

insurmountable because, as a compensation, maturity had given me an ability to focus and to concentrate in a way which had seemed impossible fifteen years earlier. Also, I could set my own pace, taking on more as I could handle more. Eventually, I did need help at home, but that was an easier matter once children were in school all day. Also, I did much of my work at home.

I think there was lots of good luck in my subsequent experiences. I found fellow students who were tolerant of the middle-aged lady in their midst, and we worked together. When I was stuck on a difficult point, I sought and obtained the help I needed, and it was gratifying when sometimes my insights helped others. As for the faculty, most paid attention to my work and not to my age or sex. Later, my thesis topic was immediately absorbing, and when the creative ideas came and I solved the problem, it was deeply satisfying. When I received my Ph.D., the job prospects seemed dim, but with incredible good fortune, I stumbled into an excellent job at the Stevens Institute of Technology. There I found a colleague with whom I did joint work (the first of many such collaborators) and enough good students to make the teaching worthwhile. From that point on it was easy. Conferences and seminar invitations broadened my world, the research problems began to suggest themselves, and my career was on its way.

What I did was natural to my life as a woman, yet at this time I would hesitate to advise other women to follow the same route, because I tend to think my good luck was atypical. I have wondered whether, if the mathematical community welcomed older women as graduate students in a serious and non-patronizing way, and if women rejected the myth that mathematics is a young man's game, we might not see real changes in those discouragingly low numbers.

Deborah Haimo

University of Missouri at St. Louis

Two events in my life significantly influenced my career choice.

Since I dutifully complied with all that was expected of me, I was generally regarded as a good student. I did well in mathematics in first year algebra because I could follow rules, but found them very rigid, and I resented the fact that

development to strangers. I was thirty-six when I found myself in an evening graduate course at the Courant Institute. My initial goal had been to maintain some small level of competence in preparation for an eventual return to full-time work, but I was actually unclear about where I was heading and simply did what seemed interesting and possible at the time. To my pleasure and surprise, the challenge of graduate work was wonderful! To be sure, I was rusty, but that did not seem

as the day-to-day supervision of my children's growth and not feel right to me to hand over a matter as important as my children as they grew and developed. Moreover, it did didn't have to do it that way, but it was pleasant to be with two days a week, then one, and finally (briefly), none. I as my three children were born, my work went down to called "Systems Analysis" in the aircraft industry. Later, stretched into a fifteen-year detour. I worked in what was graduate program, I veered off to the side, beginning what of total involvement which I knew must go with a full-time to take a math-related job which would not require the kind about the precise alternatives. When the opportunity came the traditional woman's role as a homemaker, I was less clear appealing to me. While I knew I wanted more from life than to become a professional mathematician did not seem so from college, the deep commitment which was required and more particularly at age twenty-one, when I graduated. The simple truth is that at some point during college, What went wrong, and, even more, was it "wrong"?

some excellent teachers who encouraged and challenged me. and high school, I excelled in mathematics and even had and the way things "fit together." Moreover, in elementary earliest pre-school memories are of fascination with patterns the traditional age, but that was not the case. Some of my did not discover the beauties of mathematics until I was past explanation might be that (like some of today's students) I career as a research mathematician in academia. A plausible I was forty-one when I received my Ph.D. and began a and would like to share some of my experiences with you.

In her acceptance speech for the Satter Prize, Dusa McDuff wrote about the crooked path she followed before she found her creative voice. I wandered along other crooked paths

Columbia University

Jean S. Birman

In Her Own Words

Six Mathematicians

Comment on Their Lives and Careers



we were penalized if we attempted to reach a result by some different approach. Originality or creativity were strongly discouraged.

In my sophomore year, however, something new and very exciting happened. We started studying Euclidean geometry. Here, we had a set of axioms—self-evident truths—and based on these, and some hypotheses, we were able to establish a variety of fascinating theorems. It was all reasonable and logical, and no one was requiring that I follow some rules I didn't understand. I loved the subject and tried to obtain results beyond those assigned.

One day, we came to a theorem for which an indirect proof was given. I wondered why we couldn't prove the result directly, tried to do so, and found a proof that worked, except when the geometric figures involved were positioned in a certain way. I decided that I had found the reason for the indirect proof and didn't feel a need to raise the question further.

