ashamed to turn in a blank exam and leave early, but unable to calm down and begin thinking about the questions. This initial panic is so common (believe it or not, most of the other students taking the exam are having the same experience), that it's just as well to *assume ahead of time* that this is what is going to happen. This gives you the same advantage as when the dentist alerts you that "this may hurt a little." Since you've been warned, there's far less tendency to have an uncontrollable panic reaction when it happens.

   So say to yourself, "Well, I may as well relax because I expected this." Take a deep breath, let it out slowly. Do this a couple of times. Look for the question on the exam that most resembles what you know how to do, and begin poking it and prodding it and thinking about it to see what it is made of. Don't bother about the other students in the room – they've got their own problems. Before long your brain (remember, it's a muscle) will begin to unclench a bit, and some things will occur to you. You're on

your way.

5. **Work efficiently. Math exams are usually timed, but enough time is usually given. Pace yourself – don't dally, but don't race.** Be smart about your work by being methodical and complete in your solutions. Box, circle, or underline your answers where appropriate. If you don't take time to make your work neat and ordered, then not only will the grader have trouble understanding what you've done, but you can actually confuse yourself – with disastrous results. If you get stuck on a problem, don't entangle yourself with it to the detriment of your overall score. After a few minutes, move on to the rest of the exam and come back to this one if you have time. And regardless of whether you have answered every question, give yourself at least two or three minutes at the end of the exam period to review your answers. The "oops" mistakes you find this way will surprise you, and fixing them is worth more to your score than trying to bang out something for that last, troublesome question.

6. **SHOW YOUR WORK.** In math, having the right answer is nice – but it doesn't pay the bills.

7. F**inally, put things in perspective. Check your fear at the door.** Fear of the exam will make it seem like a much bigger deal than it really is, so remind yourself what it does *not* represent. It is not a test of your overall intelligence, of your worth as a person, or of your prospects for success in life. Your future happiness will not be determined by it. It is only a math test – it tests nothing about you except whether you understand certain concepts and possess the skills to implement them. You can't demonstrate your understanding and skills to their best advantage if you panic through making more of it than it is.

8. **Learn from your mistakes.** When you get the exam back, don't bury it or burn it or treat it like it doesn't exist – use it. Discover your mistakes and understand them thoroughly. After all, if you don't learn from your mistakes, you are likely to make them again.

AFTERWORD

ath anxiety affects all of us at one time or another, but for all of us it is a barrier we can overcome. In this article we have examined the social and educational roots of math anxiety, some common math myths associated with it, and several techniques and strategies for managing it. Other things could be said, and other strategies are available which may help you with your own struggle with math. Talk to your instructor and to other students. With determination and a positive outlook – and a little help – you will accomplish things you once thought impossible.