New Directions

Volume 11 | Issue 1 Article 3

10-1-1983

Women & Mathematics

Harriet Jackson Scarupa

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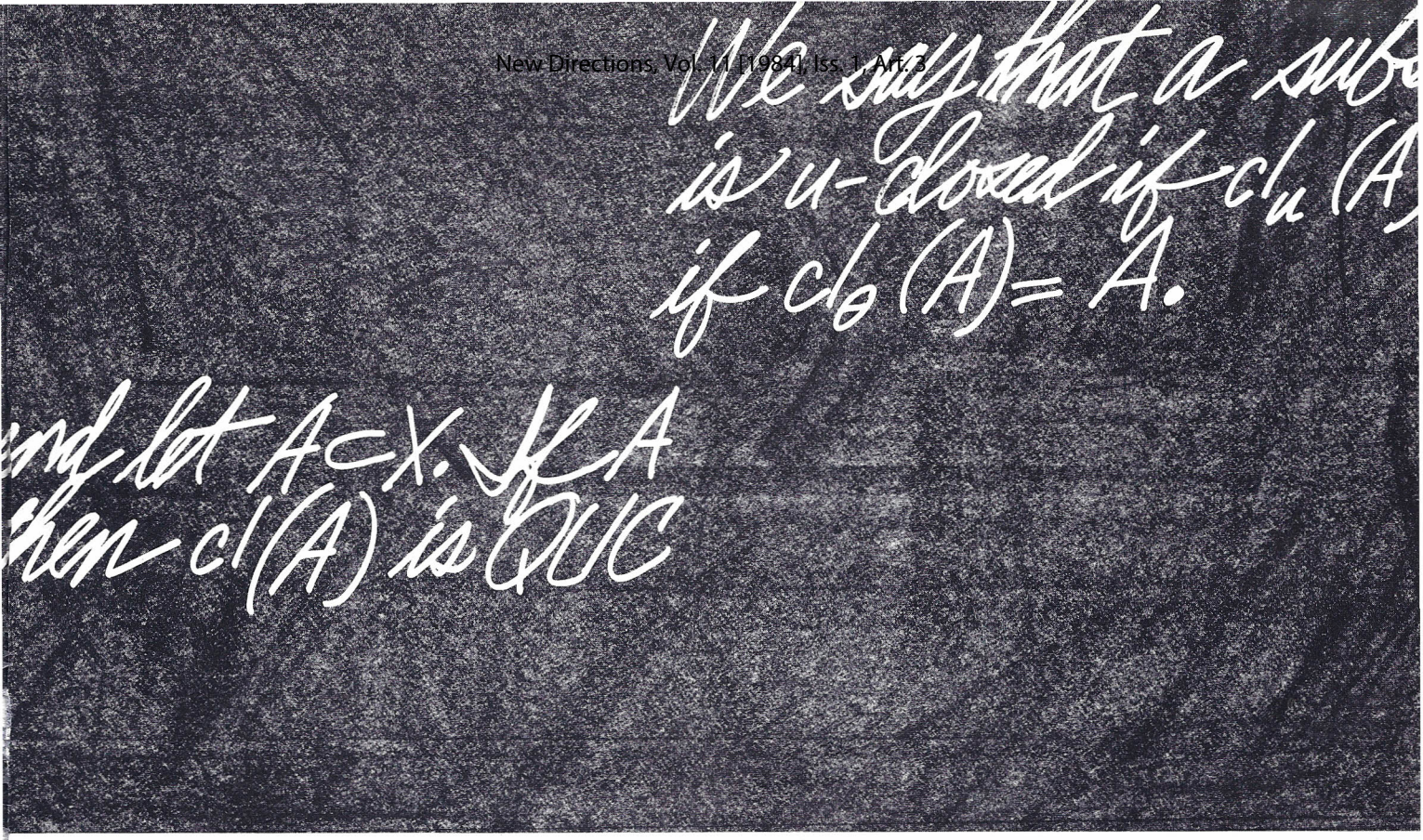

ILLUSTRATION BY ERIC MARLOWE

Women & Mathematics

By Harriet Jackson Scarupa

Johnny builds with blocks. Susie plays with dolls. Johnny works on puzzles. Susie works on her nails. Johnny reads science fiction stories. Susie reads pre-teen romances. Johnny joins a computer club. Susie takes ballet.

