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AQ FEATURE

The Pull and Example of Science Education in the United States

BY Timothy DeVoogd

U.S.-Latin American study abroad programs deliver results in Chile, Colombia and Brazil.

I expected high school biology students. Instead, I was facing 120 middle school students who were on an outing to Maloka, an innovative science museum in Bogotá.

On the fly, I changed my presentation on how the brain works into a series of demonstrations. At the end, I was awed by the questions: "My mother has epilepsy; why is it that she doesn't recognize me when she has a seizure?" "I have a pet bird. Does he learn like I do?"

The desire to learn and discover more was palpable. Yes, Latin America lags on indices of learning, not just behind Europe and North America, but behind Asian countries with similar incomes. And it's easy to attribute the deficits to low GDPs, civil unrest, high indices of inequality, or a culture in which education focused on the liberal arts.

My experience four years ago affirmed that love of scientific learning is universal in children. It helped pull me into working with higher education in Latin America, especially in the science, technology, engineering, and mathematics (STEM) fields—and in trying to promote practices such as collaborations and exchanges that I believe will lead to improved educational outcomes and, ultimately, faster national development.

What follows is a sketch of the conditions in a number of countries in the region and some proposals for how we can better integrate our hemisphere in STEM education and research. It draws on conversations with scores of scientists and administrators, both at universities and in governments throughout the Americas, and my own experiences as a neuroscientist.

The Hurdles to Excellence

First, the bad news. While the number of Latin American students entering tertiary education is large and growing, huge variation exists in the quality of universities across the region. Many teach few usable skills and send out graduates with unaffordable debt.

Even the best schools fare poorly in world assessments. The current QS rankings used to rank universities globally list three Latin American universities in the top 200 and six more in the next 100; all these from just five of the region's more than 20 countries: Brazil, Chile, Mexico, Colombia, and Argentina.

It's not just a question of money. Latin America trails countries with similar GDPs in a variety of measures of innovation and discovery, from scientific publications to patents. Throughout the region, visionary and creative educators, administrators and scientists are trying novel approaches to build university education and research and to stimulate the sort of development that has occurred over recent decades in Asia. Unfortunately, they aren't given the educational and infrastructural support that their counterparts across the Pacific receive.

A common goal in Latin America is increased internationalization of universities, including research collaborations and access to graduate training with countries in the global north. Chile is far along the path to first-world status, in part because of close ties with the United States fostered under the Alliance for Progress in the 1960s. Many of Chile's leaders in government, industry, agriculture, and science received part of their education in the United States. It's easy to trace the pathways by which such initial encounters led to the growth of such industries as wine, fish farming and fruit exports, among others.

Recent Chilean governments have sustained such international connections through scholarships for master's and PhD study abroad under a program called *Becas Chile* (Chile Scholarships), funded by a tax on copper. While the award would seem to be a wonderful resource for students and an ideal way to build national capacity in select disciplines, some poorly thought out administrative practices have been holding the program back.

For example, there's a bizarre provision that the government of Chile will only consider an application for the award after a student has been accepted to one of 150 or so universities outside the country (80 in the U.S.). However, graduate programs in elite universities such as Cornell only accept as many students as they can financially support. If students were to receive the award before they applied for graduate study (as can occur with National Science Foundation fellowships in the U.S.), their chances of admission would increase.

Additionally, committee review of scholarship applications occurs during the Northern Hemisphere's summer, just a few short weeks before the August start date for most U.S. universities. This can complicate a student's ability to accept a scholarship, even if it's awarded. As a result, millions of scholarship dollars have gone untouched in recent years.

Learning by doing: Students funded by Colciencias work in a classroom. Photo courtesy of Tim DeVoogd.

Recently, Colombia created a development fund from a tax on extracted minerals. The aim of Colombia's program was similar to Chile's—to leverage revenues from natural resource extraction to build capacity in areas of national priority through international education and innovation. As in Chile, this visionary and strategic innovation has been mired in controversy for several years and is not yet fully implemented.

Juan Francisco Miranda, former director of *Colciencias* (the Colombian national agency for science, technology and innovation), helped to shape the legislation and anticipated administering the fund once it was in place. However, President Juan Manuel Santos chose to replace him with Jaime Restrepo, who was unable to decide on and get approval of a manageable number of national priorities. Bioprospecting, engineering better ports, scaling up dairy and cheese-making, constructing better after-market auto parts, nanotechnology, and dozens of other worthy aims were presented as national research priorities, but little came of them. Restrepo was dismissed after just two years in office, after public disagreements with the president.

In the absence of proven leadership in the project, the government shifted the funds to individual departments (states), which could determine their own goals. This was perhaps useful in cementing political alliances, but is ineffective as a coherent development strategy. Approval of such departmental decisions still resides with *Colciencias*, and without much guidance on the national priorities, it has endorsed only a few recommendations to date, leaving a program with generous funding but no clear direction.

