

Science for Nicaragua Newsletter

Produced by the Nicaragua Committee of Science for the People

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Conference on mathematics teaching

Dartmouth mathematician John Lamperti has just sent Science for Nicaragua a copy of the proceedings of the "First meeting of mathematics teachers in higher education," which he attended during his visit to Managua this January. The day-long conference, sponsored by Nicaragua's National Council of Higher Education (CNES), featured six presentations on the state of mathematics education in Nicaragua, which all speakers agreed was in need of improvement. "[A]cademic performance [in mathematics] has traditionally been low in comparison with other subjects," observed CNES, in calling for this conference. In this article we present the results of a survey of student opinions on mathematics teaching, and an experimental approach being pioneered in the UNAN-Managua (National Autonomous University). Our next issue will discuss mathematics programs at the high school and first-year college level.

Students speak out

The survey, carried out by the National Union of Nicaraguan Students, posed the following question to 305 students in their first and second years of college: "What is your opinion of mathematics education, your own learning of mathematics, and your professors?" Of those surveyed, 27% considered the study of mathematics to be very important, even necessary for every professional's training; only 7% described mathematics as unimportant or unnecessary. While 69 of those responding found their math professors well-prepared technically, pedagogically, and methodologically, 67, including 45 economics majors, found their professors wanting. A fair number of students felt the need for new teaching methods, with fewer lectures and more classroom participation.

Other observations: About 12% of the students felt they didn't devote enough time to studying, and mentioned the need for home-work assignments (!). A number of students called for a more consistent use of study circles and tutors.

Students of education and the humanities were not included in the survey, nor were students at the UNAN-León, which until a few years ago was the only school offering degree programs in mathematics and the basic sciences.

Edgard Romero's mathematical laboratory

"For Nicaragua to be self-sufficient, we need a certain number of scientists capable of responding to the technical problems facing the country...For this, we need scientists who have mastered the basics of their sciences, who know other sciences, and who have the ability and the confidence needed to continue learning whatever is necessary to respond to a given situation. When our students leave the university, the most important thing we will have imparted to them is not some specific material, but rather the ability to learn...We need to create students with creativity."

These opinions of Edgard Romero are widely shared in Nicaragua. Romero, a mathematician from Seattle, has been teaching at UNAN-Managua since 1981. His concern for teaching students the ability to learn has led him to introduce radically new teaching methods into the first year mathematics program. In Romero's "laboratory" there are no lectures. Students work alone or in small groups on problem sets designed by the teacher, whose role is to guide the students toward discovery of solutions, rather than to provide pre-packaged techniques for the students to memorize. "Learning is an activity where the student constructs for

him/herself a picture of the world...The motivating force of the class must always be the student's curiosity."

Course work is completed at the student's own pace, a great advantage in a country where wartime conditions force most students to miss classes from time to time. Students who advance more quickly are encouraged to help the others; "total mastery of the material by every student" is a realistic goal. To encourage students not to be afraid to make mistakes, Romero symbolically gave each of them a pencil and an eraser on the first day of class.

The first year math program at UNAN-Managua covers elementary material, divided into three courses: logic, geometry, and "basic mathematics" (what we would call pre-calculus). Romero combined this material into a single course of 16 hours a week, reasoning that students benefit from the consistent attention of a single instructor, and that in any case the division of mathematics into distinct subjects is artificial at this level. Romero points out that teachers who don't have to prepare daily lectures have more time to spend with individual students. Combining subjects allows the instructor to take a direct interest in the development of each student.

"In the process we follow," writes Romero, "we often invert what would be called the logical order of presentation. Instead of first presenting the definitions and small observations needed to solve a big problem, we start from the problem itself...We follow the historical order, rather than an artificial logic. For example, when we begin the study of series, the students have already seen two important uses of series: Archimedes' proof that the area of the circle is πr^2 , and his calculation of the value of π ...[W]e also carry out the calculation of the area under a parabola, since it's a good motivation for integration in general. We do all this before defining series. But when we finally did define series, the students already knew why series are studied."

Romero's presentation also highlighted some of the real material problems facing students in Nicaragua. Everything is in short supply: books, paper, classroom equipment. Fewer than 10% of students at UNAN can study in their overcrowded homes. Almost all students spend at least two hours a day getting to and from school. Very few students can take lunch at the university; thus most cannot stay for afternoon classes.

Student response to Romero's "laboratory" has been overwhelmingly positive, confirming some of the opinions expressed in the survey discussed above. Romero's mathematical colleagues have been more skeptical, worrying that such a method only works well with small classes, a luxury in a country suffering from a serious shortage of professors. Nevertheless, the experiment will continue. In Romero's words, "Although the scientific history of this century is not being made here [in Nicaragua], the history of Latin America is indeed being made here, for this century and the next."

