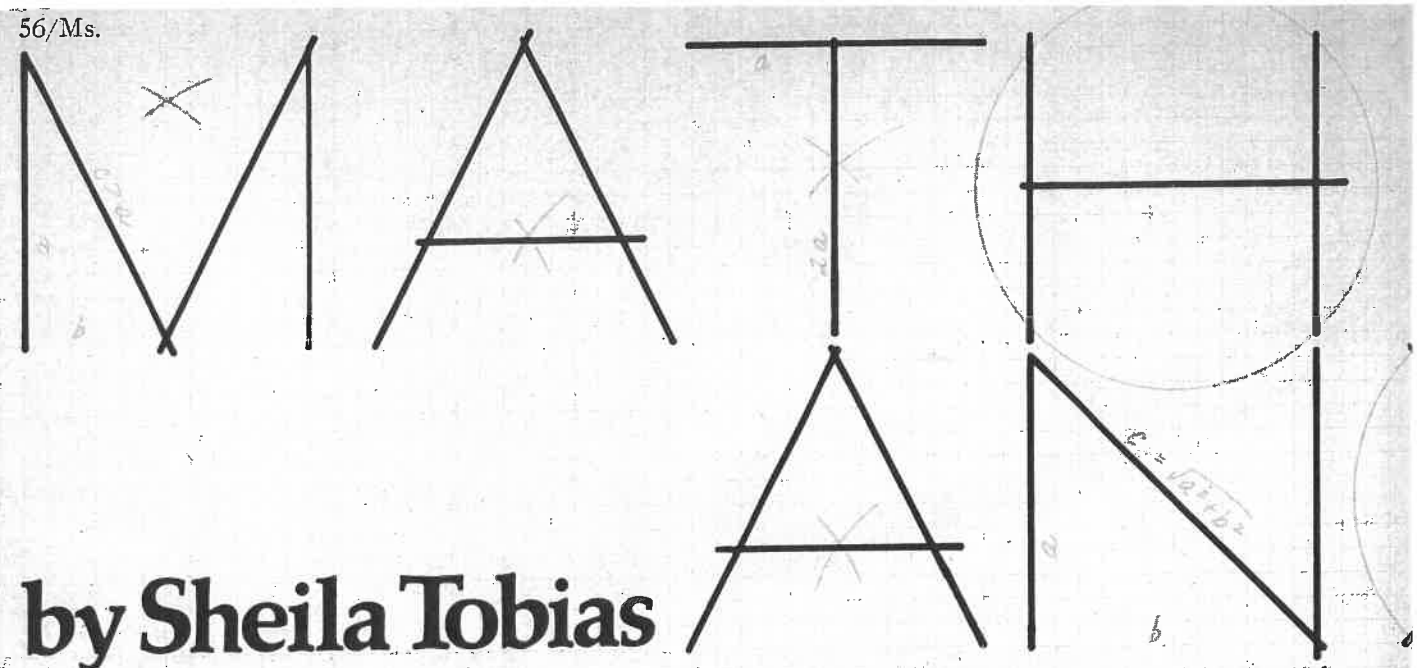


MATH

by Sheila Tobias

The young instructor stood in front of the group of students, faculty, and administrators. "I'd like you to do a simple subtraction in your heads" he said. "A woman is thirty-eight, and this is 1976; in what year was she born?" The group was nervous. Was this a test? Were they going to have to compete with one another for the right answer? Should they raise their hands? He wanted none of this. "Just do the problem in your head; don't tell me the answer. But be prepared to tell me how you came up with it." Everyone relaxed. Somehow, if no "right answer" were being demanded, it was easier to comply. And so it began.

As each person told how she or he had subtracted 38 from 76, the mood of the group shifted from incredulousness to laughter. "I had that certain feeling I had to get to the nearest ten," admitted one adult man. "And so I subtracted seventy-six from eighty and thirty-eight from forty and then adjusted my answer to account for what I had done." "I took my own age," a woman in her thirties recounted, "and knowing when I was born, I subtracted the difference between the ages and had the answer." "I wrote the subtraction on a blackboard in my mind," said a third, "and then 'did' the problem the way I was taught in school." Around the room the instructor went. No two had done the problem quite the same way. People were stunned at the ingenuity of others' methods but each found her or his own perfectly reasonable. Mostly everyone laughed, first at the others, then at themselves.

