The James R. C. Leitzel Lecture

Increasing the number of mathematics majors: Lessons learned from working with the minority community

by

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Tucson, Arizona

- This Powerpoint presentation will appear on my website:

- http://www.math.arizona.edu/~velez

Organization of this lecture

How did I get started in working with minority students?

How did my interaction with these students change over time and how did it change me?

What can be learned from this experiment, an experiment that has had some success?

How can the entire mathematics community use the results of this experiment to increase the number of mathematics majors?

A very important variable in this issue of increasing the number of mathematics majors are the attitudes of:

- a) individual faculty
- b) mathematics departments
- c) our professional organizations

Lessons Learned

- Good students need attention and advice.
- Provide timely information to students, help them to understand the system and future opportunities.
- The transition from high school to university is brutal.
- Students oftentimes choose engineering because they liked mathematics in high school.

Appointments for Thursday, July 21 2005

Time	Name	Math Cour	Ethnicity	Class	Major
9:00	M. Robles	124	H	FR	
9:20					
9:40					
10:00	I. Amene	124	B	FR	MCB
10:20					
10:40					
11:00	D. Sinohui	124	H	FR	changed to chem
11:20					
11:40	E. Jaramillo	124	H	JR	pre pharm
12:00	A. Ramsey	124	B	FR	Coe
12:20	S. Arvizu	124	H	FR	BMB
12:40					
1:00	R. Enriquez	124	H	FR	NMS
1:20	H. Flores	124	H	FR	CVE
1:40	R. Garcia	124	H	FR	AEE
2:00	A. Valenzuela	124	H	FR	NMS
2:20					
2:40					
3:00	D. Kaigler	124	B	FR	PRCS
3:20	C. Huerta	124	H	FR	BIOCHEM
3:40	Y Huerta	223	H	SO	Engr. Math

Good students need attention and advice.
Provide timely information.
The transition from high school to university is rough.
Students choose engineering because they like mathematics.

The study of mathematics opens up many doors.

Resources for calculus students

If you are enrolling in first semester calculus, review your algebra and trigonometry before classes begin. Here are two websites to help you review:

Algebra: http://prep.math.lsa.umich.edu/pmc/
Trigonometry:
http://math.arizona.edu/~trig/Math111_finalexam_studyguide.doc

Here is the math department's webpage (http://math.arizona.edu/~calc/) that contains the day-to-day calendars and suggested homework assignments. After you have reviewed your algebra and trigonometry, you should start looking at the homework sets. Try to complete the homework for the first chapter that will be covered in your course.

If you are taking math 129 or math 223, here is the website (http://math.arizona.edu/~courseinfo/common/studyguides.html) that contains old final exam questions for these courses. If you are taking math 129, go over the exam questions for math 124/125. If you are taking math 223, then go over the exam questions for math 129. Reviewing these exam questions should provide you with an idea as to how well prepared you are for the courses that you are registered in.

Here is the website for the mathematics department: http://math.arizona.edu/
This website contains a good amount of information about the department that you will find useful.

If you are a mathematics major, then here is the website http://math.arizona.edu/mathmajors/ that you should investigate. In particular, click on "internships and outside programs" to begin planning for the future.

THINGS TO DO TO SUCCEED THIS SEMESTER

1. If you are going to take first semester calculus, prepare for it by going to following sites and reviewing:
   algebra: http://prep.math.lsa.umich.edu/pmc/
   trigonometry: http://math.arizona.edu/~trig/Math111_finalexam_studyguide.doc

2. Office hours will be posted by your instructors. These office hours are meant for you. Use them. If the office hour schedule conflicts with your schedule, most instructors are willing to schedule appointments. See your instructors often. No one can help you like your instructor.

3. Do all of the work assigned. If the instructor gives points out for homework, then your goal should be to earn full points on each homework assignment. If you find that you do not understand some idea, get help immediately, either from the instructor or from some other source. Identify early the sources of help that are available.