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On the Road to a "New Education"

by Rob Wilson

When Juan Sánchez Barquero, rector of Managua's National Engineering University, the UNI, discussed with me the role he envisions science and technology playing in Nicaragua's development, he talked first of the enormous problems he and his peers must overcome. Never mind the laudable advances already made in higher education, he said: The university system still has a long way to go before it fully develops the "new knowledge, spirit, and education" his country needs to catch up technologically and scientifically with the 20th century.

He also emphasized why the "internacionalistas"—the foreign professors and instructors working at UNI and other Nicaraguan universities—are vital to the retooling of his country's system of scientific education.

It was true that the Contra war and the resulting supply shortages and tightened university budgets posed serious problems to higher education in Nicaragua. Yet, he said, even if the war were to end tomorrow, serious problems would persist.

"In the time of Somoza, there was no interest in training people [in college] to participate in the primary sectors of the economy," Sánchez explained, his voice nearly drowned out by the rattling of the old air conditioner in his small office. "In the universities, there was no planning toward which careers were the most important. In technical areas like engineering, most projects were done by international consultants. Nicaraguans weren't taught the skills. The government had more confidence in foreigners than in their own professionals."

Nicaragua is still paying the price for the shortsighted educational policies of the Somoza years, complained Sánchez, who studied civil engineering and taught in Mexico in the mid-sixties, then returned to his homeland. Many in the already small pool of experts who taught at the college level moved into government administration when the Sandinistas vastly expanded the country's private sector. They now are responsible for planning and overseeing important science, manufacturing, and high-tech projects in ministries, labs, and factories. To compound this drain on human resources, over 40% of Nicaragua's science professionals and professors have left the country, some because of political differences with the Sandinistas, others fleeing the harsh standard of living in a country where nearly half the GNP goes to the war effort.

"UNI [founded in 1983] was the first engineering school in this country. It was born in a time of great difficulty, with no labs, libraries, and books," the administrator recalled. "And it was born without all the human resources it needed. The material shortages give us big problems, but the biggest problem is with the quality of our teaching. Our teachers are most important: If they are experts in their field, they can help make the material shortages less serious."

At UNI, about 85 of the 280 full- and part-time staff are "internacionalistas." Teachers who work through Science for Nicaragua, Sánchez said, already make up an important component of the international teaching community at the university.

A Student's View

While on a fall visit of over 20 educational, scientific, and technical job sites in Nicaragua where U.S. professionals were working, I spoke with administrators like Sánchez, as well as a variety of managers, government officials, professionals, and students. During my three-week visit, an information-gathering and media project made on behalf of SftP's Nicaragua program and tecNICA*, I also had a chance to visit extensively with the U.S. teachers and volunteers.

My overwhelming impression was that the Americans had quickly settled into their jobs, adapted to difficult working

*A four-year old organization which sends volunteers to work on short-term technical projects in universities, ministries, businesses, and factories.

conditions and a cacaphony of troublesome external factors such as frequent electrical outages, water rationing, poor phone communications, and a military draft and reserve system that might call up one's students or co-workers.

It was also evident that these U.S. citizens, working on pre-organized and planned projects, were having a positive, measurable impact on their workplaces, whether in a university lab, a ministry computer facility, or a machine shop. The tangible benefits the U.S. professionals offered were particularly evident in classroom situations. Here, students enthusiastically recounted the advantages of the Sandinista-initiated and supported university system. They also were candid about the problems and shortcomings of higher education in Nicaragua.

"For a long time, we had advanced students teaching those of us in our basic years," said Fernando Barcenás, a 37-year-old student at UNI in his final term of study. "Often these were people with no [practical] experience. The people from [SftP] and other international programs have given us instructors who have the background and preparation to teach us technical specialties."

Barcenás, an electrician who took up arms against the Somoza government in the mid-seventies and marched into Managua with the victorious Sandinista forces in 1979, does not take his opportunities in education lightly. Like many of his engineering classmates, he holds down a full-time job and attends classes in the late afternoon or at night. A member of the army reserve, he may be pulled away from classes and job on a day's notice.

On a quick tour of UNI's computer lab—a facility with a collection of six functioning personal computers and a back room stacked with as much broken machinery—another student described the new curriculum opportunities that had opened up at the school in the past year. She also lamented the lack of computer time available to students, and mentioned having "only a half hour" to work on a PC. I naively wondered whether she meant 30 minutes per day or per week.

"She was talking about a half hour a semester," a West German coordinator of UNI's computer science department later informed me. "That's a tremendous step forward over last year, when each student got an average of 15 minutes per semester on a machine. When you consider that the ideal number of hours per student at many western universities is about 90 hours a semester, you get an idea of what the situation is like for these students."

