DOCUMENT RESUME

ED 351 045 JC 920 501

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TITLE Community Colleges: Promises or Preclusions.
PUB DATE 8 Nov 91
NOTE 24p.; Paper presented at the Annual Convention of the American Mathematical Association of Two-Year Colleges (17th, Seattle, WA, November 7-10, 1991).
PUB TYPE Viewpoints (Opinion/Position Papers, Essays, etc.) (120) -- Speeches/Conference Papers (150)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS *Access to Education; Articulation (Education); Change Agents; *Change Strategies; *College Mathematics; College Role; College Transfer Students; *Community Colleges; Educational Attainment; Educational Mobility; Education Work Relationship; Higher Education; Mathematics; *Mathematics Education; Mathematics Instruction; *Minority Groups; Teacher Role; Two Year Colleges

ABSTRACT

Since nearly 10% of the students in the U.S. who receive doctorates in the mathematical sciences begin their undergraduate studies in two-year institutions, it is clear that these schools are a significant part of the mathematics educational pipeline. Yet, minority students enrolled in two-year colleges are one-fifth as likely to earn a bachelor's degree as those who start out in four-year schools. Given that approximately 50% of minorities in college are enrolled in two-year institutions, the role of these colleges in increasing minority participation in mathematics-related fields cannot be overstated. Mathematics teachers and professors, and those charged with facilitating the learning process, are the major change agents for improving the delivery of mathematics for minorities, as well as for all students. Proven change strategies include: (1) supporting a paradigmatic shift which asserts that all students can and must learn mathematics, and that minorities can succeed in mathematics-based fields; (2) setting up articulation and collaborative programs that make transfer from two- to four-year institutions smoother; (3) encouraging the best students to go into teaching; (4) intensifying minority recruitment; (5) promoting mathematics within minority communities by highlighting the successes of two-year college students in these communities; (6) restructuring remedial courses to incorporate cooperative learning, peer tutoring, and computer-assisted instruction; (7) setting numerical targets for minority student transfer; (8) establishing partnerships with industry; (9) seeking financial and human resources from government; and (10) promoting the teaching and learning function in mathematics. (MAB)

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KEYNOTE ADDRESS TO THE
AMERICAN MATHEMATICAL ASSOCIATION OF TWO-YEAR COLLEGES
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Introduction

In preparing this presentation, I wondered: What could I possibly say of interest to professors of mathematics who have diligently tried numerous strategies to make mathematics work for their students? What could I say to these professors of mathematics, many of whom have had the same frustrations as I have had in teaching students who have been educationally ill-prepared for courses in mathematics? What could I say to these professionals, many of whom have given 100% in their instructional situations, only to learn that their best was still not enough to successfully reach their students? What can possibly be said that has not already been said to this erudite, dedicated group of college educators?

My answer at first was... very little. But as I analyzed the two-year colleges more closely, and examined the number and characteristics of the students served at these institutions, I saw a "gold mine," and I saw the "miners." I felt perhaps like Madame Curie when she looked at hills and hills of rock, and knew that there was something very special hidden in those rocks. She focused on what was special among those rocks, and sought to

perfect the mechanism that would make it possible for the hidden uranium to be discovered.

In this address, I will share a vision I have for two-year colleges, a vision for our country regarding the full utilization of two-year institutions, especially with respect to the role of these institutions in bridging the gap between them and the four-year institutions, and, their role in preparing students for the baccalaureate. This vision was materialized in six regional workshops, and the national convocation of the Mathematical Sciences Education Board project, "Making Mathematics Work for Minorities." This vision asserts that mathematics teachers and professors, and those charged with facilitating the learning of students in mathematics are the major change agents in making mathematics work for minorities, as well as for all students. This vision asserts the need for a paradigm shift so that all students are viewed as "can-doers" and learners of mathematics.

Let me say from the outset that the challenge of professors in two-year institutions is a great one, as you are serving a market that has drastically changed over the last thirty years, and likewise, you are well-positioned to effect significant change in the quality and the quantity of minority students in the mathematical sciences. Of course, this includes mathematics and science education.