Johnny fails a math test. Dad's response: "I don't want to hear any excuses; buckle up."

Susie fails a math test. Dad's response: "Just like your mother; she never could balance a checkbook."

That's why Dad helps with the math homework, anyway, while Mom helps with the English.

In high school Johnny takes algebra, geometry, trigonometry and precalculus. Susie takes general math.

Johnny's teachers and counselors encourage his math interests. Susie's are indifferent.

Johnny begins to think of math as "fun." Susie "hates" it. But even if she didn't she wouldn't admit it because the other kids might call her a weirdo.

In college Johnny takes more math so he can prepare for a scientific, technical or medical career. Susie says she "wants to work with people" so she doesn't need math. Besides, she's scared to death of math; it's too hard, too complicated and if she were to show she was adept at it she'd never never get a date on Saturday nights....

Such a scenario, exaggerated as it is, could go on and on. What it dramatizes, of course, are two corollary perceptions relating to mathematics and sex: 1) mathematics is a male domain; and 2) a woman who shows an interest and facility in mathematics is somehow unfeminine, weird, too brainy for her own good.

That these two perceptions are still in force — even in this math-dependent technological age — may go a long way towards explaining the notable underrepresentation of women in the mathematical sciences.

According to the National Science Foundation, in 1981, for instance, women accounted for only 22 percent of the mathematical scientists in the nation. They held 8 percent of the doctorates in the mathematical sciences, 21 percent of the master's degrees and 27 percent of the bachelor's degrees.

Or consider another example, this from the American Mathematical Society: of 9,362 math faculty members employed by four-year colleges and universities in the 1982-83 academic year, only 700 in the entire nation were women.

At Howard University during that same year 7 of 32 full-time faculty members in the department of mathematics were women, notes department chairman James Donaldson. The number might not seem startling — until you look again at those national statistics. "You've got an extremely unusual situation here," remarks Solveig Espelie, one of the seven full-time women faculty members in question. "Many math faculties have no women at all."

Why the higher percentage at Howard? "Maybe," suggests Myung He Kwack, another of the seven, "it's because people

are more open, less biased against women here." There's no maybe about it, says her colleague Louise Raphael. "At Howard they don't look at your person; they look at your work. I think other schools do that too but somewhere along the line women are not taken as seriously."

Donaldson himself sees a link between the receptiveness toward women mathematicians at Howard and the university's overall character: "I think the higher percentage of women teaching mathematics at Howard has quite a bit to do with the fact that Howard University's student body and faculty is made up, for the most part, of members of minority groups and I think we have a better understanding of the problems facing members of disadvantaged groups than some other institutions.

"And women have been disadvantaged in mathematics. There's no question about it. They've faced discrimination and prejudice. That whole old boy's network and all of that certainly doesn't do much to try to bring about change in the way things are."

Recent Studies

In recent years studies relating to the "problem" of women and mathematics have proliferated. [See "The Problem of Women and Mathematics," a booklet written by Lynn H. Fox and published by the Ford Foundation, for a handy synopsis of these studies.] One, for instance showed that boys and girls display equal aptitude and achievement in math in grade school, but that "something happens" after that to cause boys to surge ahead.

In trying to account for what it is that "happens," researchers have suggested a variety of reasons, among them:

Boys take more mathematics in high school and college (so, naturally they will display better mathematical performance and be more math-oriented in general.)

Covertly or overtly, teachers, counselors, parents and peers tend to discourage women from pursuing mathematics.

More females than males exhibit math anxiety, that confidence-stripping "I can't" syndrome, when confronted with anything mathematical.

Women's sense of values—specifically a strong sense of community — is out of sync with mathematics which often requires extreme social isolation.