"All these methods," the instructor finally commented, "represent perfectly good algorithms—systems for finding answers in a definite way. Few of you used the method you had been taught in school and most of you were ashamed that you did not. You think there's something wrong with having to get to the nearest ten. But there isn't. It's okay so long as it's correct and you're comfortable with it. And what's comfortable for you may not make the next person comfortable.

Everyone felt better.

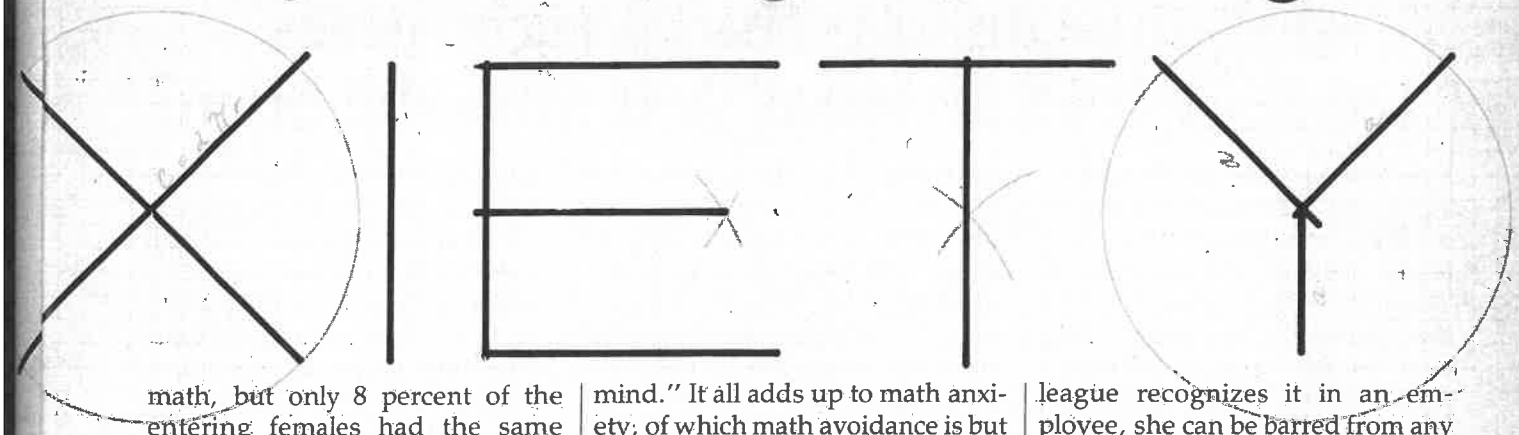
The instructor went on to teach a number system, used by the Incas, which is based on five and involves many different ways of handling symbols. Later, he played some three-dimensional ticktacktoe. And he explained how confusing it is to learn arithmetic in elementary school when as a child in kindergarten you are told unequivocally that zero is "nothing"; in first grade that it is a "place-holder"; and in fifth grade that you can't divide by zero. No wonder you didn't learn arithmetic, he implied: you were too smart, too bothered by inconsistency, too creative, to ingest all this nonsense.

The "class" was an experimental demonstration and discussion of math anxiety, a condition that disproportionately affects females and racial minorities of both sexes; and the goal of the series was to find out more about math anxiety and to begin to search out ways of overcoming it.

Some of us teachers attending that first class had become intrigued with the problem of "math avoidance" during the previous year. We had been noticing great reluctance on the part of women college students to take courses that required or might require at a later stage either calculus or heavy use of algebra or rigorous statistics. Some of our students were even contemplating changing their majors to avoid math prerequisites. Adult women, too, who came for vocational counseling, were entirely unwilling to contemplate new careers having to do with data or with "things." They wanted to work with people, they said plaintively. At first we accepted this at face value, understanding that having been socialized as women, they felt at home in the helping professions. But when feminist sociologist Lucy Sells reported on the inadequate math preparation of entering Berkeley students, the pieces of the puzzle began to fit into place.

