

Trust yourself!

Alicia Dickenstein

ABSTRACT. People who are afraid of mathematics do not realize that basic mathematics is innate in human beings, like speaking. It is a universal language that allows us to communicate with people of any nationality, age, race or gender and understand each other. Mathematics is a collective social construction; it is everywhere and trains us to look and understand how things are related. This ability to understand with critical thinking is a very powerful and increasingly necessary tool. Mathematics is also a passion and a source of great satisfaction. Of course, hard work is essential as it is in so many other human activities, including sports and arts. And a career in mathematics faces many challenges that all the chapters in this book address with different styles and perspectives.

This text is a summary of my experience as a female mathematician from a South American country. I hope that even if my circumstances were particular, it could be useful to transmit some of the challenges I had to face. My message is summed up in the title: a crucial key is to trust yourself.

How I started

I found out almost by chance that a career in mathematics existed; this is why I think it is very important that young people know about potential careers in mathematics, especially girls. I was planning to study education, but I accepted an offer from my high school to take some vocational tests. When it was suggested that I go for a degree in mathematics, I was doubtful because I had the standard prejudice that mathematicians were “strange people”. The psychologist in charge told me that she was a frustrated mathematician and encouraged me to study math. She insisted that I started with math and said that if I didn’t like it, I could move on to education. But that if I started with education, I would never study mathematics. Perhaps this had been the case with her. I followed her advice and immediately felt that this was my place . . . except that during my second year at the University I had a very boring professor teaching us multi-variable calculus, only through pictures that I couldn’t draw well and gave us no mathematical insight. For one moment, I thought about dropping my studies, but the following semester I realized that the problem was him and not me.

I never thought there were things that men could study that women couldn’t, but looking back I was lucky to share my Ph.D. years with Carmen Sessa, a female

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friend, in a universe where everyone else was a man. Our advisor was an excellent mathematician called Miguel Herrera who worked in Complex Analytic Geometry. He was just back in Argentina with a Guggenheim Fellowship, after having visited a few universities in France and Princeton. But, tragically, Miguel died suddenly at the age of 45, soon after we had completed our dissertations. My daughter had been born in the middle of my graduate studies and my son one year after graduation. The group he had formed disintegrated, there were no specialists in the area for thousands of kilometers around, email did not yet exist and regular mail was very poor. Argentina was mired in hyperinflation, the university was unable to buy any journals and the salary of my teaching assistant position was very low.

One month before passing away and knowing how ill he was, Miguel sat with us and helped us write the introduction of a paper based on a part of our theses. Writing good introductions is an art and his guidance is part of why he has a strong legacy as an advisor. He suggested that we send the article to a journal we were not aware of (in fact, I was not aware of what the mathematical world was at that time), which we did. After submitting it, we learned that it was a first class journal. Had we known this before, we would probably not have sent our article there We were then expecting to receive a letter from the editors telling us that what we had done was already known. Instead, the letter said that our paper was accepted! This made it possible for us to get Assistant Professor positions the following year, but we had no idea of what to do with our research.

It took me many years of much searching and frustration to find my way. I had been a very good student and would solve most of the problems proposed to me. But all of a sudden I needed to pose my own research questions. I still worked with Carmen for a few years, but we both felt that problems we could pose could be divided into two groups: trivial and unsolvable. After a few years, Carmen decided to turn to research in Mathematics Education, where she developed a very successful career.

Searching to be productive

Buenos Aires had a strong mathematical tradition but mostly in real and harmonic analysis. I was very isolated and tried to learn from some material I had inherited from Herrera and other subjects from some books. I felt that my colleagues could produce new results but that I could not. To my surprise, I got an invitation to a congress in Chile. I wonder now how they knew about me and managed to reach me with no phones and no internet. Then, I received a letter with another invitation for a six week school on Riemann Surfaces at the International Centre for Theoretical Physics (ICTP) in Trieste. By then my youngest child was four and with the support of my husband and my mother I was able to go there.