4. Form study groups. Arrange to meet over the weekends. Exchange phone numbers among the study group members. You can earn leadership points by becoming a preceptor for one your courses. Go to the following website to look into becoming a preceptor: http://teachingteams.arizona.edu/EP

5. Join campus groups. Engineering students should consider joining SHPE (Society of Hispanic Professional Engineers).

6. Each semester you should update your resume.
7. Try to find either a summer internship or an opportunity to carry out a research project with one of the faculty.
   www.blc.arizona.edu/ubrp/
   www.seds.org/spacegrant/programs/fellowships/internships/

8. Take charge of your education. Teachers can help you learn, but in the end, it is your education and it is your responsibility to ensure that your time spent with us will further your goals.
9. If you find that the major that you have chosen is not what you thought it was going to be and you want to talk to someone about changing your major, come by and see me. I look forward to having the opportunity to work with you in developing an exciting program of study. In particular, if you would like to know more about the mathematics major, and its many options, feel free to stop by my office.

William Yslas Vélez   Mathematics East Building, Room 146C
Office Phone: 621-2259   E-mail: velez@math.arizona.edu
Send me an e-mail _____ concerning_____

If you are enrolling in math 124/125, review your algebra and trigonometry before classes begin. Here are two websites to help you review:

Algebra: http://prep.math.lsa.umich.edu/pmc/
Trigonometry:
http://math.arizona.edu/~trig/Math111_finalexam_studyguide.doc

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Join campus groups. Engineering students should consider joining SHPE (Society of Hispanic Professional Engineers).

Each semester you should update your resume.

SAMPLE RESUME

Dorothy Villafuentes

Phone: (520) 902–1000
Email: dvillafuentes@email.arizona.edu

_____

Career Goal: I am seeking a summer internship in an industry or organization where I can apply my mathematical knowledge and my analytical/problem-solving abilities. I have augmented my mathematical studies with courses in computer science and I am interested in finding a position where I can combine mathematical analysis with numerical simulations.

Education:
The University of Arizona, 2003-present Valley High School, Graduated 2003
Major: Mathematics. Minor: Computer Science Boca Raton, California
GPA: 3.4, Major GPA: 3.5, Minor GPA: 3.4
Expected graduation date: May 2007

College credit earned in high school: I earned college credit for first semester calculus.

Computer skills: I have a solid general knowledge of computers as well as proficiency in Java and C.

Relevant coursework completed by May 2005:
<u>Mathematics courses</u>: Calculus 1, Calculus 2, Vector Calculus, Introduction to Linear Algebra, Formal Mathematical Reasoning and Writing, and Analysis of Ordinary Differential Equations, Complex Variables
<u>Computer science courses</u>: Introduction to Computer Science, Program Design and Development, and Object-Oriented Programming and Design
<u>Other Relevant Courses</u>: Two semesters of Chemistry and one semester of Biology

Work Experience:
I was an Undergraduate Teaching Assistant in Fall 2004. My supervisor was Dr. W. Valentoso. I tutored algebra four hours per week and developed several Excel spreadsheets for the business mathematics course for Dr. Valentoso. I also held weekly review sessions for the students in his course.

I held a Undergraduate Research Assistantship in Spring 2005 under the direction of Dr. Warren. I am investigating the practicality of reconstructing phase information from images taken in two different focal planes (the near field and the far field). This research will continue into next academic year.

Honors/Awards: I received Honorable Mention for Fall Semester 2003 and was on the Dean's List for the other semesters. I am an out-of-state student and have been receiving out-of-state tuition waivers as a scholarship. I have also been part of the Honors College since my first year.

Activities: Since Fall 2004, I have been a member of Math Cats, the Undergraduate Mathematics Club. I have participated in several outreach activities sponsored by this club. I am also a member of the Microsoft Student Users Group: A club dedicated to the discussion of programming technology and theory, both of Microsoft and in general.

Volunteer Work: I was a volunteer mathematics tutor at a middle school (five hours per week) during the academic year, 2003-2004.

Citizenship: USA

Availability Date: May 31, 2005 – August 13, 2005

Try to find either a summer internship or an opportunity to carry out a research project with one of the faculty.

www.blc.arizona.edu/ubrp/

www.seds.org/spacegrant/programs/fellowships/internships/

If the student has any thoughts to pursuing a graduate degree in some quantitative field, that student should add mathematics as another major.

Mathematics and X makes for a more competitive program.

Adding mathematics as a major in your resume makes recruiters think that you are smart.

If you find that the major that you have chosen is not what you thought it was going to be and you want to talk to someone about changing your major, come by and see me. I look forward to having the opportunity to work with you in developing an exciting program of study. In particular, if you would like to know more about the mathematics major, and its many options, feel free to stop by my office.