Of the entering class at Berkeley in 1973, Sells reported that 57 percent of the males brought with them four years of high school

Why is a smart girl like you counting on your fingers?



math, but only 8 percent of the entering females had the same preparation. Thus, 92 percent of the women in the first-year class were not even eligible to take any calculus or intermediate level statistics course. Moreover, all but five of the 20 majors at Berkeley in the early 1970s required either calculus or statistics. Women, then, were crowding themselves into the remaining five fields (the humanities, music, social work, elementary education, guidance and counseling), not only because of sex-role socialization but because of math avoidance.

If math avoidance were the result only of poor guidance counseling at the secondary school level, then the solution would be relatively simple: just get the word out that the social sciences have become "mathematized" over the past two decades, that business requires at least a familiarity with operations research, and that almost every administrative job will involve some work with budgets, financial statements, and comparisons of rates of change. Then girls and women would flock to remedial math classes and the problem would soon be solved. The problem was far more serious—growing out of a culture that makes math ability a masculine attribute, that punishes women for doing well in math, and that soothes the slower math learner by telling her she does not have a "mathematical mind." It all adds up to math anxiety; of which math avoidance is but a symptom.

Math anxiety is an "I can't" syndrome, and whenever it strikes—for some as early as sixth grade, with word problems; for others, with the first bite of algebra; for still others, not until calculus or linear algebra or statistics, after a high school record of achievement in mathematics—it creates the same symptoms and response. "I can't do this. No amount of practice or trying will make it work for me. I never really understood math. I always memorized and got away with it. Now I've hit the level I always knew was there. I can't do it."

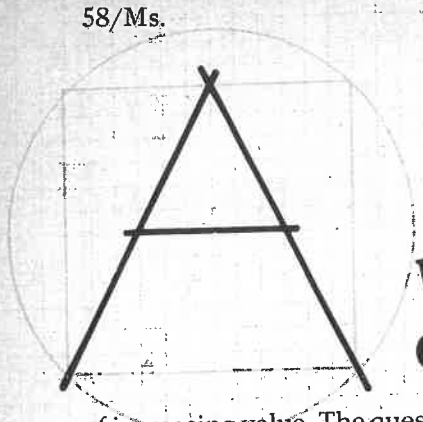
Once a person has become frightened of math, she or he begins to fear all manner of computations, any quantitative data, and words like "proportion," "percentage," "variance," "curve," "exponential." Some students think that a simple table in a history textbook, showing, say, yields of a crop, by year, is "mathematics," and therefore inaccessible. Unless the same information is presented in a series of declarative sentences, they are uncomfortable with it.

Math anxiety is a serious handicap. It is handed down from mother to daughter with father's amused indulgence. ("Your mother never could balance a checkbook," he says fondly.) Then, when an employer or a colleague recognizes it in an employee, she can be barred from any endeavor or new assignment by the threat that the new job will involve some work with "data or tables or functions."

What can be done about this syndrome? We at Wesleyan University in Connecticut are developing one project that may help cure the symptoms, if not the causes. With the assistance of a grant from the Fund for the Improvement of Post-Secondary Education (Department of Health, Education, and Welfare) in Washington, D.C., we have opened a "Math Anxiety Clinic," for undergraduates and adults. It is intended to be a place where people who admit that they are unable to cope with their math problems can be diagnosed, tested, interviewed, and helped in a variety of ways, including therapy and counseling.

Since the problem seems to be emotional as well as cognitive, one-to-one discussion in a nonthreatening and supportive atmosphere is essential to the process—as is unhurried probing of the client's memories about how she first learned math in elementary school.

One student confessed in such a session never to have understood why, when fractions are multiplied (1/5 x 1/4, for example), the answer is always a still smaller fraction. It didn't fit with what she had been taught about multiplying as a way



woman is thirty-eight years old. In what year was she born?

of increasing value. The question is a good one, yet she never had the courage to ask it because, like many female students, she felt so alienated in the math classroom that she was inhibited by a fear of appearing both too smart and too dumb. Or she assumed, incorrectly, that everyone else in the class understood the issue that was bothering her, and, embarrassed, she hid her question.

