Mathematicians and Education Reform ...Forum...

Summer 2000 *Special Issue* Volume 12 Number 3

Minority Mathematicians: Who is responsible?

by Raymond Johnson, University of Maryland, College Park

The underrepresentation of minorities in science, mathematics and engineering is frequently explained by pointing fingers. Graduate school professors complain about the quality of American students attracted to further study in mathematics. The fact that university professors trained the very students of whom they complain is rarely mentioned. It is particularly striking to me that we find the undergraduate preparation of foreign students noteworthy, but not enough to modify our training and expectations.

The same professors complain about the mathematical knowledge of students coming into the university. However, it is also unusual for mathematics professors to take responsibility for the mathematical training of elementary, middle-school and high school teachers of mathematics. The problem is always placed somewhere else— the school of education and the stifling bureaucracy in the school system are pointed to as causes— but rarely is a mirror used. The forthcoming CBMS report on the Mathematics Education of Teachers will offer departments an opportunity to contemplate their proper role in this area.

Bill Vélez has seen the effects of these attitudes on the number of minority students who receive Ph.D.'s from a variety of perspectives: as a program officer at NSF, a faculty member at Arizona and as a member and Past President of the Society for Advancement of Chicanos and Native Americans in Science. Sadly, for all of the so called good will in the mathematics community, it seems

continued on page 2

Minority Mathematicians: Who is responsible? was a section of three talks in the special session on Mathematics and Education Reform at the 2000 January Joint Mathematics Meeting in Washington, DC. This special issue, which includes three articles based on the presentations and two additional articles, continues the discussion about the issues and successful approaches to improve the participation of underrepresented minorities in mathematics, especially at the graduate level and in college and university mathematics departments.

Inside Contents

continued from page 1

that more Ph.D.'s were produced in the "racist" forties and fifties. At least, enough good people were produced to staff the mathematics faculty at historically black colleges and minority institutions. Now, because of the poor production of minority Ph.D.'s, and because of the better job opportunities that those Ph.D.'s have, we are unable to replace retiring faculty at the historically black colleges and minority institutions.

There are, of course, many schools that are experimenting with various aspects of their curricula and I believe that over time, we will see stronger mathematics students come out of such programs, but the attitudes of the mathematics community toward its students gives them an additional hurdle to overcome.

Spelman College offers an example of a program that has always taken the education of African American women seriously. This has happened under the leadership of Etta Falconer, who served as Chair of the Mathematics Department, as Associate Dean for Science Programs and Policy, and two years as Provost of the College. She was succeeded in the first two roles by Sylvia Bozeman. While serving in these roles, Dr. Falconer initiated programs with support from NASA and NSF that served to both reform the undergraduate curriculum and to produce students for whom research is part of their identity, thus easing the transition to graduate level work. I learned how to value students from my colleagues at Spelman who regard their work as an investment in their students' future. No one wants to see an investment go bad; Spelman professors make every effort to assure that their students reach their full potential, the appropriate return on Spelman's investment.

There are outstanding examples of successful programs involving minorities in science and mathematics, but one wonders why there are not more. What is striking to me is that many of the programs, from Lee Lorch's efforts at Fisk which resulted in six undergraduate students going on to receive a Ph. D. (this had not happened at Fisk before, nor since) through Clarence Stephens efforts at Potsdam (which produced astounding percentages of math majors) up to the efforts at Spelman and Morehouse, are based on the same idea: treat students with respect, get to know them personally, build a community of scholars, and help them to realize the high expectations which they have set for themselves. All of these ideas help in building a community; while a school may occasionally succeed in getting one brilliant student through graduate school, a school has a much better chance of success working with a group.

Schools should also understand the importance to minority students of being able to return something to their community; this frequently leads to an interest in questions that have some type of real-world application. If a school has no such programs, that should be clearly explained to minority recruits. David Manderscheid describes a program, which contains many of these ideas and has been successful at the University of Iowa. If Iowa can do this, why can't other schools? The simple answer is that Departments have not made it a priority. When it is a priority, many examples of how to proceed are available to guide a University in dramatically increasing the number of minorities with degrees in science and mathematics.