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The most controversial view along these lines was advanced by two Johns Hopkins University researchers, Camilla Benbow and Julian Stanley. Writing in the December 12, 1980 issue of *Science,* they reported that the mean Scholastic Aptitude Test, SAT, mathematics score of boys in the top two to five percent of a group of seventh and eighth graders was consistently higher than that of girls. They contended that performance on the math SAT is a good measure of natural aptitude for mathematics (because seventh and eighth graders had not been formally taught the underlying principles of the math problems on the test.)

And they concluded: "Sex differences in achievement in and attitude towards mathematics result from superior male mathematical ability." The obvious inference from such a conclusion: women are underrepresented in mathematics because women are biologically less capable of doing mathematics.

No sooner was the Hopkins study publicized when it came under attack. Writing in the January 16, 1981 issue of *Science,* mathematicians Mary Gray of American University and Alice Schafer of Wellesley College pointed out what they saw as the study's two crucial flaws. It did not take into account environmental and cultural factors. "Anyone who thinks seventh graders are free from environmental influences can hardly be living in the real world," they wrote. What's more, they said, there was no clear evidence that math SAT scores constitute a good measure of inherent math ability.

Putting it even more bluntly, Sheila Tobias, author of "Overcoming Math Anxiety," told a *Newsweek* reporter: "If your mother hates math and your father tells you not to worry your pretty little head about it, do you think that a math test would be an accurate measure of your ability?"

Meanwhile, two University of Chicago researchers, Zalman Usiskin and Sharon Senk, studied how tenth graders solve geometry proofs (which they viewed as a better determinant of inherent mathematical talent than SAT scores) and they found *no* sex differences in math ability.

No sooner were these results reported and publicized when their study, too, came under attack. The charges and the countercharges go on ... leading many thoughtful onlookers to wonder if all the time and energy involved in fueling the controversy wouldn't be better spent simply trying to encourage more women to go into mathematics.

"There's really a tremendous shortage of mathematicians in this country," observes Donaldson, who also notes that Howard University in 1975 became the only predominantly Black university in the nation to offer a Ph.D. program in the field. "So that's one of the reasons we need more women and more members of minority groups in mathematics.

"But there's another reason and that, of course, is that every group ought to be represented in every profession so that it

would never be thought that one particular profession is for people of a certain gender or a certain race. And the way to counteract this is for young people to see examples of others from their own group who are working in the profession."

Women engaged in mathematics study, research and teaching at Howard don't spend too much time thinking about being Role Models. They're too busy doing their work. But the fact is, they are. We asked some of these intellectually-driven women to tell us what it's like to be in such a male-identified field, why they think women still shy away from mathematics and what should be done about it.

Why were they attracted to mathematics in the first place? What kinds of pressures did they encounter? What kinds of adjustments and sacrifices have they had to make, if any? How did they manage to overcome societal stereotypes in order to follow the pull of their intellects? What kind of advice do they have for others, especially the parents of daughters, about shaping a new generation with an androgynous view of mathematics? Will such a view ever prevail?

Here, then, are some of their stories, their opinions, their insights....

Solveig Espelie

When Solveig Espelie was in high school, she remembers going into the office of the vice principal to find out her scores on some tests. "He looked up the English score and it wasn't so good," she recalls. "He wasn't even going to bother to look up the math score for me because he assumed it would be lower. But he did, and it was significantly higher. He was surprised. It wasn't expected."

Later when she was a math major in college [Luther College in Iowa] and planning to apply to graduate school, she found she had to go through "a careful selection process." "My professor warned me not to apply to any of the large universities in the Midwest because he said they weren't quite ready for women in mathematics," she says. "He said I should go either East or West." [She went East, earning her master's and doctorate from the University of Maryland.]

Then when she began her first job teaching mathematics at a university in Ohio, she found she was the first woman the department had ever hired. "Faculty had to share offices and I understand there was a *big* discussion about which office to put me in."

"My professor warned me not to apply to any of the large universities in the Midwest because he said they weren't quite ready for women in mathematics."