The classroom is not the sole locus for math learning. The child who is precocious in math comes in with some previous understanding; other children get help at home. Since from seventh grade on, girls tend to go for help in all subjects to their mothers (and boys to their fathers), it is likely that the mother's math problems are directly passed on to her daughters, and she cannot give them the help they require.

Another explanation is that the ability to do math beyond computations is correlated with the ability to do spatial relations. Spatial relations tests usually show two- or three-dimensional objects in one view and require that another view of the same object be "visualized." Females at all ages tend to do more poorly than males in spatial relations. It is possible that boys are better because they play with building toys and get involved in taking apart and putting back together all manner of things, from broken toys to clocks and eventually automobiles. In the process, spatial relations ability may well be increased. But since spatial relations is not taught in school, there is no way for girls to get this experience.

This observation raises some interesting questions about the design and function of the elementary school curriculum. If girls come to school with more highly developed verbal skills than boys, then the verbally oriented elementary school curriculum would provide them with rather easy tasks, tasks that soon become boring. Boys, with poorer verbal skills, are being provided in elementary school with precisely what they need. Though the curriculum may be more difficult for them at the outset, they pick up much needed skills in elementary and junior high school, and are able to exceed females in general achievement by age 17. (In a recent longitudinal study of the school achievements of 900,000 children [*Time* magazine], it was pointed out that at age nine, girls and boys are about equal in all school subjects, but that by age 17 boys have far exceeded girls in all but creative writing and music.)

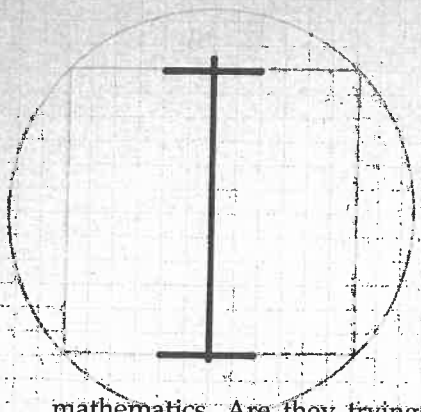
If there is some link between good spatial relations ability and math learning, then one of the objectives of a math anxiety clinic might be the teaching or perfecting of spatial relations ability. Lenore Blum, head of the mathematics department at Mills College in Oakland, California, an all-women's college, has had considerable success in a precalculus workshop where she has her students become familiar with graphic representations of algebraic functions. In this way, they become "fluent" in the new (to them) language of analytic geometry. Since this is done *before* the students go on to calculus, where competence in confronting these curves is a critical part of mastering the subject, they do much better in college math. In traditional calculus courses, the analytic geometry and the calculus are taught concurrently, making it doubly hard for women who may find the curves alone so off-putting that they never get to the calculus itself—and, worse yet, never understand what it is that got in their way.

Blum does not believe that the approaches to math anxiety need be either psychological or remedial. The Mills College course introduces new and exciting concepts related to the calculus and relies upon peer-taught workshops to provide individual help and a support system. Blum and her colleagues believe that anxiety can be substantially reduced if women and girls have at least one positive experience in learning math.

This kind of effort has rarely been undertaken before, possibly because math anxiety is primarily a woman's problem, and therefore unworthy of attention. Another reason is that there is a widespread social belief that mathematical aptitude is inborn, granted only to a few geniuses. Part of the work of a math clinic is to persuade learners, teachers, and those who make educational policy that "mathematical abilities are accessible by the majority, if properly taught and if accompanied by the right kinds of support."*

The psychological or emotional components of math anxiety are harder to pinpoint but should not be underestimated. Some of our clients are daughters of math professors or engineers; men who have talent and interest in

*Lazarus, Mitchell. "Mathophobia: Some Personal Speculations," in *The Principal* (January/February, 1974).



always knew I couldn't really do math. I memorized and got away with it. But sooner or later, I knew I'd be found out."

mathematics. Are they trying too hard not to identify with their fathers? Others of our students are deeply fascinated by math and science, but go to great lengths to deny this interest because it is "masculine," or because it will make them too unusual. One woman student, who graduated a year ago, went through three years as an English major before taking her first science course, certain, as she admitted later, that she would be "hooked on" science if she ever "let herself" take one course. She was hooked indeed; she is now in medical school.