Brazil's *Ciência sem Fronteiras* (Science Without Borders) has been far more effective. Launched by President Dilma Rousseff in 2011, the government has allocated large sums of money for international education, including graduate degrees abroad and a junior year abroad program for highly qualified students in STEM fields.

Cornell has accepted 61 students under this program, with all costs, airfare, tuition, room and board, books, and insurance paid for by the *Coordenação de Aperfeiçoamento de Pessoal de Nível Superior* (Coordinator for the Improvement of Higher Education—CAPES) and the Brazilian science ministry. Even within the past 18 months, Brazil has demonstrably benefitted from the program. Students have become co-authors on research projects carried out with U.S. mentors. U.S. universities have actively sought Brazilian students to return to the U.S. for graduate school after they complete their degrees back home. A number of major corporations have offered jobs to Brazilian students doing summer internships (including companies planning on opening or expanding plants in Brazil).

Then there's the effect of such programs on the students themselves, as I have witnessed. The Chilean and Brazilian students whom I've worked with have talked glowingly of their time in the U.S. and of their impressions of the country and its people. Most tellingly for Latin America, they have spoken with wonder of the commitment U.S. professors have to research, and of the learning and discovery that occurs when a student and a professor carry out research projects together.

Ensuring Better Access

One of the greatest challenges for these programs—and any future ones—is the need to address the region's existing social and educational stratification. Cornell requires a high score on the TOEFL (English proficiency exam) for admission. Science students who have that level of English typically went to private high schools or come from families with resources and opportunity to travel. The poor, Indigenous and people of African descent often have not had those opportunities.

A partial answer to this structural problem is to select program participants based solely on academic achievement, irrespective of language proficiency; those whose English is inadequate would be placed in an 18-month program in which the first six months before academic study are dedicated to intensive English–language studies. Brazil has funded a number of such programs in the U.S., but budget constraints may force the program to scale back.

Mexico is currently designing similar exchange programs under the 100,000 Strong initiative, but doesn't yet have a way of dealing with this issue. Ideally, C*onsejo Nacional de Ciencia y Tecnología* (National Council of Science and Technology—CONACYT) would coordinate the entire effort, as CAPES does in Brazil. However, CONACYT does not take responsibility for English in its scholarship programs and doesn't support undergraduate study abroad. At this time, it doesn't envision asking President Enrique Peña Nieto or Congress for permission to increase its mandate accordingly.

Smaller countries are following in the footsteps of their larger neighbors, creating their own scholarship programs to train promising students overseas. In Paraguay, President Horacio Cartes approved a scholarship program limited to students from lower socioeconomic backgrounds. While this program, codified under a legislative amendment, represented a well-intentioned effort to help less advantaged students study in prestigious U.S. schools—schools that they otherwise could not afford—the targeted students often lack the preparation to qualify for admission, and students with more resources who do not qualify for this program are still unable to afford elite U.S. universities. To date, Cornell has received no students with these scholarships.

National scholarship programs try to stretch their funds by negotiating with U.S. host institutions. This approach has had some success: several state university systems have agreed to charge Latin American students in-state tuition, often as a result of pairings first made under the Alliance for Progress. However, this typically does not happen with elite U.S. schools. Universities like Cornell, for instance, receive thousands of applications every year from Asian students willing to pay full tuition, and so rarely make special agreements. In an alternative arrangement, Harvard has set up a foundation in Mexico, substantially funded by Mexican alumni, that provides need-based aid to any Mexican student accepted to a Harvard graduate program. This has resulted in a huge increase in applications to Harvard from Mexican students, and is a model that could be followed by other U.S. universities and encouraged by Latin American governments.

Improving Local Quality

Another major goal in Latin America is to raise the quality of universities. Editorials, policy papers and statements of strategic goals have exhorted leaders to move to a knowledge economy with a culture of learning. Hundreds of campaign speeches have pledged to turn universities into centers of innovation and entrepreneurship. While much is being achieved, progress is uneven.

U.S.-style research institutions and programs have not emerged evenly or widely across the region. The reasons for these failures stem in part from the misguided effort to impose these changes from above. The U.S. happened on a model for science that linked university research to government funding and industrial production. Wildly successful, it was driven by the radical changes forced on universities to speed up innovation because of World War II. Under the remarkable leadership of Vannevar Bush (head of the Office of Scientific Research and Development), the federal government began massive support of STEM research at universities. Discoveries in turn were shared with industry to be rapidly moved into production for the war effort.

The National Science Foundation was started after the war to sustain this process of discovery and development. Funding for this system of science was maintained as a result of Cold War competition with the Soviet Union, and further energized by Sputnik. The program now includes funding for research based on researcher-generated ideas and projects from a range of life or physical sciences. Funding is based on rankings that are determined by peer review and includes routine payment of indirect costs, discovery ownership by the researchers and the university, a system for ethical oversight, and transparency of the entire process.

When Latin American countries and universities have emulated these principles and processes, they have achieved similar bursts of productivity. Unfortunately, peer-reviewed research and independent, researcher-driven funding have been far from the norm in the region.