We had intensive courses every day. I learned mathematics and I also learned the difference between the English and the American accents with my basic English. Also importantly, I met many colleagues and made mathematical friends. One day, which I still remember vividly, I was standing in the beautiful ICTP wooden auditorium when I had a “revelation”. I discovered I was missing a lot of knowledge because I did not have access to the necessary resources... and that there are many mathematicians who have a creativity beyond my possibilities, but perhaps with more knowledge, I could be as productive as almost all the colleagues I saw around me. This marked my whole mathematical life: a fight for information. After

having had the possibility to stay for long periods at different institutions around the world, I could well experience the difference between being in a place where the information “flows naturally around” and marginal places where even nowadays we need to invest more effort in this search.

Tracing the path

I kept on working, learning from different sources. I wrote reviews for *Mathscinet* and *Zentralblatt* and could then read the recent articles they sent me to summarize, close to my thesis work in several complex variables, with ingredients from analysis, algebra and geometry. I followed several courses and seminars on effective algebraic methods and complexity offered by a Swiss mathematician who had moved to Buenos Aires following his Argentinian wife. I tried to relate my previous analytic work to effective duality questions for polynomials. I also followed a course offered by an Argentinian mathematician working in the US who visited Buenos Aires for a sabbatical and kept on sending me reprints and other information about events. I then applied and was invited to attend a fantastic Regional Geometry Institute held in the US for a month where I learned about computational algebraic geometry and got interested in toric varieties. I made many contacts who encouraged me and helped me develop my career. That year I had also been invited to be a professor in France because of the course notes that I had written for an event held in Mexico, which had been a follow up of the ICTP School.

Then, I had another key moment. I lamented that I did not work in any well-established area, where there was an “umbrella” of developed results and questions to address; that I had managed to know a little about many topics but not much about anything. So I thought that the only possibility for me was to make my strength out of my weakness and that as the Spanish poet Antonio Machado said: “Caminante, no hay camino, se hace camino al andar.”, which could be translated as: “Walker, there is no path, the path is made by walking.” And I kept going and worked on what I could, on different topics, several of them related to the study of singularities. In recent years I have also become interested in the study of cell signaling networks in biochemistry, using algebraic and geometric tools that were not usual in applied mathematics. You can read about this approach in the article [1]

In charge of my department

With a bit of chance due to a resignation, I became the first female and quite young Director of my Department and I chose a younger female Deputy Director. At that moment, I didn’t think that this was something special. I was an associate professor and practically all the full professors were men. I learned what it is to have many responsibilities and almost no power. In addition, most days I would go back to work late at night when everybody else went to sleep. But it was an excellent experience. One of the issues that I tackled was the lack of “democratization” of the professional information on conferences, funding sources, etc. which until then only circulated among friends. I am happy because the changes that I introduced survived.

When my term finished, one of my most respected male colleagues came to tell me the following (meant as a compliment): “When you took office we all thought

what is this woman¹ going to do?, but in the end everything was very good.” It was the same colleague who had told me one day during my graduate studies, when he found me in my office looking for some papers with my nine-month-old daughter, that if I had a daughter I should have stayed at home to take care of her, words that I discarded from my memory until recently. He certainly thought that this was the best choice for me. As in this opportunity, I find that it is important to have self-confidence to discard all bad advices given to us, sometimes even coming from our own loving families.

I could have stayed for another term, but I didn’t because I was invited for a Special Semester at the Mathematical Sciences Research Institute (MSRI) in Berkeley, which was also a turning point in my mathematical life. There, I learned many new things and made many new mathematical friends.

And then

I have always lived in Argentina, but without realizing it and also with the invaluable support of my family and colleagues, I traveled more and more to exchange knowledge, generating new collaborations with colleagues who have become friends, developing human resources and taking on more organizational responsibilities at different levels.

