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Getting the Odds to Favor Success in Science

A common misconception is that success in mathematics or other scientific areas depends on innate intelligence that’s carried in our genes. In reality, it depends on two things: luck and hard work. In my case it was mainly luck (although from time to time I also had to work hard).

When I was a child, my family spent a year in Baroda, India (now called Vadodara). I attended a Catholic school, although my family was not Catholic, because at the time it was the only one in the city that taught in English rather than Hindi or Gujarati.

The school had strict standards, and taught math at a higher level than my school in the U.S. At age 6, I learned how to multiply multi-digit numbers. When I returned home the following year, my teacher was amazed that I already knew how to do that. She gave me a more advanced textbook to study while the rest of the class learned how to multiply. She didn’t know about my school in India and mistakenly assumed that I must be very smart. Her encouragement had a big effect on me as a 7-year-old.

Another lucky break for me, ironically, was that I grew up during the Cold War between the U.S. and the Soviet Union. The Cold War was, of course, a terrible thing. Two nuclear powers were so hostile to one another that people lived in fear of a war that would destroy human life on Earth. But bad things sometimes have a “silver lining”. Because of the competition between the U.S. and the Soviet Union in science and technology — especially the “space race” — the American government was prioritizing science education, and the American people were very respectful toward scientists.

This is not the usual American practice. Countries such as Vietnam, China, Korea, and Japan have a deep-rooted tradition of respect for education, but we in America do not. Anti-science attitudes are widespread in the U.S. That’s why over 800,000 Americans have died of Covid-19. A huge number of Americans refuse to believe what scientists tell them about the importance of getting vaccinated.

In the 1950s and 1960s, when I grew up, Americans generally had more trust in science and rational thinking than they do now. Although I was socially awkward as a child and terrible at sports, other children respected me because I was “good at math”.

When I was 14, I attended a government-financed summer program in mathematics at a university. Later that year, in another stroke of luck, I met a famous mathematician named Mark Kac who was willing to teach me some advanced topics. Kac, like many of the best American scientists, had immigrated to the U.S. from Europe in the 1930s in order to escape the Nazis.

My schools were generally much better than the average in America. But the math teaching was not particularly good, and I mainly studied math on my own. There are two things that I'm especially grateful to my secondary school for, and neither is directly related to math.

First, I had excellent English teachers, who taught me how to write well. This was crucial to my career. Scientists and mathematicians who want to be broadly influential need to be able to communicate clearly with non-specialists. Science and math are not about calculations (a computer can do calculations much faster than humans) — they are about *concepts* and *ideas*. Most scientists and mathematicians (especially applied mathematicians) work collaboratively in teams, so we have to be able to communicate well in speech and writing.

Second, my secondary school started a class in the Russian language, and so I started learning Russian and was inspired to continue studying it on my own later.

During my university years I traveled to the Soviet Union twice, and then immediately after receiving my PhD I spent a post-doctoral year in Moscow under the guidance of the famous Soviet number theorist Yuri Manin. In the 1970s and 1980s Moscow had the highest concentration of eminent mathematicians of any city in the world. (This was no longer the case after the collapse of socialism in Russia.) I returned to Moscow for six months in 1978 and again in 1985 as part of the U.S.-U.S.S.R. Academies of Sciences exchange program.

Despite the political hostility between the two governments, American and Soviet mathematicians had very friendly relations. In the 1980s I started working on the mathematics of cryptography, and in 1985 gave a talk on this subject at the Moscow Mathematical Society. My Soviet colleagues found it amusing that the first Moscow Math Society talk ever given on secret codes was given by an American! Even though my Russian was pretty good, I was very nervous about the talk, because several dozen of the world's greatest mathematicians would be in the audience.

Sometimes early experiences can give us a foretaste of the direction of our career many years later. When I was 12 or 13, in my geometry class I found an error in a proof in our textbook. The teacher refused to believe that the author could have made a mistake. So, without the teacher’s permission, I organized the class to write a letter to the author about the mistake. He replied, told us we were correct, and supplied a valid proof. The teacher was furious at me, and complained about me to the school administration.

For the past two decades most of my research has had a striking similarity to that incident. In collaboration with colleagues in Canada and India, I’ve been studying claims of cryptographers that they’ve “proved” mathematically that their system of encryption, digital signature, or exchange of secret keys is secure and safe from cybercriminals. It turns out that many of these “proofs” have fallacies or logical weaknesses and do not support anything like what is claimed for them. The reaction of some of the authors whom we’ve criticized is similar to that of my geometry teacher a half-century earlier.