Peer influence also is not to be discounted. In a very provocative brochure on "Math and Sex," written two years ago under the supervision of statistician John Ernest of the University of California at Santa Barbara, it is reported that through elementary school, girls and boys tend to think that their own sex does better in all subjects; by high school both boys and girls assume that boys do better in math. Moreover, when asked why they do poorly on a math exam, high school girls tend to attribute their failure to lack of ability, while high school boys (of the same capability) usually say they did not work hard enough. "The attitudinal patterns of both self-image and peer group," Ernest's team concluded, "are unfortunately reinforced by those of the teacher." Both female and male teachers believe girls do less well than boys in math, even when the female teacher herself may like and even have specialized in math.

Despite such assumptions, there is no known connection between the sex gene and "dyscalculia," an actual brain dysfunction in performing calculations (comparable to dyslexia, which prevents visual decoding of word symbols). Moreover, Mitchell Lazarus, a specialist in math learning at the Education Development Center in Newton, Massachusetts, notes that what Jerrold Zacharias of the Massachusetts Institute of Technology some years ago named "mathophobia" is very common in people who are fully capable of elementary arithmetic though they may dislike it.

Lazarus is particularly insightful in his description of how mathophobia develops (though he seems to be insufficiently sensitive to the special aspects of mathophobia in women):

. . . mathophobia can pass through a latency stage before becoming manifest . . . consider the plight of a high school student who has always relied on the memorize-what-to-do approach. Because his grades may have been satisfactory, his incipient problem may not be apparent to anyone, including himself; he may not even know that there is any other way to learn mathematics. But the time and effort that his approach demands will increase dramatically through high school, subjecting the student to a constantly increasing strain. Moreoever, since it has now been some years since he last understood what he was doing, he is in no position to switch over to the more appropriate strategy of actually comprehending the material . . . he simply lacks the necessary knowledge . . . When his grades finally drop, as they must, even his teachers are unlikely to realize that his problem is not something new, but has been in the making for years. And at this point, it is doubtful that casual, remedial work would accomplish much, because the student needs nothing less than a complete reeducation in mathematics.

Others argue that without a complete reeducation in mathematics, little can be done for math anxiety. But we are still looking for simpler ways of unlearning poor early training and relearning arithmetic at a higher level of sophistication. Knowles Dougherty, a consultant to our project, believes that we should study Oriental-American children who, through their traditional games played at home and their facility with the abacus, which requires the learning of a table of simple division, are far more advanced in math concepts than other American children at the elementary school level.

Whatever the causes of math anxiety may be, the cure presupposes a highly specific diagnosis of an individual's problem, including an attempt to do a kind of "cognitive map" of the person. Such a "map" could indicate whether she or he might better learn math through words (highly verbal, low spatial, medium numerical); through pictures (highly spatial, low verbal, low numerical); or through numbers, that is, through a method suited to her or his own personal cognitive strengths and weaknesses. Imagine numbers being introduced as either:

One, two, three, four, . . .; or
1, 2, 3, 4, . . . ; or
-+--+---+----. . .

At Wesleyan, a considerable proportion of our resources are being put into the diagnostic aspect of

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math anxiety. Students talk about their associations with math ("How did you feel when you entered this room today?") and their last positive math experience. The client may balk at in-depth analysis, or resist a thorough reeducation ("I only want to learn enough to understand the demand curve in my introductory economics course. No more than that.") And the quit-rate also is high.

In addition to diagnosis, we offer "standard" remedial sessions, reviewing algebra for the most part, though the instructors are willing to go back to fractions, percents, and long division if necessary; and "nonstandard" remedial work, still in the design stages. It is here that some development in spatial relations ability, or game-playing with math concepts may take place. Somewhere along the line, math has got to become fun, as well as make sense.