Even modest increases would be welcomed. Walter Massey, when head of NSF, challenged mathematics departments to increase the number of minority Ph.D.'s they produced by one per year. It would be interesting to see how many universities have met that challenge. ■

"treat students with respect, get to know them personally, build a community of scholars , and help them to realize the high expectations which they have set for themselves."

The Invisible Minorities in Mathematics

by William Yslas Vélez, The University of Arizona

This article is written from the perspective of a Chicano mathematician. Over the years, I, like many of my Chicano colleagues, have devoted considerable energies to increasing the number of students from our cultural groups who go into mathematics-based fields. The Hispanic population in this country is growing, yet this is not evidenced in our graduate schools and among our faculty. I believe that mathematics departments have ignored the minority community in the past, and I want to point out some instances of this. I also want to make some recommendations that would serve to increase minority participation.

1. The impact of just one Chicano mathematician

Manuel Berriozabal received his Ph.D. in mathematics from The University of California, Los Angeles in 1961. He spent fourteen years at Tulane University and the University of New Orleans and finally arrived at The University of Texas, San Antonio (UTSA) in 1976, where he has continued his professional life to the present. Berriozabal is perhaps best known for the creation of the TexPREP program, which he began in 1979. This program is a mathematics-based academic enrichment program targeting middle and high school students. Its focus is on the development of abstract reasoning and problem solving skills.

Berriozabal had to overcome many obstacles along the way. When San Antonio Prep first started, the conventional wisdom was that the program was doomed to failure because middle school and high school students would never want to spend eight weeks during the summer on a college campus studying mathematics and its applications. Indeed, a San Antonio magazine published a feature article on UTSA in 1979 in which an anonymous member of the Texas Higher Education Board expressed his opposition to approving an engineering program at UTSA. In his words, "The Mexican-American community is not where engineers come from anyway."

Berriozabal's program has now been replicated in over 14 cities. More than 17,000 middle and high school students have completed at least one eight-week summer of TexPREP. 81% have been minorities and 54% have been women. A 1999 follow-up survey of former TexPREP participants revealed a high school graduation rate of 99.9%, a college entrance rate of 92% and a college graduation rate of college entrants of 90%, with 53% being awarded degrees in science and engineering.

Berriozabal, like many minority mathematicians, has a profound concern for the education of the minority children in his city. More importantly, many minority mathematicians have attempted, in some fashion, to act on this concern. If every mathematics department had such individuals, we would now see a different make-up of the professorate. It takes years to develop talent. With so few minority mathematicians in our universities, this under-representation will continue to exist. Had mathematics departments, which were located in minority communities, hired more minority mathematicians thirty years ago, we would not have such a gross under-representation of the minority population in mathematics based fields; the present situation is a direct result of the hiring practices of the mathematics departments over the last thirty years.

2. Data

In 1997, African-Americans, Hispanic/Latinos, and Native-Americans comprised 24.5% of the US population [8], yet they make up only 4.5% of those holding scientific doctorates [11]. It is projected that by the year 2010, the Hispanic population will be the largest minority group. There is little doubt as to the small numbers of minorities participating in the mathematical sciences. As reported in Science [11], of 179 institutions surveyed, 88 universities graduated fewer than one minority Ph.D. in mathematics per year in the time period 1992-1996 and 76 graduated none! The existing data, though depressing, is even worse than it appears. The Science article cited includes a table listing the mathematics departments that have produced the largest number of "minority" doctorates in mathematics, for the years 1992-1996. I was surprised to read the figures for my own department at The University of Arizona, which averaged 2.4 minority doctorates per year for this time period. I obtained a listing of doctoral recipients for the department of mathematics and the program in applied mathematics. There were a total of 62 doctorates awarded during this time period. There were no African-American, Chicanos or Native Americans among this group and only one U.S. born Hispanic of South American ancestry. According to this article, there should have been 12 minority Ph.D.s in this group of doctorates, yet there was only one. There were six Mexican nationals who received their Ph.D.s at this time, which could account for this grossly inflated figure. As it turns out, the data did not ask for citizenship. When reading about data concerning minorities, I cannot

continued on page 4

continued from page 3

help but wonder how often citizenship has been ignored.