An essential ingredient of the U.S. system of science is payment of indirect costs to universities. If research is a key component of the mission of a university, the university must provide the infrastructure to support it, including laboratories, access to scientific journals, electricity and, most basically, provision of time for faculty members that is not consumed by teaching. Since U.S. universities get funding for indirect costs only when a faculty member is successful in getting grant support, they have strong incentives to assist the faculty member in setting up a lab, applying for the grant, and carrying out the research.

Wide variation also exists in legal and practical issues related to intellectual property. Obtaining patents is difficult in many countries, and universities typically do not have legal offices to assist in the process, as is common in the United States. More insidious is the lack of a clear definition of ownership. Governments often assert that research carried out with federal funds at public universities belongs to the government. This dampens any incentive to do research within the university.

Several faculty members at the *Universidad Nacional de Colombia* told me of discoveries they had made that are potentially marketable and either have not been pursued or may be pursued in the future in a venue outside the university. The logical answer is for universities, including public ones, to co-own discoveries with the researcher, and be free to sell them to industries and retain the profits.

Last, transparency and oversight are critical. It has been too common throughout the region for money to flow to relatives of those in power. Even in the world of funding for scientific research, researchers question whether decisions are based on merit alone. Publication of proposals and public access to data would ease some of this distrust. A functioning avenue for dealing with misuse of funds or scientific error would go further.

The U.S. Fulbright scholarship program has shown that awards for research based on merit can be

done. As a result, in Paraguay, Panama, Colombia, and elsewhere, in-country scholarship money has been transferred to Fulbright programs because of the certainty that it will be fairly awarded and administered.

How to Change It

Academic programs in the U.S. that last a year or longer are expensive. They take time and require an efficient administrative structure. However, many less expensive and more nimble forms of interaction are possible. For example, Mexico is starting a program where undergraduate students in the sciences spend summers at U.S. research labs.

On a smaller scale, research universities in the U.S. have weekly colloquia in most of their stem departments. These could easily be live-streamed to similar departments in Latin America. Semester-long seminars could be jointly offered, with students at each university being assessed and receiving credit within their own institution. At Cornell, we have done this during the past semester for a course with a group from the *Instituto Tecnológico y de Estudios Superiores de Monterrey* (Monterrey Institute of Technology and Higher Education), and in June we met another group in Chiapas for a three-week field trip.

Existing semester-abroad programs for students coming from the U.S. typically focus on language and culture. However, students in STEM fields are often not served by such programs. We have created a new program for such students in which they are placed in research labs at major universities. They can augment their knowledge of techniques and research questions within their field, while joining a ready-made "family" who by necessity speaks English. If needed, they can take intensive language instruction outside the lab. This program is starting with opportunities in molecular biology and neuroscience at the University of Havana, and will continue with astronomy, robotics, glaciology, and atmospheric science at universities in Chile.

U.S. professors are often reluctant to spend an entire sabbatical leave at a Latin American university. However, many are willing to offer one-week short courses in their disciplines. Similarly, short-term visits to labs in the U.S. are practical for Latin American faculty members with full teaching commitments, as well as highly useful for becoming current in research and joining a network that can then be used in future collaborations.

Some government and university officials worry that such initiatives encourage brain drain. However, creative incentives to return can minimize this.

CONACYT in Mexico has a program that subsidizes a returning scientist's initial salary. Other agencies provide loans for study abroad that are forgiven on returning and working in national universities or research institutes. More visionary officials are recognizing that having citizens in prominent positions abroad can be a resource for training, collaborations and oversight of national programs. CONACYT has a program that provides funds to citizens employed abroad for time spent on collaboration during return visits to Mexico.

Most of the ideas discussed above have been proposed or even implemented in one or another Latin American country. However, as I've traveled throughout the region, I've been surprised at the extent

that I've resembled an itinerant medieval scholar, bringing unheard-of news from far-off lands. Increased South–South communication and cooperation can help. A significant part of the transformation is simply believing that it's possible and requesting that governments follow through on their campaign promises. On one of my trips to Bogotá, I was taken to a high-crime, high-drug area in the south of the city. A facility had been created there with advanced equipment in biology and engineering. Local high school students would line up at 6 a.m. waiting for the doors to open and were soon designing bridges or learning to sequence DNA.

I was told that on one occasion, the CEO of a major firm toured the facility and was deeply impressed, thanking the director and the government ministry that created it for so effectively training future employees. One of the students then said as the CEO was leaving that he didn't want to work for the company; he wanted to own it.

That intelligence, that creativity, that ambition are close to the surface throughout Latin America. Students want to do more than walk. With facilitation from government and universities, they can fly.

John W Finn · 7 months ago

TIm, great article. Good point about the lack of South-South cooperation to share indigenous innovations. And it's thrilling to hear how much Cornell has implemented. So glad you are continuing the mission you worked on as a Jefferson Fellow.

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