I would like to mention other supports that allowed me to pursue my attempts to develop a career in academia from a non-central place. During my graduate studies, a crucial help was the existence of affordable childcare at my university, something that is not that common all over the world. In addition, funding is in general scarce in Argentina, the economic situation and the currency exchange rate are always unstable, with a critical level of inflation that is difficult for foreigners to believe. In this context, I learned that one should not stop devising projects just because there is no financing; if one is capable of generating a good project, one way or another, maybe not exactly as imagined, it can probably be realized. I am very grateful for the support I received from different national and international institutions and organizations to pay for my travel and accommodation expenses. I learned about these possibilities along the way and this is important information to look for. It is also fundamental to belong to a community, something that I was only able to enjoy somewhat late, but then I also had the experience to actively help generate several mathematical communities.

I would like to call readers’ attention to the interesting and inspiring video [2] from the virtual Heidelberg Laureate Forum 2020 featuring an interview with Abel Prize winner Karen Uhlenbeck. Last but not least, as Karen Uhlenbeck says, we should take advantage of our “luck”. And I add: trust yourselves and follow your passion.

What I started to realize

It was pretty standard until recently that I was one of the few female speakers at a math conference. For instance, Figure 1 displays the nice handmade poster of a workshop on several complex variables in 2000 that I attended in Gävle, Sweden, where the red part represents a mathematical *amoeba*. This seemed “natural” to me and I felt comfortable.

¹He in fact used a colloquial and a bit despective way of calling a woman. The precise word that he used is “mina” from the Argentinian slang.



FIGURE 1. Only one female speaker

It was only in the last years that I began to get interested in gender issues. Once you start to see the point, the situation becomes clearer and clearer. I would like to illustrate this statement with four small anecdotes.

The first anecdote is from early 2015, not long ago, when I began my term as vice president of the International Mathematical Union. A proposal had been raised to create the Committee for Women in Mathematics (CWM) [3], which has in the meantime developed very interesting initiatives. At that time, I was not sure we should have such committee, but when we started to discuss the acceptance of the proposal, I asked my colleagues to raise their heads. This meant looking at the two long rows on either side of the long wall in front of us with photos of all the past IMU presidents and secretaries. There is one woman -someone said with a smile. It was a reference to the picture of Ingrid Daubechies, the single female IMU president until now. After this visual impact, the proposal was approved immediately as it became clear that there still was a long way to go to balance gender participation at the highest levels. So I started paying attention and read about this issue.

A few months after that I was at an international meeting and there was a discussion about the low participation of female mathematicians on the editorial boards of the most prestigious mathematical journals. The editor-in-chief of one

of these journals was there. He said that his advice for his female colleagues was to not accept invitations to join these boards because as the acceptance rates are low, authors tend to get angry and so they would receive their aggressive messages. I asked him why he would say this only to his female colleagues. There were a few seconds of silence in the room. He then answered that he would say the same thing to everyone. I think that the point is that his intentions were good and that he was trying to protect his female colleagues. Again, a bad advice that we have to discard, as it produces self-censorship.

I began to realize that in many instances there is an invisible and unconscious bias in our concepts. When we try to say this to colleagues of any gender who are consciously clearly against discrimination, they tend to get mad at this comment and say that this is not like that. But our brain takes its own unconscious decisions based on our experience, sometimes overwriting our rational thinking. I would like to suggest that you look at Figure 2..

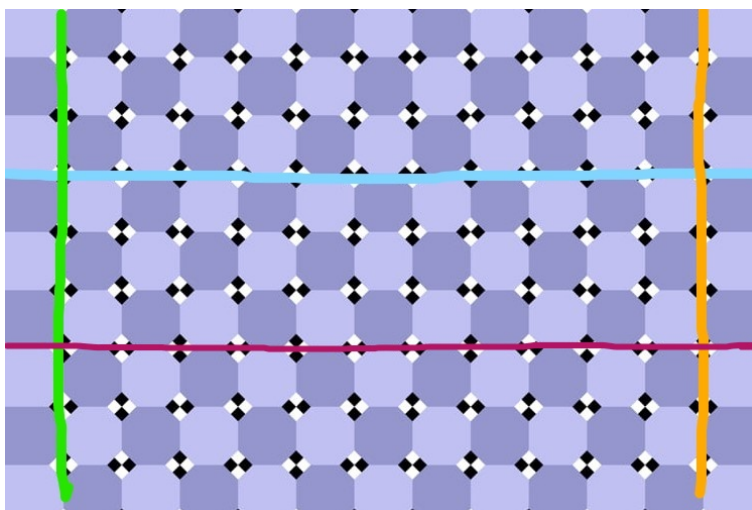


FIGURE 2. Can you see that the curves are straight lines?