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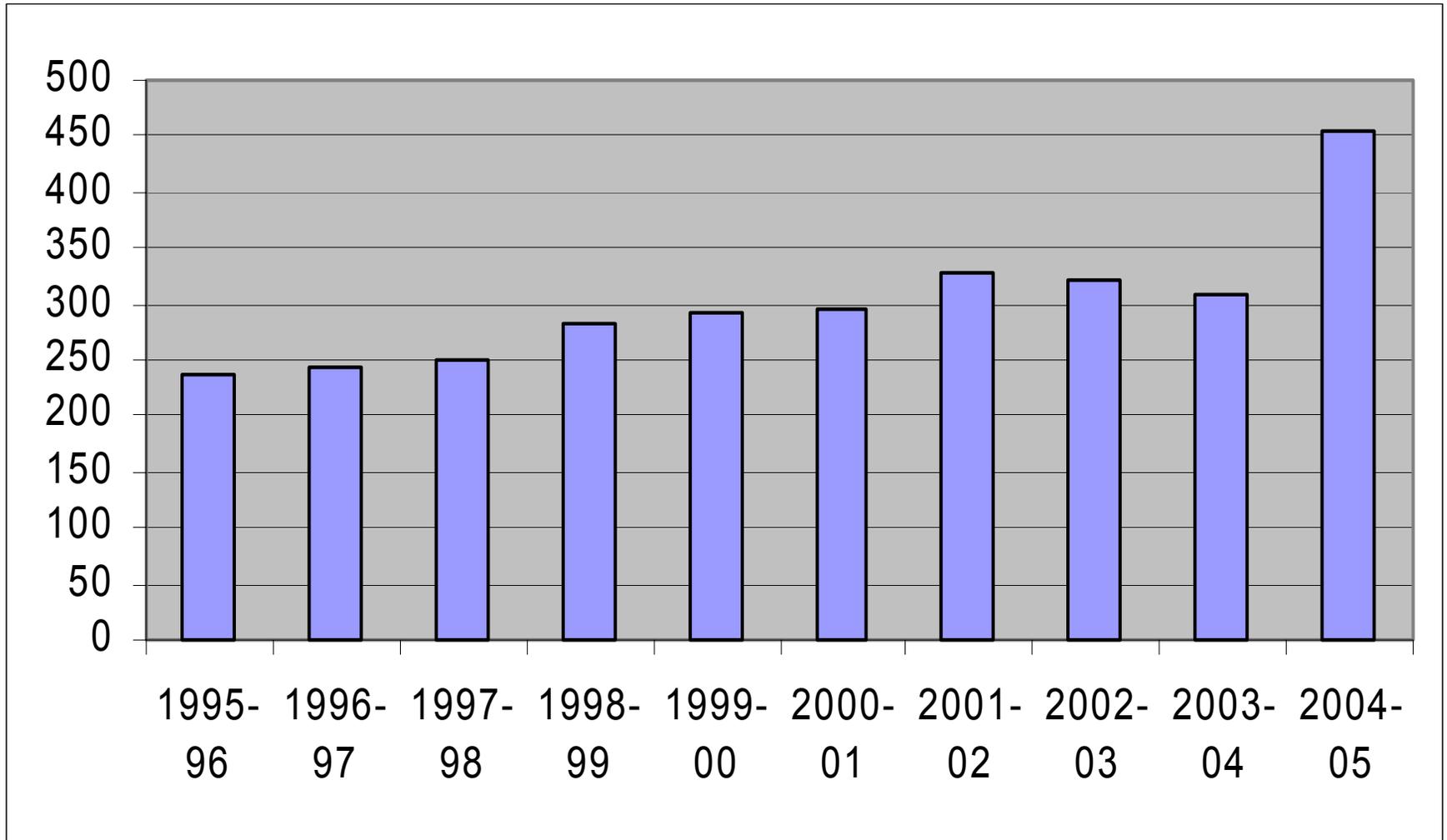**Send me an e-mail _____ concerning_____**

Reactions from students when I suggest that they become mathematics majors

- Some see the logic of my suggestion.

- Others almost faint.