Espelie is now a full professor at Howard, having taught at the university since 1969, and she cites such incidents to show the kind of subtle prejudices women have often encountered in mathematics. That she was not thrown off course by such incidents and the mentality they reflect she attributes to the support she received from her parents and teachers and from her own early interest and achievement in the field. "I suppose I liked math because I did well in it," she remarks. "It's easier to enjoy something when you get a reward, right?"

The reward is still there though her current research field, topology, seems far removed from what goes on in the average grade school or high school classroom. Concerned with general transformations of shapes in which a certain correspondence between points is preserved, topology has often been called "rubber sheet geometry" because it is often illustrated by drawing figures on sheets of rubber and then stretching, shrinking or twisting the rubber. Although research in topology may indeed lead to some practical applications, the field falls under the general category of pure mathematics.

If there are few women in mathematics, there are fewer still in such a seemingly arcane specialty. Espelie thinks this is because "girls aren't pushed; they're funneled out [of math] at an early age. If they're not pushed, if they don't take the right courses in high school, by the time they get to college they're already far behind. The thing about math: it's almost impossible to catch up."

So what's to be done to turn this around? "Parents have to be aware of what's happening in the schools and the attitudes of teachers and counselors," she answers. "Counselors might think that if a girl is planning to major in English in college she really only needs one math class in high school. But that girl may change her mind in college and by then she's already shut out of so many options — science, medicine, engineering, not to mention advanced mathematics."

In Espelie's view, it's the early experiences girls have with mathematics in the classroom that is critical. "I had some grade school teachers who probably steered me into mathematics because I think they really liked math," she says. "Today a lot of teachers in elementary school — and a lot of them, as we know, are women — can't explain what's happening. So the kids are going to get all confused and they're not going to like math either. It's a whole cycle. And we're really messing up now because we're just continuing to put out students [from schools of education] who have less and less math and it frightens me to think that they're going into the schools and teaching our children."

For her, then, the task of encouraging more female students to go into mathematics is intimately linked to the task of improving mathematics education overall. Right now, she sees no shining light at the end of the tunnel: "There's some realization of some of the problems with mathematics education at the lower levels now,

would never be thought that one particular profession is for people of a certain gender or a certain race. And the way to counteract this is for young people to see examples of others from their own group who are working in the profession."

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I think, but I don't know that anyone has really begun to attack these problems."

Until then, women in mathematics may sometimes still feel the way she did when she arrived at that Ohio university: "like an oddity."

Louise Raphael

When Louise Raphael was in college and guys would ask her what her major was, she would hate to say. Once, she admits, she said it was drama. Then there were times when people did know her major and they threw another question her way: "What's a nice girl like you doing in mathematics?"

Raphael laughs today when she thinks about those questions. She is currently an associate professor of mathematics at Howard, having taught at Clark College, the Massachusetts Institute of Technology and several other universities. She holds a Ph.D. in mathematics from Catholic University, is married to a physicist and is the mother of two.

But she still remembers those questions because she believes they reflect the popular sentiment that if a woman excels in a male-identified field like math she'll surely scare away all the men.

Raphael says there's another side to the picture, though, one that is seldom given exposure: "There's something appealing about smart women. Of course there are always men who will be attracted to women just from a physical point of view, but I think the other is more pleasing — to have people want you because of what you know." And her message to younger women: "Brains are attractive."

That was something she realized early on when her parents — especially her father — showered her with praise when she did well in math. She also realized something else early on: that old adage about in-knowledge-there-is-power applies just as well to mathematics as it does to everything else. She found *that* out in second grade:

"It was a Catholic school and the nun taught us a way to subtract and she didn't explain it correctly. What she said and what she was doing were two different things — and I could not subtract. So I went home and my father showed me how. His method, though, was different from hers and she wouldn't let me use his method. But I was able to figure out how his method was equivalent to hers and how she should have explained subtraction in the first place. Then I realized I knew more than she did. And that sort of thing kept happening in math. I would see things the teachers wouldn't see. . . I know that sounds strange."