3. Diversity: What does it mean?
Diversity means that our faculty should reflect the population of this country. Conversations that I have had with faculty and administrators lead me to believe that our professorate is not fully aware of the problems that the minority community faces. Let me provide just three examples.

a) In a conversation that I had with the President of a research university in the Southwest, I pointed out the very small number of Chicano mathematicians at our research universities in the Southwest. The President expressed surprise at this and said that there were lots of mathematicians in Mexico. Why didn't we just go there and recruit?

b) At a large meeting, I was giving a presentation on the small numbers of minority mathematicians at our research universities. After the presentation, a mathematician came up and said that he simply didn't understand the remarks that I made concerning the lack of diversity. He pointed out that they had mathematicians from all over the world. His department was extremely diverse, even though there were no "under-represented minorities" on the faculty.

c) I was talking to the chairman of a mathematics department at a university in the Southwest, and I commented that they did not have a single Chicano faculty member in their department, and had not had one in many years. This university was situated in a city with a high percentage of Mexican-Americans. The department head replied, "Why do we need one?"

Indeed, "Why do we need one?" A fair question, and one that deserves an answer. Who, in a department that is so international in character, cares about the education of the local population? Who is willing to take time away from their research to reach out to a population whose culture, and perhaps language, is so different from that of the university? One natural candidate for these activities is a person who is part of that community, and that is what is lacking. Not only is the local minority culture different from that of the international character of the university, it is often also economically impoverished. This makes it even more difficult to make a connection. I know of many mathematicians who have given of their time to reach out to the local minority community. However, if we were to compare the percentage of university mathematicians who have made such efforts to the percentage of minority mathematicians who have done the same, we would see a tremendous difference in these two numbers. It is natural. We in the minority community care deeply about the minority community, and yet we have been excluded from the very same universities that should be educating us.

It bothers many of us in the Chicano community that foreign-educated mathematicians who grew up speaking Spanish are counted as minorities when they hold academic positions in this country. Some of these individuals empathize with our problems and have contributed to helping these communities, but then so do many other non-Spanish speaking mathematicians. Diversity among the professorate should mean that those who have gone through the K-12 educational system in this country should also be able to participate and succeed at our universities. The chances that a minority faculty member will be interested in working with minority students and be able to positively impact them are higher than for a non-minority. After all, we have gone through the K-12 system, we better understand this culture, and we still have family in this culture, family that is going through those same problems that form barriers to higher education. Notice that I am not saying that minority mathematicians should have these concerns nor do they necessarily have the ability and will to act to try and solve some of these social problems, but many of them do.

4. Lack of respect for U.S. students
There is a joke going around mathematics meetings. We bemoan the fact that many students arriving at our campuses from high school must take remedial mathematics courses. Students entering our graduate courses find it difficult to survive the beginning courses. The joke is that departments will have to develop remedial courses in linear algebra for new faculty.

Of course, all of these comments only apply to U.S. students. Across the country, departments find it difficult to attract good U.S. graduate students. The U.S. students that do show up arrive woefully under-prepared for the rigors of graduate school. Foreign educated undergraduates are much better prepared and fare much better in our graduate schools. Many graduate programs rely very heavily on foreign graduate student enrollment. It would not be a stretch to say that it is U.S. students who are becoming under-represented, both in the graduate schools and among the faculty of these graduate schools.