Teacher Training Very Important

Many Nicaraguans feel teacher training is one of the most important aspects of Science for Nicaragua. Free tuition and vastly expanded elementary and secondary school systems, recently-added departments and majors, as well as whole new colleges like UNI, dictate that advanced students will continue to participate in the university teaching process for some time. Many of the senior level students working with SftP instructors are or will soon be cast in the role of student teacher.

Some of the SftP teachers, like Donna Perdue, an expert in plant physiology, worked nearly exclusively with Nicaraguan university instructors. "[The teacher education program] is a common-sense approach to a very large problem," said Perdue, as she prepared for a class in her tiny office—a desk sandwiched between shelves of reptiles and plants preserved in jars of formaldehyde. "If the level of teaching expertise is low, the quality of training will be low and the next generation of teachers will be poorly prepared. It's a vicious circle that can be broken only by improving the skills of the instructors."

At the UNAN-Managua, Barbara Kritt, a 30-year-old Ph.D. candidate in sociology at the University of Michigan, also worked with university staff, advanced students, and full-time employees at an economics research institute. Like many foreigners working in Nicaraguan universities, she found herself adapting her teaching to

some unexpected subjects.

"The two courses I had planned to teach were cancelled, so I'm teaching statistical analysis and research methodology," she said. "Some of my students are turning right around and teaching their students what they've learned from me."

Curriculum Development

Despite the obvious impact they are having on the content and quality of higher education, the North Americans working in the universities emphasize that their curricula are formulated in careful consultation with their Nicaraguan hosts and students.

"The [curriculum] priorities are ultimately made by people here," Perdue said. "There is a tremendous respect for us, and our background, but there is no assumption that what [we] recommend is necessarily correct."

According to Manuel Toledo, an electrical engineer from Puerto Rico who taught at UNI in the SftP program, the technical courses reflect the ideology as well as the academic needs of Nicaraguan higher education. "[The Nicaraguans] believe that technology has a real use for the society, that it should be enjoyed by everyone," said Toledo, who was the area coordinator of the electronic engineering department. "The classes in my department teach how to apply science to solve human needs."

The 29-year old engineer, who taught technical courses at several Boston-area colleges before joining SfN, added that many of his American students fantasized constantly about high-paying manufacturing and management positions at firms engaged in aerospace, weapons development, and other defense-related work. "Here, students seem more interested in designing everyday, practical things and making them work," he said.

At UNAN, the head of the computer department, 36-year-old Luis Alberto Williams, elaborated on Toledo's point. The department boasts four IBM XT clones where, last year, there were no computers at all. "When we created all these programs and courses after the Triumph, we weren't thinking about technology for war, we were thinking about technology for the good of the country," he said, over lunch on a shaded campus bench that he shared with the Canadian and Swedish computer instructors in his department.

Alberto, like Sánchez at UNI, talked of the formidable lack of supplies, spare parts, machinery and other resources that had hamstrung the university system's efforts to deliver even simple technology and, more importantly, the personnel to make it work for the people. And he enthusiastically discussed how the problems had been and would be "conquered, one little step at a time."

When lunch was over and he prepared to return to the always-busy computer center, Alberto asked me the rhetorical question that many Nicaraguan administrators, professors, and students had posed. "What do you think we might be able to do with that \$100 million, if your government gave it to us and not to the Contras?" he asked, with a smile.

Announcements

*** New Berkeley office *** Robert Van Buskirk, a founding member of SfN, recently left Cambridge to continue his graduate studies in the U.C. Berkeley Physics department. In Berkeley, Robert has opened an office of SfN, which will take primary responsibility for recruitment and placement of instructors, as well as for expanding the program on the West Coast. The Berkeley office is located at 1627 Euclid St., Berkeley, CA 94709; telephone (415)-549-1233.

*** Agreement with CONAPRO *** During his January visit to Nicaragua, Víctor López-Tosado of the SftP Nicaragua Committee signed a *Convenio de Colaboración* between SftP and the Nicaraguan Federation of Professional Associations (CONAPRO). This agreement will provide SfN instructors with the opportunity to organize training seminars to members of CONAPRO, who include professionals of all categories. CONAPRO is especially interested in seminars in engineering, forestry, health, mathematics and statistics, and agriculture.

A complete report on Dr. López-Tosado's trip will appear in the next issue of this newsletter.

*** Update: March 1987 *** As of this writing, six SftP instructors have been confirmed to begin teaching this March. Three will be going to the Universidad Centroamericana (UCA): Cornell University grad student *Ralph Bierlen* will be teaching agricultural economics; *Robert Sutcliffe*, a developmental economist from U. Mass. Amherst, will visit the sociology department; and *Carlos Suarez*, a graduate student in physiology at Boston U. medical school, will teach in the biochemistry department. *Kathryn De Riemer* will be leaving Bolivia to teach biology at UNAN-Managua, where *Jeffrey Woodside*, a particle physicist from Madison, WI, will be teaching physics. Finally, *Thomas Jackson*, a hydrologist from Baltimore, will be teaching civil engineering at the UNI, as well as working on specific water projects sponsored by Elders for Survival (see below).