Let me tell you what I see in the image: there is a series of horizontal and vertical curves, which are not straight. I traced several lines with color and indeed, they are straight lines (my traces are not perfect because I did them with my hand on the screen, without a ruler). So, I know that they are just lines, but I still see them with curvature nonetheless. This happens to everyone around me. I am by no means an expert in perception but I find this a convincing example to try to understand that our unconscious biases may guide what we think and what we do.

The third anecdote happened at the Faculty of Exact and Natural Sciences of the University of Buenos Aires where I work. They had the idea to produce small videos to attract young people to study science. Eight nice short videos were produced, each one with one of our young professors inviting others to study their disciplines in a kind of short stand-up monologue. The professors in all eight videos were men, but I was sure there had been a serious intention to involve women speakers as well. When I asked, the answer was that they had invited three young female professors, but that eventually all three said no. One flatly

rejected the proposal, another had some family responsibilities, and the third one had an academic trip. It is true that we have far fewer young female professors than male. The timing to get this position is not favorable for women in general, as for instance we cannot have children at any age. But then I realized something else: the problem was one step before the question we were looking at; it was in the format chosen for the communication. These stand-up videos were of this kind: one young researcher telling the public that what he/she was doing was great and inviting them to follow him/her. If you think for a moment, standing in front of others and inviting them to do what you do is something a woman would not do in general. I mean that the idea of these videos had a masculine bias. If they wanted women to be involved and drawn in, the format probably should have been different. Many things in our societies seem natural and impartial, but maybe they are not. For instance, in the document [4] prepared in 2021 by the Ministry of Science, Technology, Knowledge and Innovation from Chile, in conjunction with the organization ComunidadMujer, it is argued (in Spanish) that an implicit social bias affects the way we measure “excellence” and even the definition of “excellence”. This is a subject that I have not thought about enough to have an opinion, but I mention it here because I find it deserves a deeper reflection. The danger of all these initiatives is that an immediate accusation is raised that this is an attempt to lower the level of mathematical research, so serious experiences and studies are needed.

An interesting investigation was performed in Italy and reported in the paper [5], which I find quite rigorous. The study included around 1,400 math and literature teachers working in 102 schools in northern Italy, who self-administered the Gender-Science Implicit Association Test (IAT). The author provides evidence that the difference in the scores of boys and the scores of girls in standardized tests, substantially increases when students are assigned to math teachers with stronger gender bias. The conclusion of the study is that teachers’ stereotypes induce girls to have less self-confidence to perform in mathematics and the overall effect is that they self-select into less demanding high schools, based on the recommendation of their teachers. Thus, girls end up unable to reach their full potential.

The fourth anecdote happened three years ago when I started to produce a Spanish-English bilingual version of a math book for 10-14 year old children, originally in Spanish. The problems in the book are divided according to context and not to the mathematical tools used to solve them. There is a section with sports-related math problems, where all the sports were done by boys. Girls didn’t even understand how the scores are calculated (just because they were not interested in understanding) and all the pictures in this section featured boys. Who wrote that book? Well...I wrote the book thirty years ago! At that moment this seemed to be completely normal. I only noticed this when translating it and adapting it with my colleague Juan Sabia, and we decided to update this section [6].

We are at a time when, in many places, there is no longer any room for obvious discrimination, but the hardest thing ahead of us is to make “invisible discrimination” visible. As this is at the base of our culture, it is very difficult to perceive and recognize, for people of any gender. Our footprints are the path and we are walking it.

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DEPARTMENT OF MATHEMATICS, FCEN, UNIVERSITY OF BUENOS AIRES AND IMAS (UBA-CONICET), CIUDAD UNIVERSITARIA, PAB. I, C1428EGA BUENOS AIRES, ARGENTINA
Email address: `alidick@dm.uba.ar`