It is correct to say that foreign students entering our graduate schools are better prepared than the great majority of undergraduates from this country. Is it that foreign students are so much brighter than the Americans? Before jumping to this conclusion, let's think about the

educational systems in this country. We believe in a Liberal Arts education. A student going through our universities must go through a liberal arts curriculum. In many cases no more than a third of the courses that a student takes can come from one department. For many foreign students, the exact opposite is true. A mathematics major in another country means that the student took primarily mathematics courses, probably more than double the number of mathematics courses that a typical U.S. student would take.

We force our students to go through a liberal arts education, and then when they apply to graduate school, we complain that they are not as well prepared as a foreign student. In choosing the foreign student over the U.S. student, graduate programs condemn our own educational system.

We hear all too often the complaints of faculty about the under-preparedness of U.S. students for our graduate programs. Is it really in the best interest of this country to have developed a graduate educational system that almost guarantees that U.S. students will fail? Have our undergraduate programs really failed our own students? When has become. In my own department, 30 of the 62 current faculty are foreign born.

5. Hiring practices of our universities

In 1978, I conducted a survey of Chicano and Native American Ph.D.s [9]. This survey was not restricted to mathematics. One of the questions in the survey dealt with the efforts of these Ph.D.s to gain employment at universities in the Southwest. It will come as no surprise that the vast majority of them tried to find such employment and that most of them failed in this endeavor. There has simply been no interest at these universities in hiring these minority scientists, as evidenced by the data and by the remark that the department head made, "Why do we need them?" How many other Berriozabals have been lost to the minority community because there is no perceived "need" for us? Yet by seeing the impact these individuals have had on their local communities we have dramatic evidence to show why we are needed.

I often talk to new Chicano Ph.D.s, and I am amazed how little interest there is in hiring them at our universities in the Southwest. Time and time again I have seen these

"It would not be a stretch to say that it is U.S. students who are becoming underrepresented, both in the graduate schools and among the faculty of these graduate schools."

I began my graduate studies in 1970, my entering class had more than 20 students in it. I was the only one of the group to receive a Ph.D. In the thirty years since then, have things gotten worse? How could they?

This disrespect for U.S. students came to the fore in an e-mail that was recently sent out. A university had just received a VIGRE (Vertical Integration of Research and Education) grant from NSF. The conditions of this grant specifically state that only U.S. citizens and permanent residents can be supported through VIGRE funds. The mathematician who sent out the announcement for postdoctoral positions included the following statement, "They are unfortunately restricted to U.S. citizens and permanent residents...." The fact that this person would send out this public message makes it appear that he does not feel isolated in his disregard for the education of our citizenry.

The mathematician who sent out this message finds it "unfortunate" that his university has to use federal funds to further the mathematical careers of U.S. citizens. He finds it unfortunate that the net used to attract mathematical talent to his university cannot be more international in its scope. Even a cursory look at the mathematical enterprise of this country will show how international it Ph.D.s ignored as they attempt to find employment. We as a community of scholars have lied to them. We tell them how important it is to pursue those advanced degrees and when they listen to us and achieve these goals, we ignore them. We hire foreign-born mathematicians who have more "potential" and more research credentials.

The e-mail message mentioned above got me to thinking about the Chicano mathematicians that I have known over the years. Unfortunately, that number has not grown much. In 1977, I accepted a position at The University of Arizona. Around that time period, the Chicano mathematicians that I knew at Ph.D. granting institutions in the Southwest were: Efraim Armendariz (University of Texas, Austin); Joaquin Bustos (Arizona State University); Richard Griego (University of New Mexico); David Sanchez (University of California. Los Angeles); Richard Tapia (Rice University); Bill Torres (New Mexico State University). These individuals have all had a positive impact on minority students at their institutions as evidenced by the fact that Berriozabal, Bustos, Tapia and myself are all Presidential Awardees for Mentoring. These individuals serve on many commit-

continued on page 6

continued from page 5

tees for the AMS and the MAA. They are called upon to represent the Chicano community on many different committees.