- Are you nuts? I got a C in first semester calculus and you want me to become a mathematics major?
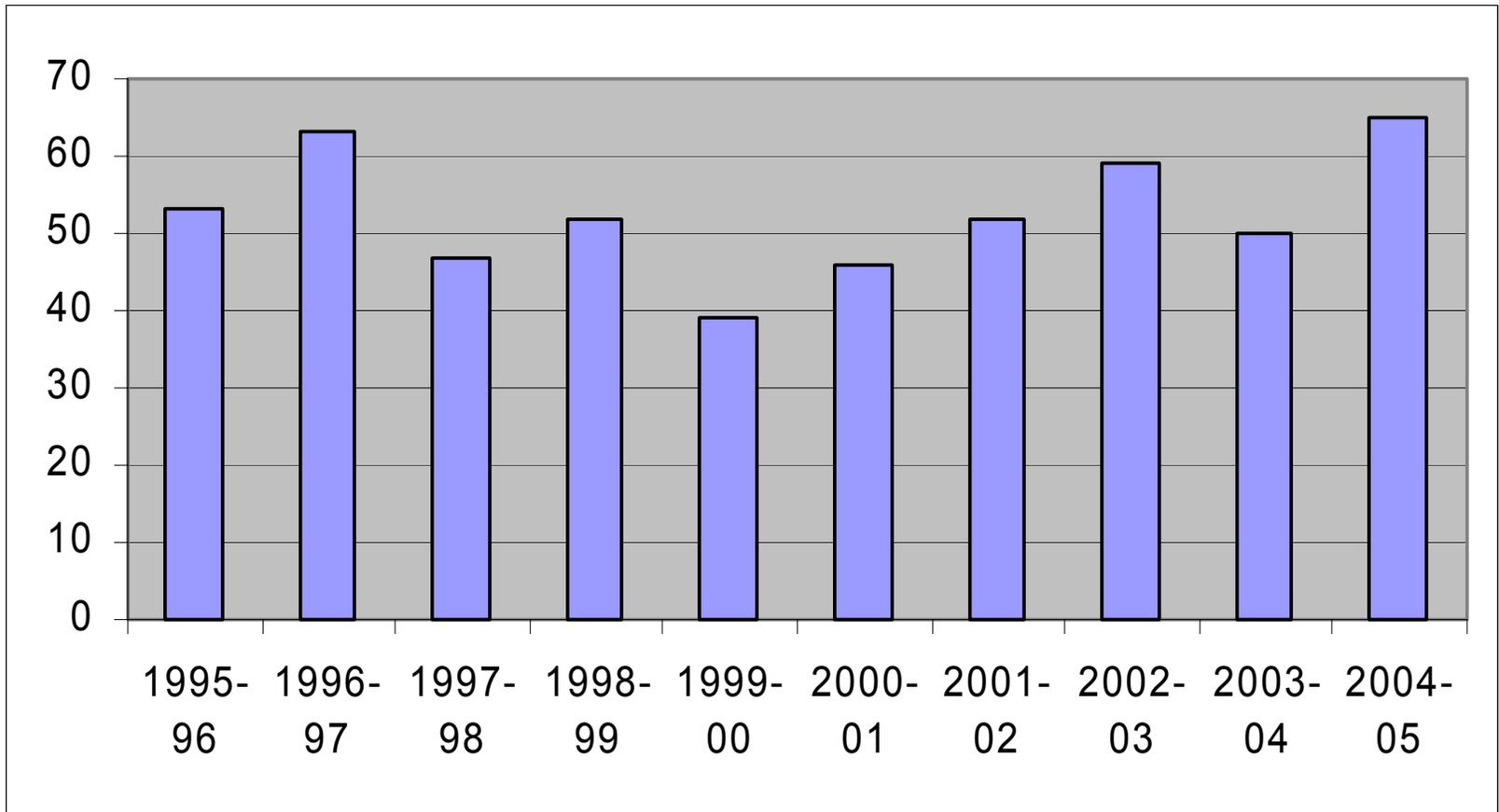
Two years ago I accepted the position of Director of the Math Center. The Math Center had been in existence for more than 10 years, and its existence and organization was greatly impacted by Bill McCallum, whom many of you know.