Her own childhood experiences showed her how being able to do mathematics — and do it well — can boost self-assurance, which is something she tries to communicate to her students today. "If a problem is hard and the students know it's hard and you can get them to solve it easily, they will have self-confidence," she says. "That, to me, is one of the general purposes of mathematics."

Mathematics, for Raphael, is also, quite simply, "fun." "It's not work. It's playing around with concepts," she says. Her research deals with summability theory, eigen function expansions and approximation theory. The first is concerned with the addition of infinite numbers and can be applied to the second which involves determining the right answer from data points. The third relates to approximating answers to mathematical problems, an area of reseach currently being supported by a grant from the U.S. Army Research Office. Most of this research bridges the gap between pure and applied mathematics. Approximation theory, for instance, is used in the development of weapons, lasers, airplanes.

In such fields, too, there are very few women investigators. And Raphael, too, has stories to tell about the kind of subtle prejudices a woman in an essentially male world can encounter.

Like the time she was at an international conference on differential equations and the conference organizer introduced her as someone who had traveled on the same train with him instead of as a fellow mathematician.

Or the time at another conference when a well-known foreign mathematician asked her to make numerous phone calls for him to arrange lecture dates, a quasi-secretarial chore he didn't dream of imposing on a male colleague.

"What's a nice girl like you doing in mathematics?"

Or the response she sometimes gets when she delivers a paper: "I can tell that the male mathematicians are really listening hard. But in the interaction afterwards, they say 'nice talk,' and then go on to tell me about work *they* did. Now, normally, when you're really interested in someone's work you'll want to talk about it."

Such irritations are likely to continue until women who do advanced research in mathematics are the norm instead of the exception. Raphael agrees that day wil not arrive until mathematics instruction in elementary school, junior high and senior high is improved. Meanwhile she believes parents can help their children — boys *and* girls — to become more mathematically sophisticated by keeping tabs on what's going on in their children's math classes, by providing their children with mind puzzle games, computer exposure, subscriptions to science magazines and the like.

But even with her helpful hints to parents and her own strong "brains are attractive" message, Raphael has no real answer to the sticky question of how to combat societal conditioning. "Girls still think it's better to say, 'Oh, I can't do my math' just to be popular," she says "My own [15-year-old] daughter does it. . . . She told me she'll take four years of math not because she likes it but because she thinks it will be useful."

Fern Hunt

Of course, mathematics is useful, Fern Hunt would proclaim. An assistant professor of mathematics at Howard, Hunt recently spent a year doing mathematical modeling at the National Institutes of Health. [The Society for Industrial and Applied Mathematics defines a mathematical model as "a description of a real world situation in mathematical terms designed to explain or predict behavior."] Specifically, she was involved in designing drug schedules based on the dynamics of tumors. The aim of this research: to find the best possible dosage of certain drugs to give to a cancer patient.

She is currently writing up the results of a mathematical model she developed for analyzing the parts of a bacteria that are responsible for its toxicity and for bacterial diseases. Such research falls under the general field of mathematical biology, i.e. mathematics applied to problems in biology.

Hunt first became interested in this field when she read a book about it during her senior year in college. "I thought, how odd, biology is squishy living things and how are you going to do any mathematics with that," she recalls. Intrigued, she investigated the field further and when it came time to write her Ph.D. dissertation in applied mathematics she chose a biologically related topic.

That she, a Black woman, has earned a Ph.D. in mathematics makes her a statistical as well as sociological oddity. An article in *The American Mathematical Monthly* notes that fewer than 30 Black women in the nation have *ever* received the degree. [Espelie's background is Norwegian-American; Raphael's parents were Armenian immigrants.]

"Statistics on the number of women in math are dismal," Hunt acknowledges. "But for Black women, they're *terrible!*" Perhaps that is why she was emerged as such a strong advocate for the increased participation of women and Blacks in mathematics. Consider some of her views:

On the barriers facing Black people in mathematics: "The situation with Black people and the mathematical sciences today is a lot like the situation with Black people and athletics in the earlier part of the century. Namely, most white people didn't believe Black people could compete with white people on an equal basis, much less excel. Most white people think of mathematics as a kind of mental athletics and they think, therefore, that Black people are incapable of excelling at it. What's more important, a lot of Black people feel they can't excel."