Twenty years later, Bill Torres has left academia, Richard Griego has retired and David Sanchez has moved to Texas A&M. I know of no other Chicano mathematician at any Ph.D. granting institution in the Southwest other than those I have mentioned.* You will observe that our numbers have in fact decreased; yet many mathematicians find it "unfortunate" that they have to restrict their recruitment to U.S. citizens and permanent residents. The situation that I have just described points to a crisis for the mathematical education of the Chicano population. In ten years many of the people that I have mentioned will have retired! Who will represent us in AMS deliberations? It takes at least ten years to move along the faculty ranks to become a Full Professor. This scenario points to the very real possibility that there will be no Chicano Full Professors of mathematics at our Ph.D. granting institutions in the Southwest ten or fifteen years from now! Is it possible that our mathematics departments will look like missionary schools in the future, staffed by apostles from other lands, come to educate the poor minorities?

This is intolerable. Universities must realize that the education of its population is foremost in its mission, and that we, the minority community, should play a prominent role in the education of our children. The federal government has invested large amounts of taxpayer funds to support research in this country. Does the research community believe that publishing papers is the only goal of this support? This support is aimed at universities, not at research institutes. One of the goals of this support is to enable these universities to better educate their citizens. If this is one of the goals, then it has failed us. The number of Chicanos who have earned Ph.D.s in mathematics numbers in the tens. What is needed is not more money to support the research community, but a stronger collective will to educate the children of this country.

6. Elitism in mathematics

There is one fact that is certain. Few U.S. students are choosing mathematics for their undergraduate major. I recently read that fewer than 5% of students who take calculus at our universities choose mathematics for their major. This is a depressingly low figure. Can this be blamed on the K-12 educational system? It would appear that the instruction that they are receiving from a professional department is more to blame for this low number. If mathematics departments and their faculty spent more energy in motivating students to further studies in mathematics, then more and better prepared U.S. students would arrive at our graduate programs.

A question that naturally comes up is why our calculus students do not choose mathematics for their major. An answer could be in the way that we choose to present mathematics. However, I am beginning to think that there is a more basic reason, and that is that mathematicians do not think that mathematics is useful.

I have had the enjoyment of teaching out of the Harvard calculus reform text for several years. It is a real pleasure. The reform movement in calculus has served to make calculus much more germane to science and I applaud the efforts. The reform movement has put new material in the hands of mathematicians. But simply putting this material in their hands is not enough. Mathematicians can continue to teach as they have before, even though the material has a different emphasis. What is needed is a departmental commitment to use the calculus courses to increase the number of students taking mathematics. A different book is not enough to help faculty have a different focus on their teaching.

I am often called upon to talk about minority issues. One of the things that I mention in these talks is that I have managed to increase the number of Chicano students who pursue undergraduate degrees in mathematics. Every time I have mentioned this, a mathematician asks the question, "Why should we encourage minority students to pursue degrees in mathematics when the job market is so bad?" Mathematicians are so focussed on research in mathematics that they do not think much about the uses of an undergraduate degree in mathematics. Mathematical training at the undergraduate level should not have as its only goal the production of new Ph.D.s. An undergraduate degree in mathematics, coupled with a solid knowledge of computer science or some other science, is a very marketable degree. We should encourage more students to pursue this path. However, before we encourage our students in this, I believe that we have to educate ourselves as to the usefulness of undergraduate training in mathematics.

7. Recommendations for change

A large part of our profession deals with the communication of the mathematical enterprise to our students. Yet our professional training does not prepare us well for this activity. Most of the graduate education that a student receives deals with the technical training that is necessary to write a doctoral thesis. This same point of view carries

* In the early 70s I made a formal survey of Chicano scientists in universities in the Southwest, which was the basis for my initial data point on this question. After that point, my knowledge of Chicano mathematicians comes from my position as President of the Society for the Advancement of Chicanos and Native Americans in Science, and my continued interest in this organization.

over once a person joins a research department. There are weekly seminars and colloquia, all directed to the transmittal and creation of new mathematical knowledge.