*** Positions for Environmental Engineers *** Elders for Survival, a San Francisco-based group which has organized two brigades of older people to pick coffee in Nicaragua, has for two years been recruiting hydrologists to work with IRENA and INAA, the Nicaraguan agencies concerned with water resources and the environment. Several have stayed for up to six months; another spent six weeks giving a course in applied hydrology to a group of 23 Nicaraguan engineers.

IRENA is now looking for specialists who can help Nicaragua overcome its extensive problems with toxic wastes and unclean water, which

"...have arisen as a direct consequence of the misuse of natural resources, the use of technology inappropriate to our circumstances, the employment of inadequate traditional cultural practices by rural inhabitants, the lack of economic resources to

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control and reduce the discharge of domestic, industrial, and agricultural waste into the environment, the accelerated concentration of population and industry in rural areas (due to the lack of land planning in accord with our development), etc.

The Elders are hoping to fill two positions for IRENA: a *sanitary engineer*, with special expertise in water quality and the treatment and disposal of toxic waste; and a *specialist in the preparation of environmental impact statements*. Inquiries should be addressed to the SfN Berkeley office (address above).

Science, Food, and the Contra War

We are often asked why we have chosen to send scientists to Nicaragua and not to any of the other impoverished countries of Central America. The reason is simple. Like most Third World economies, those of Central America have historically been dominated by the markets for certain cash crops—bananas, coffee, sugar cane...—and as a result have been unable to achieve self-sufficiency in food production, let alone to develop even a rudimentary industrial base. Nicaragua is the only country in the region attempting to break out of this cycle of dependency. No other Central American country has put in place a system of education capable of assimilating the kind of expertise provided by SfN, because no other Central American country has made a priority of developing an indigenous science and technology.

An article in the November 27 issue of *New Scientist* describes agricultural research at the National University in León (UNAN-L), based on inexpensive and easily accessible biotechnology. Donna Perdue, one of the authors of the article, spent the fall semester of 1986 as a Science for Nicaragua instructor in the School of Ecology of the Universidad Centroamericana (UCA) in Managua. We are including excerpts from the article, which illustrate Nicaragua's inventiveness in adapting state-of-the-art science to local conditions.

"The production of beans, a staple part of the Nicaraguan diet, has been seriously affected by the war—Contras have attacked agricultural cooperatives, killed peasant farmers and government workers, and prevented transport in important growing regions in the north of the country. Farmers are now growing beans and maize on the old cotton lands on the Pacific coast...Ecologists at the [UNAN-L] are beginning to study ways of controlling pests on these food crops, which are being grown on a large scale under new conditions...[R]esearchers are seeking cheaper alternatives [to imported pesticides and herbicides] in the form of biological control measures and integrated programmes for managing pests.

"A new biological-control laboratory at [UNAN-L], partly funded by the Organization of American States and Oxfam (America), is rearing parasites and predators that attack the noctuid moths which are the principal pests of maize and beans in the area. Workers at the laboratory have reared an indigenous species of...a parasitic wasp that attacks the moths' eggs, in the laboratory. In field trials, they have managed to infect 70 to 80 percent of noctuid eggs with parasites.

"Another pioneering venture is a project currently underway at the Biological Control Laboratory of the Agricultural University in Managua. Here, ecologists are looking for a substrate that can be produced from local raw materials on which to culture *Bacillus thuringiensis*, a bacterium which, when sprayed on crops, kills caterpillars without harming vertebrates or other insects. If the project is successful, it could result in the first large-scale production facility for this pathogen in the Third World."

The article also describes Nicaragua's efforts to encourage conservation of its rainforests, 30% of which had been converted to grazing land during the last ten years of the Somoza dictatorship. "The country's National Park Service has proposed to Nicaragua's neighbors, Costa Rica ... and Honduras ... that they create two large, international biosphere reserves across their borders, under the auspices of UNESCO...Sadly, for both the conservation of forests and for the Nicaraguan people, the US has built several new military bases on the border of Honduras.

"The challenge now facing students and scientists in Nicaragua is to build the scientific base necessary to fulfill the promise of the revolution to feed the people. However, because of the war against the Contras, even this important task has to take second place to bouts of military service and spells with the coffee-picking brigades."

Donna has now returned to Cornell University, where she is a graduate student in plant physiology. She is currently in the process of preparing the lecture notes from her course at the UCA to be printed up for future use in Nicaragua.

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