Some time later, we had a similar problem involving the same geometric figures, where, again, an indirect proof was given. This time, the teacher pointed out that the problem could also be solved directly, and outlined a proof that was essentially the one I had discovered earlier. I then raised the question of the difficulty that arose when the figures were positioned differently. The teacher had an immediate response, "You have an axiom that states that geometric figures can be moved in space without affecting their properties." Incredible! It was an axiom that we had not used and I had forgotten all about it. What a beautiful subject! Everything fell into place so neatly!

I entered college with great uncertainty about a major. I didn't know what I could do with mathematics. About the only career option in that area, as far as I was aware, was school teaching, and I knew I didn't want to be a school teacher—if for no other reason than the fact that, as a woman, I would not be allowed to marry and remain a teacher—at least in public schools in my area, and I knew no other. Physics was suggested to me as a subject with greater career options and a good alternative to mathematics. My select high school, restricted to girls, did not offer physics. In college, however, I enrolled in a freshman physics course to consider it as a possible major.

In one of our early labs, we were to do the standard experiment of scattering iron filings on the lab table, placing a magnet in their midst, and noting how the filings align about each pole. Everyone in the class did the experiment very readily—everyone, that is, except for me. My iron filings refused to follow the expected pattern, and instead, kept arranging themselves in bizarre formations. One after another of my classmates, realizing what I was experiencing, came over to offer advice, and to watch the strange results. Finally, the entire class, including the instructor, was gathered around, with everyone trying to explain why my iron filings were so uncooperative. One observant girl finally solved the mystery. She pulled out a drawer that was directly under my work space, and, believe it or not, it was full of magnets!

That episode brought to mind my experience in geometry class. I concluded that, in mathematics, we control over our assumptions—if they are poor, our results will not be good, but we know what we are working with. In physics, there may be factors that are completely unknown to us, but can distort our results and unbeknownst to us, make them invalid.

That drawer of magnets determined for me that I loved mathematics and it would be my major, regardless of my need to be practical and to select a field with a greater number of more reasonable career options.

Susan Landau

University of Massachusetts, Amherst

My husband and I married while I was a graduate student in computer science at MIT. "Don't have children until you finish," cautioned a friend, the wife of a history professor. I nodded easily. I was then twenty-five. At twenty-eight I completed my doctoral thesis. "Don't have children until you get tenure," warned a member of the faculty. I was leaving to become an assistant professor at Wesleyan University. This time the nod didn't come so easily. My husband and I wanted a family. I didn't want to wait until I was thirty-five to begin one.

Choosing which came first was not hard for me. If I had tenure at thirty-five, but was then unable to have children, the pain would have been unbearable. I knew I could handle the opposite situation. I had my first child at thirty-one, my second at thirty-three. At thirty-four I have my family even if I don't have academic permanence.

All along I felt that the choices were more mine than my husband's. We both raise the children. I'm the one who's pregnant. I have the fuzzy brain for nine months; I'm the one who can't go off to conferences during the late months of pregnancy and the early months of nursing. My work suffers, my energy flags, my batteries fade. I've lost about two years of research in the first five years after my Ph.D. (What I've gained is immeasurable—but not the subject of this essay.) So I get 51% of the vote. As it turns out, we both voted for children first, tenure second, so it was no contest. But there's a price I may yet pay in my career.

I didn't know I'd be in a state of torpor for nine months of pregnancy, but I also didn't expect the burst of creative energy that followed the birth of each child. That energy more than made up for those lost nine months. Every academic mother has a different experience, but all of us face the ticking of those simultaneous clocks of tenure and the childbearing years.

Academia doesn't help. Few universities have maternity leave. Those that do ignore what happens next. For example, my university has an excellent maternity policy (one semester's leave at two-thirds salary), but no child care facilities, despite over a decade's lobbying by male and female faculty. Thus my kids are at a center forty-five minutes away. I can't attend late afternoon colloquia or faculty meetings. Last year my husband and I were both invited to spend our sabbaticals at a university where we

assumption: education for a woman was not intended to lead through marriage and children; her education was intended to help her be an intelligent partner to her husband and well-informed mother to her children.

I had a grandfather who was an amateur practitioner of mathematics and I was supposed to have taken after him. In any event, as a teenager it was my favorite subject at the all-girls' high school that I attended. I was fortunate to have a good mathematics teacher under whom I studied Euclidean geometry and learned to write proofs. I went on to do my BA in Mathematics at a co-educational college in Madras. The curriculum was old-fashioned and the textbooks were those that had been used in England at least 30 years earlier. I graduated from this uninspiring program and enrolled in a Master's program at the University of Madras, at which point the quality of my education changed dramatically.