Mathematics departments should recognize the complex role that faculty have in the mathematical enterprise of this country. The creation of new mathematical knowledge is but one component of the equation. Mathematicians are invited to give colloquia because the faculty is interested in learning about their research results. I suggest that the role of faculty colloquia should be expanded to encompass more than just having talks on research. Individuals, who have developed ideas and programs to serve to increase student interest in mathematics, should be invited to give talks in the regular colloquium series.

There are individuals and departments that have managed to greatly increase the number of mathematics majors. This should be of paramount importance to a mathematics department. Individuals who can speak about their successes in this area should be invited to give talks.

How does one properly mentor a student, and provide a departmental atmosphere that supports students in their pursuit of advanced training in mathematics? We all know that the transition from undergraduate studies to a graduate program is a serious obstacle for students. Having an effective mentoring program in place would greatly help students with this transition.

I believe that mathematics departments should more fully appreciate the central role that mathematics plays in today's job market. The role of calculus instruction should be a central one. Most mathematics departments view this course as a service to the university. Instead we should view it as the student's first real introduction to mathematics. This course should be viewed as a vehicle to increase the number of students who choose mathematics for their major.

As we increase the number of students choosing mathematics for their major, we also have to find ways to support this interest. Research Experiences for Undergraduates is an excellent vehicle for doing this and these activities should be expanded. The private employment sector must also be courted. Internships for undergraduate mathematics majors must be sought out in all of the economic sectors in this country. Mathematics departments have to find ways of integrating the mathematics majors into the life of the department, hiring them to work and maintain the computer system, tutoring and grading, and running help sessions for lower division courses.

Mathematics is fundamental to today's society. We have to recognize our unique and special role in educating the children of this country.

The author acknowledges the partial support for this article provided by the President's Award for Excellence in Science, Mathematics, and Engineering Mentoring Program, NSF grant, HRD 9724886.

REFERENCES

1. Advising as an Aggressive Activity, W. Y. Vélez, FOCUS, The Newsletter of the Mathematical Association of America. Vol. 14 (4), 1994, 10-12.

2. Are Foreign Students Displacing Minorities in Biomedical Graduate Education, David Burgess, The Journal of NIH Research, April, 1997, Vol. 9, 17-22.

3. The Integration of Research and Education, W. Y. Vélez, Notices of the American Mathematical Society, Vol. 43 (10), 1996, 1142-1146.

4. Names on a Wall-A Perspective on Why Diversity Matters, W. Y. Vélez, American Scientist, Vol. 85 (2), 1997, 200.

5. The Research Mathematician as Storyteller, Joseph Watkins and W. Y. Vélez, to appear, Proceedings: The Future of Mathematics Education at Research Universities, Mathematical Sciences Research Universities, Berkeley, Ca, 1996.

6. Some Thoughts on the Funding of Mathematics, W. Y. Vélez, Notices of the American Mathematical Society, Vol. 41 (2), 1994, 101-103.

7. Some Thoughts on the Teaching of Algebra, W. Y. Vélez, The Algebra Initiative Colloquium, Volumes I and II, U.S. Department of Education, Office of Educational Research and Improvement, edited by Carole B. Lacampagne, William Blair and Jim Kaput, 1995, 223-229.

8. Statistical Abstract of the Unites States 1998, The National Data Book, Issued October 1988, U.S. Department of Commerce, Bureau of the Census.

9. Underrepresentation in the Sciences: Chicanos and Native Americans, Celestino Fernandez and W. Y. Vélez, Proceedings of the Conference on the Status and Issues of Chicano and Native American Participation in the Sciences, Boulder, CO, 1978, 44-61.

10. University Faculty, Priming the Pump or Laying in Ambush, W. Y. Vélez, Access Denied, Race, Ethnicity, and the Scientific Enterprise, edited by George Campbell Jr., Ronni Denes and Catherine Morrison, Oxford University Press, 2000, 215-218.

11. Wanted: a Better Way to Boost Numbers of Minority Ph.D.s, Jeffrey Mervis, Science, Vol. 281, 1998, 1268-1270.

■