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Family and cultural surroundings play a large role in whether young people are attracted to the sciences and achieve success there. My father was a college professor and my mother was a schoolteacher. Although neither was a scientist, they attached great importance to the intellectual development of their children and were always supportive of my interests in math and science.

My generation of Americans was unusual. We were the "post-Sputnik" generation that benefited from the big push to improve education in the sciences so as to "catch up to the Russians" and beat them to the Moon. In addition, starting around 1960 many young people mobilized in support of civil rights for African Americans. Then a few years later we mobilized to protest against the barbaric American War against Vietnam.

By today's standards, our material lives were simple. Compared to American students today, we had few material possessions and few distractions. It was much easier to concentrate on what was important — such as our studies. Serious students tended to scorn the excessive commercialism that we saw taking hold of our country.

As we grew older, many of us who entered the sciences kept this belief in rejecting the extreme consumer culture that was promoted in the U.S. media. In 1982 my friend and colleague Hà Huy Khoái visited me in Seattle; he was one of the first Vietnamese scientists to visit the U.S. At the end of his stay, I asked him what in the U.S. had been most surprising to him — something he would be sure to tell people about in Vietnam when he reported on his visit. He said it was that American professors often carry backpacks and ride a bicycle to work. In Vietnam at that time backpacks and bicycles were associated with hardship and poverty. For us in Seattle, bicycles were seen as an inexpensive form of transportation that is good for the environment and good for our health. At the age of 73, I still bicycle to work.

A problem in the U.S. and some other countries is that young people are too distracted — by their cellphones, by social media, and by the consumer culture that surrounds them. It's necessary to break free of those distractions in order to study math and science at the highest levels.

Vietnam has a longstanding tradition, going back to Văn miếu, of great respect for scholarly achievement. Vietnam's senior scientists can help the younger generation remain faithful to that tradition.

When my wife Ann and I were in Vietnam in August 1995 to celebrate the 10th anniversary of the Kovalevskaia Prizes, the Vietnam Women's Union had a group of women students visiting Hanoi from different parts of Vietnam. We joined the group at the Hanoi Mathematical Institute, where we heard the late Professor Hoàng Tụy talk to them about why they should pursue a career that they truly love — such as scientific research — rather than one that might be more lucrative or popular among friends. The young women were fascinated; most likely they had never heard an eminent scientist speak from the heart in such a manner.

Scientists and mathematicians in Vietnam have an important role to play in helping the younger generation resist the lure of false values and false priorities imported from the West.

Vietnamese young people have tremendous advantages compared to the generation of Hoàng Tụy and other pioneers of science in Vietnam. When Ann and I first visited Vietnam in 1978, it was one of the poorest countries on Earth, struggling to recover from many decades of devastating war and colonial subjugation. Vietnam was isolated. Except for those who went for advanced study in the socialist countries, Vietnamese people had little contact with other countries. There was of course no Internet or cellphone communication, and the postal service worked poorly. When I left Vietnam after our early visits, my colleagues would give me mathematical correspondence and preprints for me to mail in the West so that they'd reach their destination.

Opportunities for ambitious young scientists and mathematicians are much greater now. Vietnam is fully integrated into international networks. Major conferences are held in Vietnam. In 2016 I came to Hanoi for the first Asiacrypt (Asian cryptography conference) to be held in Vietnam. It was an impressive event, expertly organized by Professors Ngô Bảo Châu and Phan Dương Hiệu.

If young people take full advantage of these opportunities, they will bring honor to the intellectual traditions of Vietnam, and Vietnam will have a bright future in science and technology.

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I'd like to conclude by listing some actions that the government and institutions of Vietnam can take in order to increase the scientific potential of the younger generation.

● Mobilize researchers from the Vietnam Academy of Science and Technology, winners of the Kovalevskaia Prizes, and other leading scientists to visit secondary schools and universities. They should talk to the students about their work and lead them in activities designed to convey the joy of scientific discovery.

● Start programs at universities outside of the usual course framework that introduce students to actual scientific work. This would be similar to the Research Experiences for Undergraduates (REUs) that are supported by government funding at many U.S. universities.

● Start internship programs for university students at scientific research institutes and industrial laboratories. In North America such internships were pioneered at the University of Waterloo, Canada’s leading technical university, more than 50 years ago.

● Greatly expand Masters programs in scientific subjects. Vietnamese students should be encouraged to get a Masters degree before going abroad for a PhD. In that way they will (1) be more competitive for the best international PhD programs, (2) get greater benefit from such programs, and (3) be more likely to return to Vietnam rather than join the “brain drain”.

● Make special efforts to attract women and economically disadvantaged groups, including ethnic minorities, to the sciences. The scientific professions should welcome everyone, not just the privileged and not just men.