My position is full time Director.
Chris Mikel is the Coordinator of the Math Center
Terri Croteau is the Administrative Assistant
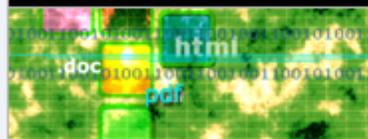
Number of math majors

Number of Bachelor's degrees

National Science Foundation
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Text Only

Dear student: I am delighted to see that you are interested in studying X. Are you aware of the linkages between mathematics and X? I am attaching an article from Science that shows the importance of mathematics to X. I invite you to consider becoming a double major in math and X. I sincerely think that your first semester of study should include mathematics (and hopefully Computer Science 127a). I would be more than happy to develop a program of study that would open up many doors to you. Please contact me if you have any questions or visit our website at …

The High School Calculus Class Visitation Project

- Objective: Visit every high school calculus class in the city of Tucson.

- Visitation Team: Faculty or Post-doc, graduate student, undergraduate student

A Mathematics major schedule

First Semester	1st Year
Course	**Units**
Calculus I (Math 125)	3
Comp. Sci. 127A	4

Second Semester	1st Year
Course	**Units**
Calculus II (Math 129)	3

First Semester	2nd Year
Course	**Units**
Vector Calculus (Math 223)	4
Linear Algebra (Math215)	3

Second Semester	2nd Year
Course	**Units**
Differential Equations (Math 355)	3
Formal Reasoning (Math323)	3

	3rd Year
First Semester	

Course	Units
Applied Analysis (Math 422)	3
Probability Theory (Math464)	3

	3rd Year
Second Semester	

Course	Units
Statistics (Math466)	3

First Semester	4th Year

Course	Units
Matrix Analysis (Math 410)	3

Second Semester	4th Year

Course	Units
Mathematical Modeling (Math485)	3

How is the high school calculus teacher going to motivate his/her students to become mathematics majors if we don't provide them with information as to the opportunities that exist?

I think that this is such a goldmine of students that the mathematical societies should develop special materials specifically aimed at this teaching population, perhaps even a special journal aimed at applications of calculus for calculus students.