An important presence in the mathematical scene at Madras was a Jesuit priest, Father Racine, who headed the Mathematics Department at Loyola College. He was acquainted with the latest mathematical developments in Europe. Several of his undergraduate students later went on to do research at the prestigious Tata Institute of Fundamental Research in Bombay. However, Loyola College did not admit women and thus women students were denied the opportunity of studying under and being noticed by Father Racine. The first piece of good luck I had was that Father Racine gave a course on abstract algebra at the University of Madras, using the great text by van der Waerden based on lectures by Emmy Noether. I also had courses on topology and other subjects from two other excellent professors. Thus I was suddenly thrust into the twentieth century, and this was an exciting experience for me. However, I did not have any ambitions to be a researcher in mathematics at this stage, or, for that matter, to pursue any serious career at all.

After receiving my master's degree I got married, as was expected of me, and followed my husband to Manchester, England, where he, a mechanical engineer, was to receive practical training. This was my second big break, for I enrolled in the Ph.D. program at the University of Manchester and started working with J. A. Green. In spite of exposure to western intellectual life, both mathematical and otherwise. My husband was totally supportive of my having a mathematical career and sometimes opposed his own family. So now there was no turning back.

My husband returned first to India, and I followed after completing my Ph.D. I got a position at the University of Madras. Though I did not experience overt discrimination, it was quite common for people to say to me "Your husband has a good job; why should you work?" or "Aren't you taking away a job from a breadwinner?" and so on. One well-meaning family friend said "It is a pity you don't have children; but isn't it wonderful that you have something to keep you occupied?".

During my years at Madras I had some contacts with western mathematicians. In particular, I met Armand Borel

would have great research opportunities. Lack of day care there meant we couldn't go.

There's a touch of the priesthood in the academic world, a sense that a scholar should not be distracted by the mundane tasks of day-to-day living. I used to have great stretches of time to work. Now I have research thoughts while making peanut butter and jelly sandwiches. Sure it's impossible to write down ideas while reading "Curious George" to a two-year-old. On the other hand, as my husband was leaving graduate school for his first job, his thesis advisor told him, "You may wonder how a professor gets any research done when one has to teach, advise students, serve on committees, referee papers, write letters of recommendation, interview prospective faculty. Well, I take long showers."

When I decided to become a professor, it was because I loved mathematics. I wasn't married, wasn't thinking of children or timing, or any of the issues that are now so crucial. Had I been, my decision might have been different. The tenure process was established in an era when men had professions and women had babies. Women now have had professions as well as babies, but the academic world hasn't changed. My two maternity leaves in two years seemed like a lot to several of my colleagues. I see it as two maternity leaves over a lifetime. Even if a faculty member chooses to work half-time for ten years, that still leaves thirty years for full-time scholarship and teaching. Universities can afford to be far-sighted. My university's generous maternity policy gave me time after childbirth to catch up on the research that I had been unable to do while pregnant. A National Science Foundation mathematics postdoc has just given me more time during the years when my children are young.

There are any number of complex reasons why women have not reached the top echelons in a variety of sectors. This is a simple, avoidable one. Fellowships, maternity leaves, and on-site child care can make a huge difference. Universities should be leading society on this one. As long as they make it difficult for us to be professors and mothers, they are engaging in a policy which effectively keeps a significant segment of women off the faculty.

(This piece was written in 1988 when the author was a faculty member at Wesleyan University. Wesleyan has since acquired an on-site child care facility and the author has since moved to the University of Massachusetts.)

Bhama Srinivasan

University of Illinois at Chicago

I grew up in Madras, India in a liberal and progressive family where books and education were taken for granted. There were precedents in my family for higher education in the West. My father and uncle had studied at Oxford, and a cousin did brilliantly at Cambridge, where she later became a don at Newnham College. Her brother became a radio astronomer and worked at Cambridge, Starford, and Sydney. (A byproduct of this environment was that I learned English as a child and grew up bilingual.) However, behind the expectations of doing well at school was an unspoken