"Statistics on the number of women in math are dismal, but for Black women, they're terrible!"

And the barriers facing women: "Again, it's this image of mathematics as mental athletics. Men really see themselves as particularly suited for mathematics and view women as not being as strong. Women have internalized this belief."

On women and math anxiety: "Women have more math anxiety because there's more socialization machinery inside of them that's telling them to go so far and no further because if you go too far then you won't get married and you won't have kids which is still the primary goal of most females on this planet. I'm not trying to play down that goal. God knows it's an important goal. But it's my belief that it's very hard to reconcile that with high achievement in an intellectually demanding, intellectually consuming field like mathematics. But thank goodness more and more women are able to do it and it will be done. I hope."

On one way to encourage girls, especially Black girls, to go into mathematics: "Girls math clubs are an excellent idea. Then girls would stop worrying about 'what the boys think.' When boys play sports they certainly don't say, 'Well, I wonder what the girls think about how I'm going to shoot this basket.' They are absolutely not concerned about it. The whole point is that girls should forget about 'what the boys think.' It's what *they* think that is important because that's going to determine how far they go."

The strong feminist and Black consciousness that energizes Hunt's words seems the natural outgrowth of how far *she* has gone in mathematics.

Actually, she confesses, "I didn't even like math in elementary school. I knew you needed it for groceries but beyond that I didn't really understand what the point of it was. And some of it, especially division by decimals, seemed horrendous!"

But in junior high school [in New York], the cover of an algebra book caught her eye. "It was white with bold red print and it had this marvelous stick figure writing some complicated formula on the board," she recalls. "Somehow it attracted me. It looked very fascinating. So I got interested in algebra."

About this same time, a science teacher, one of her few Black teachers in junior high, encouraged her to pursue science and in his own teaching demonstrated a high level of scientific and mathematical reasoning. It was at his suggestion that she applied to a science honors program which met Saturdays and summers at Columbia University. Her participation in the program solidified her interest in mathematics, an interest she then pursued at the Bronx High School of Science, a highly competitive specialized public high school; Bryn Mawr College; and New York University's Courant Institute of Mathematical Sciences.

As she moved through school, though, she found little of the caring and guidance she had received from that Black junior high school science teacher. "To be honest, when I was going to college and in graduate school I don't think I got a lot of encouragement," she says. "By and large I had to seek out the professors and I didn't get a lot of good advice about what to do and when to do it. In graduate school I think the professors probably thought it a bit odd that there was a Black

woman studying mathematics at that level. I was very conscious of having to validate my own legitimacy."

Today Hunt has found that women and Blacks seem more welcome in applied mathematics than in the perhaps more lofty area of pure mathematics. "Maybe it's because applied mathematics is newer and the people involved seem to be more open and less bound by tradition," she says. "Also, society needs applied mathematics so badly as a tool for analyzing problems that there is much less prejudice against women and Blacks with this kind of mathematical expertise. Since I've gotten my Ph.D. [1978], I've seen the walls really crumble."

Hunt (like Espelie) is single and she says she *has* found that there are a whole lot of men around who do seem to feel threatened and intimidated by women they perceive as brainy. "There is some social isolation involved in choosing a career in mathematics," she believes. "There's little doubt about that." But she also knows something else: "If I had to give up a career in mathematics to get a particular man I would not be interested in being with that person and having a family with that person."

Mathematics, quite frankly, is something she could never see giving up—for anyone or anything. "There's something addictive about it," she says. And something beautiful: "Mathematics is in some sense a language and a way of picturing. It has a reality of its own that is very beautiful and very appealing in very much the same way art and music are. That's what captured my interest and has kept it even now."