There is some risk that in focusing on math anxiety in women, feminist educators may unintentionally support the prejudice and discrimination against women mathematicians. It should be understood that currently about 10 percent of the Ph.D.s in mathematics are earned by women. But there is no question that math anxiety is a significant handicap for most women, since nearly every important issue of the day has a strong mathematical component. From a feminist perspective, mathematical literacy is a way to demystify the world. We feel that if we could develop a cure for math anxiety and "bottle" it for women engaged in self-help activities, these women would show increased self-reliance and with it increased self-esteem.

Sheila Tobias, Associate Provost of Wesleyan University, is codirector with Professor Robert Rosenbaum of the Math Clinic at Wesleyan University. The clinic is staffed by a learning disabilities counselor, Bonnie Donady, and Dr. Steven Shmurak, Jean Smith, and Susan Auslander.

A collection of papers on math anxiety may be obtained for $3 from Sheila Tobias, Associate Provost, Wesleyan University, Middletown, Connecticut 06457.

THE NEW NEW MATH

A few programs have begun to concentrate on improving the attitudes and achievement of very young women *before* math anxiety takes hold. "Math for Girls" is an eight-week, discovery-oriented course for 6- to 14-year-old girls, conducted by Nancy Kreinberg and Rita Liff at the Lawrence Hall of Science, University of California, Berkeley, Calif. 94720.

Several one-day conferences and seminars aim to stimulate high school girls' awareness of the variety of math-related fields open to them. On October 23, 300 seventh- to twelfth-grade girls will participate in math and science workshops, discussions, and lectures that are the second in a series of such conferences at Mills College, Oakland, Calif. 94613.

The Mathematical Association of America has established a visiting lectureship program, "Women and Mathematics," geared to tenth-grade girls. Regional information can be obtained from Eileen L. Poiani, St. Peter's College, Jersey City, N.J. 07306.

Several colleges have either full curriculums or workshops to prepare women students for entry into the calculus sequence required for advanced work in science and math. Contact Professor Lenore Blum, Department of Math and Computer Science, Mills College, Oakland, Calif. 94613, for information about the "Women in Science" program there. Lillian Faderman, Assistant Vice President for Academic Affairs, California State University, Fresno, Calif. 93740, can provide information about that university's tutoring and counseling program. A "Discovery Course in Elementary Mathematics and Its Applications" is part of a pilot program directed by Alice Schafer, Mathematics Department, Wellesley College, Wellesley, Mass. 02181. The program's aim is to develop new models for teaching math.

Information about a one-week course or a week-end course for math-anxious women can be obtained from Ruth Afflack, Department of Mathematics, California State University, Long Beach, Calif. 90840. Information about an introductory math sequence for women is available from Professor Carolyn MacDonald, Physical Science Program, University of Missouri, Kansas City, Mo. 64110. *–Nancy Kreinberg*

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says. "Later on, back at my apartment, we began to make love. Then while we were still clothed, but when I was highly aroused, he got up, said it was fine to see me, and abruptly left. I know this might sound like an overreaction, but I respect my instincts and I'm convinced that he planned the whole evening to hurt me. I know he has always been jealous of the close relationship between me and my friend (who, incidentally, doesn't give a damn about sexual fidelity) and I am certain he planned the aborted sexual exchange as a vindictive act. It made me realize that with my awakened interest in sex, men can use it as a weapon against me, just as effectively as, traditionally, women were supposed to use it against men."

Obviously, there is still a great deal of distrust and misunderstanding among women and men vis-à-vis sex. But with more women choosing to face men as sexual equals, a growing rapprochement may be in the works. As one 25-year-old woman speculated: "Since men were always on the advancing side when it came to sex, I think I grew up assuming that men were always ready for, always wanted, sexual contact. So at first it threw me that a man could actually *not* want to make love to me if I indicated that I would be receptive and responsive to his advances. It made me reassess my assumptions about male sexuality, which was ultimately a good thing. I think it's as important that we rethink our inbred assumptions about them as it is that they rethink their assumptions about us."

A sexually fearless free-lance artist stated her growing empathy with men quite plainly: "Now I know how all those teenage boys felt when they called me for a date and I said I was 'busy.' "

Bette-Jane Raphael is an editor at "Working Woman" magazine, an actress, and a free-lance writer.