the same number of courses, at the same level as full-time faculty, for a graduate student stipend. Of course, I did nothing else except teach these courses, as I still felt my first responsibility was to my small children. Even with my teaching, I found this life stultifying. We had little money, so we could not hire babysitters or household help. My husband was very ambitious, worked long hours and did not feel he should help anyway, which was common then. When the youngest, Ben, was old enough for kindergarten, I decided to take the plunge and get a full-time position—in the Boston area, of course. Naturally, I tried some of the many colleges and universities there. What were they to make of someone who had done no research but some teaching since her degree? Aside from that, I did not feel that the academic atmosphere then was conducive to women. Tufts asked me, "didn't I know that it was a men's school?" and that all the calculus instructors graded exams in one room? I thought they considered it improper for a female to also be in that room. I heard at least one person say "I would never hire a woman." Fortunately, there was an Air Force research laboratory, AFRL, nearby. And fortunately, there were mathematicians there working in a new area, error-correcting codes, who thought my algebra background could be useful. I thought the atmosphere toward women at AFRL was much better than in the academic institutions I had seen. That was how I started working on error-correcting codes, and I have never stopped.

I had to learn how to handle leaving home—day-care was not so good or widespread then. My relatives said, "What if a child has an accident while you are away at work." Guilt was added to my other concerns. A few of my husband's physicist colleagues were working mothers, and I followed their advice closely. We even formed an organization WISE (Women in Science and Engineering) to help others. I was president of WISE for a few years. Needless to say, I did not have the time for this in addition to my family and job, but I found our "consciousness-raising sessions" valuable in enabling me to regard myself as a professional and to develop confidence in my own work and opinions. When our third child (a son) was born, I only took a few months of maternity leave.

At AFRL, we hosted monthly workshops in coding which were attended by many coding theorists. Andrew Gleason was a regular member of these sessions, which I found quite stimulating. I stayed at AFRL for ten years until the Mansfield amendment was passed and the laboratory was unable to continue its basic research work. I decided to return to academic life, even though I found the transition very painful. I spent three years as a research associate in MIT's Project MAC until I got my present position at the University of Illinois at Chicago. So my first regular academic position was full professor. It was wrenching to leave the Boston area as my youngest son stayed there. After five years of separation, my husband and I divorced, and my son came to Chicago to live with me. I enjoy academic life very much now and am pleased that my department contains such good people.

I had no ambition to become a mathematician, girls at that time aspired to be wives (of successful men) and mothers. Maybe some "unfortunate" girls never married and pursued careers but, as far as women mathematicians went, I never saw one the whole time I was a student. However, I did know about the work of Emmy Noether and it may have influenced my choice of area, algebra, although I think the teaching of Irving Kaplansky was what really inspired me. I worked for my Ph.D. (under the direction of Alex Rosenberg) because it was a more interesting occupation than the job I had while waiting for my husband to complete his Ph.D. in high-energy experimental physics. After he got his degree, he received an offer from MIT and we moved to Cambridge. I had not finished my thesis but did have a good start. Alex was amenable to my finishing by correspondence. This occurred with many helpful, humorous letters from Alex. I only went back to defend my thesis, which was about two weeks before my first child, a daughter, was born (she was early). Fortunately, everything worked out alright; Alex had warned me not to have the baby during the defense, since it would upset the janitors.

It never occurred to me to work, not even in the Boston area. Going to another city was inconceivable. My oldest son Ben was born two years later. When Ben was in nursery school at the age of three, I taught two courses at Boston University in order not to forget everything I had learned. It never occurred to me then that I was teaching

to others.

Despite much progress it is still more difficult for women to become mathematicians than for men, and, as I have been concerned about this situation, my history might be useful

University of Illinois at Chicago

Vera Pless

when he visited Madras and he invited me to a special year on algebraic groups and finite groups at the Institute for Advanced Study in Princeton. This was another great opportunity for my research and to make further contacts.

In 1970, I emigrated to the U.S. and started teaching at Clark University. (By this time, my husband and I had parted for reasons not connected with my career, but we remained friends.) I plunged into a new life and a new career in the U.S., and made new friends, especially with some women mathematicians in the Boston area. I moved to Chicago in 1980 when I got a position at the University of Illinois at Chicago. While keeping in close contact with my family in India, I am now very happy living and working in America.

If I think back, in middle, to the early stages of my career, I realize that many of my decisions and advances were due to fortuitous circumstances such as being in the right place at the right time and having the right kind of support at the right moment. My male relatives and friends held as a birthright the idea that they would strive for the best professional life they could attain; for me this was a long time in coming. I welcome the changes in women's expectations that have taken place in the last decade.



conversation predictably degenerated at that comment. But still, the point is that my awareness of the problem is regarded as some personal fable of mine.