Other Voices

A biographical sketch of Fern Hunt and of other Black women with doctorates in mathematics is included in Patricia C. Kenschaft's article, "Black Women in Mathematics in the United States." [October 1981 issue of *The American Mathematical Monthly* and an updated version in the April 1982 issue of *The Journal of African Civilizations.*]

"Mathematical talent is both scarce and precious; our society cannot afford to waste it," Kenschaft writes. "Possessors of such talent, whatever their race or sex, need encouragement and help if they are to develop fully their abilities and to enter fields previously denied to them."

"Mathematical talent is both scarce and precious; our society cannot afford to waste it," Kenschaft writes. "Possessors of such talent, whatever their race or sex, need encouragement and help if they are to develop fully their abilities and to enter fields previously denied to them. These Black women are role models for those who follow. They should inspire all of us to look for talent wherever it is found and try to provide the needed support."

How well is Howard University doing in encouraging "possessors of mathematical talent, whatever their race or sex?" On the faculty level, as we have seen, it is doing well — at least when compared to most colleges and universities in the nation. On the undergraduate level, it is doing very well and has been so doing for quite some time. Last spring, for instance, the math department had 45 male math majors and 39 female. At the graduate level, all 18 students pursuing master's and doctorates were Black but only three of these were women.

Vernise Steadman, who holds bachelor's and master's degrees in mathematics from Howard, is one of them. She is currently working on her doctorate in the area of differential equations and has taught mathematics at the University of the District of Columbia and (as a graduate student) at Howard.

"I love mathematics because of the way it involves my mind," she says. "It's the only thing that involves me totally. Everything else I get bored with. As a matter of fact, all through high school [in Trinidad] and undergraduate school, other things came easily to me. Not math. I have to work at math."

Says Crystal Williams who graduated from Howard in 1983 with a major in mathematics: "At Howard I was encouraged by a professor [Tepper Gill] to pursue mathematics because he thought I was talented. Before, I had thought that mathematics was a field for *geniuses,* but what I've found is that all you have to do is like it, apply yourself and work hard." (She now works for a local actuarial consulting firm and hopes to do graduate work in applied mathematics.)

That "mad genius" image of mathematicians is still around, though, she's found. "There are people who expect you to look a little kooky, dress sloppy, scratch at your head all the time and wear lopsided glasses," she remarks. "They look at me and say, 'Huh, you're in math? You look normal.'"

More seriously, she adds, "Certainly it's kind of rare for a Black woman to be in mathematics, especially in my field. The number of Black women in actuarial science is hardly even countable; we're represented as a trace. . . . So when you see another woman in mathematics, especially, a Black woman, you get this happy, tingly feeling, like, 'Wow, I've got a friend here.'"

But she believes the times are changing "very very fast" and that more Black women will be going into mathematically-oriented professions. Vernise Steadman agrees: "We have to have mathematical training and knowledge because look at the way the world is going — high tech and everything. We have to be prepared for the new century coming up."

Some women involved in mathematics take heart in recent statistics that show an increase in the number of women earning doctorates in math. In 1970, for instance, only 6 percent of Ph.D's in mathematics went to women; 10 years later that percentage had risen to 14. [The earlier figure given in this article was for the overall percentage of women with doctorates in math, not for those earning *new* doctorates.]

Others believe that this percentage, which seems to have stabilized, is still far too low and that even the progress it represents is endangered. That Hopkins study proporting to show inherent male mathematical superiority "threatened to set back two decades of efforts to gain recognition of the mathematical capabilities of women and bring more women into math and science," charges Sheila Tobias in a *Psychology Today* article entitled "Sexist Equations."

But Fern Hunt, an equally ardent feminist, prefers to take the longer view — and we close with her words:

"Mathematics or scientific activity is a kind of index of a measure of people's confidence in themselves, in their ability to think and to be able to make sense out of the universe they find themselves in. . . .

"There has been a tremendous change in women's consciousness. Women no longer think of themselves primarily as mothers and wives. They think of themselves primarily as people. And that is going to mean that there are going to be little girls coming along with mathematical talent and with a desire to pursue mathematics." □