Just silliness
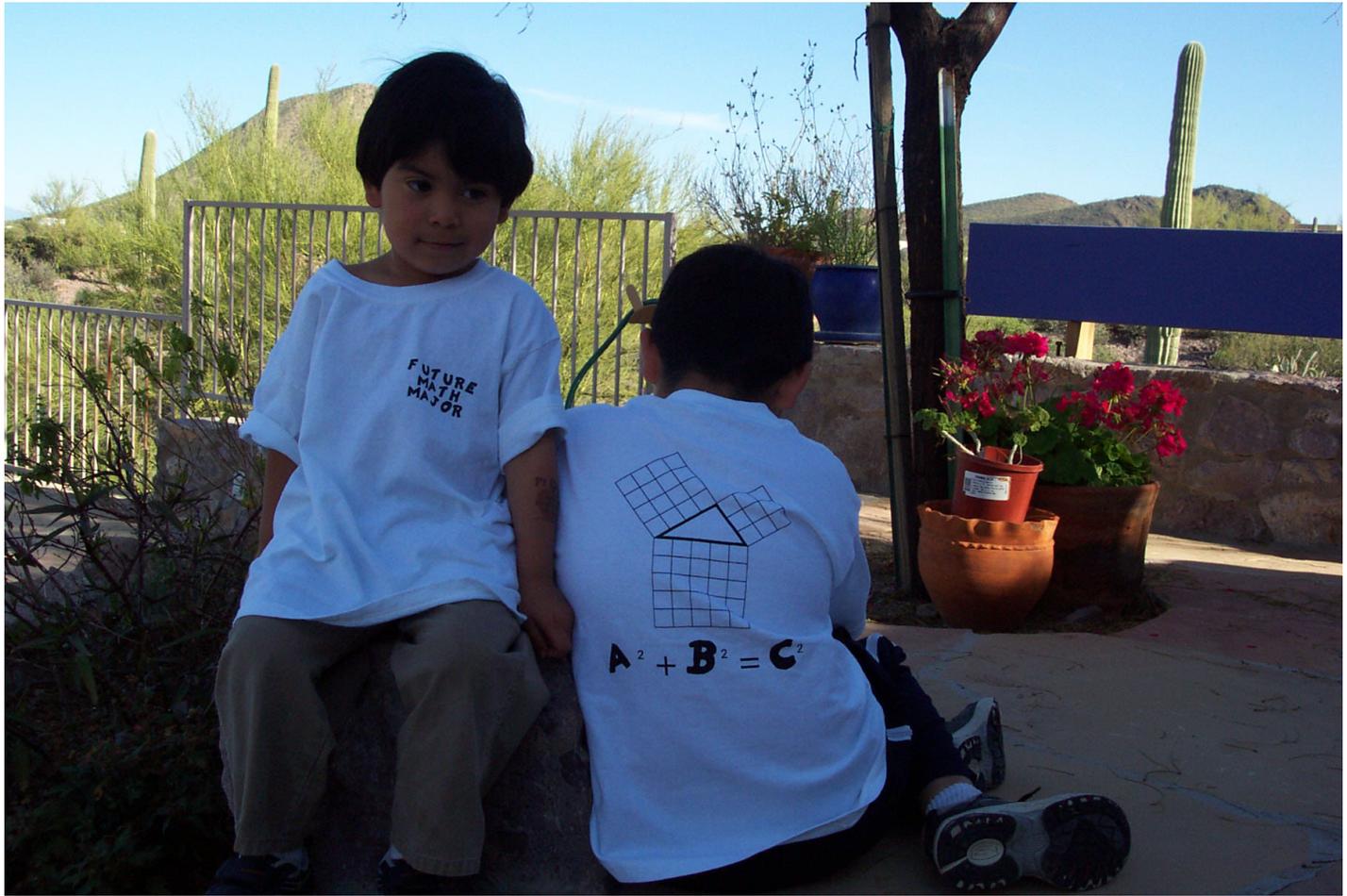
INREACH

Let's reach into our mathematics classes and convince those students that mathematics is vital to their education.

We teach thousands of students each year and yet we convince very few of them that they should continue their study of mathematics.

The real purpose of a math course

The real purpose of this course is to convince each and every one of them that they should become mathematics majors. And it is not I who will convince them. The students are going to find the subject so interesting, so germane, that they are going to come to me to inquire as to the possibility of becoming a math major.

Dear :

I would like to invite you to consider becoming a mathematics major. You have performed very well in my course and I think that you would do well in this major. You might also consider adding mathematics as a double major. If you have any thoughts of going on to graduate school you will find that a solid understanding of undergraduate mathematics will prove extremely useful.

The mathematics major offers several options (the website, http://mcenter.math.arizona.edu explains these options and describes many internship and employment opportunities). If you would like to learn more about the details of majoring in mathematics or about the opportunities that exist for mathematics majors, feel free to stop by my office so that we can talk. You could also stop by the Math Center (Math East 146) and talk to either Chris Mikel (mikel@math.arizona.edu) or William Y. Vélez (velez@math.arizona.edu). The Math Center is open 8-12 and 1-5, Monday through Friday. It would be best to email them to set an appointment.

I look forward to talking to you and exploring with you how mathematics can fit in with your career goals.

Sincerely,

Copt to: William Yslas Vélez, Associate Head for Undergraduate Programs

Another opportunity

- If I saw a student in trouble, I asked them to stop by and see how best to develop a program of study for them that help them reach their goals.

- I suggested a different selection of courses to take that might fit in better with their career plans.

- Or, if they were plugging away at math courses I would send them a message like: I see that you are not that far away from completing the requirements for a math major. It appears that you only need 4-5 more mathematics courses to complete the math major requirements. Why don't you stop by my office and we can talk about this.

Chemistry

I was going through our math 254 enrollments and I see that you completed this course. It appears that you are majoring in chemistry and that you have done very well in your classes. I congratulate you on your performance. Have you given any thought to double majoring in math and chem? If you are thinking about going on to graduate school in chem, you will find that having more math would be helpful.

If you would like to explore this possibility, send me a message and we can arrange to meet. My office is part of the Math Center.

Best. WYV

PS: I am attaching a profile of one of our recent graduates who double majored in math and chem.

Engineering

I was going over enrollments for math 254 and I came across your name. I see that you are majoring in engineering and that you have done very well in your classes. Have you ever thought of adding mathematics as another major? We have several students with double majors in engineering and mathematics. If you have any thought of pursuing an advanced degree you will find that the undergraduate mathematics will be of tremendous assistance in that endeavor. You only need to take about 7 more mathematics courses to complete the math major requirements. If you think that you might be interested in this I would suggest that you replace math 322 with math 215 next semester. This is a useful course anyway for engineering.

If you would like to talk about this possibility, send me a message and we can arrange to meet in my office. My office is part of the Math Center.