Item: Math Counts. This is a fine mathematics team competition for middle school students; my daughter has been active in it and loves it. But when I saw the list of sample problems they had to study, I was aghast: every single word problem had male names, if there were any names at all. I went to observe the regional competition, and listened to the "Count-down Round" (where the top ten students are asked questions orally). Exactly the same thing—all names mentioned were male. The only question which involved females at all (1) had no name attached to the girl (as opposed to the other questions) and (2) concerned the number of different outfits she could assemble if she had three skirts, two blouses, etc. Talk about stereotyping! I felt betrayed, that the "good guys" (as I consider Math Counts to be) should do this.

Item: The profusion of messages (e.g. on the Op-Ed page of the New York Times) about how "it is a dirty lie" to suggest to students that they can have a full-time career and a family too. The least offensive of the current phrases seems to be that "you can have it all, but not all at the same time." I agree with Jane Pauley that to "have it all" requires (1) good intelligence, (2) good energy, (3) good health, and (4) good luck. Since you haven't got much control over these factors, you certainly can't count on "having it all" and you shouldn't feel it a personal failure if you don't succeed. But it is also wrong to discourage students from trying.

Item: Retirement party for Joanne Elliot. One of my (male) colleagues reminisced about seeing Joanne as an attractive young woman in the common room at Princeton surrounded by young men eager to be near her. The comment made me feel very uncomfortable, since it placed emphasis on her attractiveness in a setting where conversations are often mathematical. If only the men had been clustered around her because they were eager to hear her theorems and conjectures! But at least as the story was related, that was not the case.

Emily Noether

"Emily Noether's career was full of paradoxes, and will always stand as an example of shocking stagnancy and inability to overcome prejudice on the part of the Prussian academic and civil service bureaucracies. Her appointment as *Privatdozent* in 1919 was only possible because of the persistence of Hilbert and Klein, who overcame some extreme opposition from reactionary university circles. The basic formal objection was the sex of the candidate: 'How can we allow a woman to become a *Privatdozent*: after all, once she is a *Privatdozent*, she may become a Professor and member of the University Senate: is it permissible for a woman to enter the Senate?' This provoked Hilbert's famous reply: 'Meine Herren, der Senat ist ja keine Badenanstalt, warum darf eine Frau nicht dorthin! [Gentlemen, the Senate is not a bathhouse, so I do not see why a woman cannot enter it!]'"

—from an address, "In Memory of Emmy Noether," delivered by P.S. Alexandrov, then president of the Moscow Mathematical Society, on September 5, 1935. Quoted from *Emmy Noether*: 1882-1935, by Auguste Dick. Birkhäuser, 1981.

In retrospect, I think I was very lucky. I worked in coding from its beginning and it has developed into a fascinating mathematical topic. I have appreciated the opportunity to work with many wonderful mathematicians, in particular Richard Brualdi, John Conway, and Neil Sloane. I was able to care for my children in their younger years in a low pressure environment. I would find child rearing difficult facing the pressures our assistant professors face. Our discipline is not the only one demanding a great deal. My daughter, a medical resident with a young daughter of her own, has plenty to say about the long hours required of residents. Unfortunately, our society is probably losing valuable contributions from women for these reasons, and many women are paying a great emotional toll either in forfeiting careers or in not devoting as much time to their families as they feel they should.

Jean E. Taylor

Rutgers University

My main message is that things aren't as different now from what they used to be as many people think, in spite of twenty-five years of "women's lib" and twenty years of the Association for Women in Mathematics. Each of the following is something that happened within the past five months.

Item: A recent conversation at Rutgers with the guy in charge of assigning who teaches what in the department. Due especially to an attractive early-retirement package, many faculty members, including two women in the department, are retiring. Rutgers used to employ a large fraction of the women professors in the U.S., but we will be down to four (Barbara Ososky, Tilla Milnor, Amy Cohen, and myself) next year, with Ingrid Daubechies making it five in 1992. In the conversation, I was bemoaning the loss of this large fraction of the women faculty, and his response was "Oh, that's all you ever think of. I'm interested in the number of bodies available to teach classes!" (The situation is aggravated by a hiring freeze imposed on the university by the state budget situation.) I responded that I too was interested in bodies, in particular in women's bodies. The