Best. WYV

Physics and Russian

I was going over enrollments for math 223 and I came across your name. I see that you are thinking about majoring in physics and that you have done very well in your classes. You also appear to be interested in Russian. Have you ever thought of adding mathematics as another major? If you have any thought of pursuing an advanced degree you will find that the undergraduate mathematics will be of tremendous assistance in that endeavor.

One more thing: Every semester we have 1-2 students who go to "Math in Moscow". This is a program of intense study of mathematics in Moscow. This might be of interest to you.

If you would like to talk about these possibilities, send me a message and we can arrange to meet in my office. My office is part of the Math Center.

Best. WYV

Responses

Student 1:

Actually, I was thinking about it. I just have not had the time to declare the major and find out exactly what courses I still need to take in order to complete the degree. I have time tomorrow, or after spring break if you would like to talk about this more in depth.

Student 2:

Yes I have, and I am definitely interested in the possibility of adding math as a major. When would be a good time for me to stop by your office? Thanks in advance,

Student 3:

Yes, I have in fact considered a double major in math and physics. I am pursuing the B.Sc. degree in physics and plan to go on to graduate school. Since math is such an important part of physics, it would be a good idea to study as much math in my undergraduate career as possible.

Student 4:

I have given it a great deal of thought about changing my major to math. If I do not completely change my major to math, I still want to incorporate it in some manner (perhaps double major or minor). I was taking math 215 to pursue this. I have been wanting to talk to someone in the math department but I wasn't sure as how to do that. I would like it very much to discuss this possibility. Thank you for noticing my enrollment! It is greatly appreciated.

Student 5:

Thank you for bringing this possibility to my attention. I was actually considering double majoring in math because I find my current class quite interesting. It would be wonderful if I could meet with you sometime to discuss this. I looked through the profile you attached and was intrigued by it. Thank you again for your kindness.

Example 1

- Marc was double majoring in physics and astronomy.
- I contacted him when he was taking sophomore level linear algebra.
- He said that he wanted to go to graduate school in physics or astronomy.
- I suggested that he add mathematics to his majors, which he did.
- He will begin graduate school in applied math in fall 2005.

Example 2

- Sara
- Yuri
- persistence

Conclusions

- If students are given the correct information, they will choose to study mathematics.

- The fact that there aren't more math majors is not the fault of our educational system or employment opportunities, it is our fault.

What is it that the mathematical establishment can do to increase the number of mathematics majors?

- **The departmental can reallocate its resources to support the undergraduate math major program.**

The colloquium series should reflect the expanded mission of a mathematics department. Colloquia should address not just the creation of knowledge but speakers should be invited to give talks on educational trends and diversity initiatives.

INREACH should be of greater concern. All of our courses should be viewed as vehicles for introducing students to the importance of increasing the mathematical content of their undergraduate curriculum. Mathematics departments are not service departments.

In particular, our calculus courses should be given special attention, not in their content, but in providing information to calculus teachers that would provide these teachers with material to use to motivate their students.

The Bachelor's degree in mathematics can lead to employment. You don't need to earn a PHD in mathematics.

- Many of us have shown that it is possible to increase the number of math majors. The most important ingredient in all of this is not new courses or new programs. It is us and the excitement that we have for mathematics.

- Rather than asking the National Science Foundation for hundreds of thousands of dollars to develop materials and programs to increase the number of mathematics majors, I would like to pass on you a piece of advice that the Vice mayor of South Tucson gave to me, and gave to me often:

Hablando se entiende la jente

By speaking we make ourselves understood.

Let's talk to our students.

Articles from Science

- Educating Future Scientists, Vol. 301, 12 September 2003, pg. 1485
- Bioinformatics, Vol. 287, 18 February 2000, pp. 1221-1223
- Introductory Science and Mathematics Education for 21-st Century Biologists, Vo. 303, 6 February 2004, pp. 788
- Mathematicians offer answers to everyday conundrums, Vol. 283, 12 February 1999, pp. 925-927
- The art of the orbit, Vol. 283, 29 January 1999, pp. 620-622
- From Solitaire, a clue to the world of prime numbers, Vol. 282, 27 November 1998, pp. 1631-1633
- Death by the numbers, Vol. 283, 26 February 1999, pp. 1244-1247
- The quandary of quantum information, Vol. 293, 14 September 2001, pp. 2026-2027