I want to stress at this time the importance and necessity of all of our educational institutions to work in concert for all students. It will not be enough to just prepare some students in the area of mathematics, but it will also be important to prepare all students for the workforce and for living in a technologically driven society with a global economy.

I stand before you today, a product of segregated schools (except for my Ph.D. degree) because of exemplary teachers -- teachers like yourselves who set out to prove to those who created the segregated system and showed that students, in spite of the system, could significantly learn in schools and colleges with lesser resources. And in spite of the barriers, students could become prepared to contribute to our country in the mathematical sciences. Individuals such as Walter Massey, Director of the National Science Foundation; mathematicians/mathematics educators Etta Falconer, Richard Tapia, and Freda Locklear, and physicist John Tabouga were educated in segregated schools at some point in their educational careers.

Before we set out to examine strategies that could be useful in two-year colleges to make mathematics work for the diverse student population, it is important to put the problem of minority achievement and representation in its proper perspective. We must also look at the nature of the two-year institution, to examine the missions of these institutions, and to determine how these missions

fare with the current perception of the two-year colleges in both academic circles and in the communities they serve.

I'll say to you now what Henry VIII said to each of his wives, "I won't keep you long..."

I come to you today with the challenge, the vision, and the Strategies.

The Challenge

In reviewing the literature on two-year colleges, it became clear to me that this group of institutions is suffering from the same perception that has plagued racial minorities for many years -- the Rodney Dangerfield Syndrome -- "they get no respect," especially in academic circles. It appears that the larger academic community is unaware of the multiple missions of the two-year institutions, and clearly unaware of the multiplicity of tasks that you gallantly carry out. There appears to be a dearth of positive information in the literature about the role of these institutions in educating minorities for a productive life in the U.S., and for making a viable living in this country. Although approximately 50% of the minority students in college are in two-year institutions, and 23% of the student population in these institutions are minorities, it is sad that there appears to be little recognition in this country of the current contributions and potential contributions of two-year colleges in the preparation of minorities for the work place,

or for their capacity to function in a technologically driven society. There further appears to be little recognition that the quality of all of our lives will be considerably weakened if large numbers of Americans are not prepared adequately to take on the many different jobs in America, thus forcing these jobs to be filled elsewhere.

I don't have to tell you that the idea for the two-year institution was conceived in this country unlike the idea of the university or the schools which came from Europe. The two-year institutions were established in the early part of the twentieth century and had as their major purpose to provide the first half of the requirements for the bachelor's degree in one's own community.

In the late 60's and early 70's during the height of the civil rights struggles, there was a dramatic increase in the number of and enrollments in two-year colleges. During this time, two-year institutions also became diverse in their mission. No longer was there a principal focus on preparing students for transferring into four-year institutions, but rather the expanded mission included preparing students for specific jobs, preparing students for vocational degree programs, providing developmental instruction for those with weak academic skills, and retraining employees for local businesses.

The MSEB publication, **Moving Beyond Myths**, lists ten(10) programmatic charges for the two-year colleges. The question of whom is served by each of these missions is one of importance to me, and one with serious implications for minority students. Too often, non-Asian minority students find themselves perpetually in remedial courses with instructors with little teaching experience and limited mathematics background. Frequently, "remediation" has put them on an island, never to get off -- not being able to navigate through the seas of technology, and never to join the ranks of those preparing for transfer, or those preparing to serve our society in technical areas.

Today, two-year colleges abound and make up 40% of the institutions of higher education. Today, there sxists 1,452 two year academies and 2,135 four year institutions (U.S. Dept of Education, 1990). Two-year institutions enroll nearly 40% of all undergraduate students and account for nearly 40% of the undergraduate mathematics course enrollment. In the fall of 1990, the total full-time faculty in two-year mathematics departments was 7,222 with another 13,680 individuals -- 189% of full-time faculty teaching on a part-time basis. These numbers are compared to 19,411 full-time mathematics faculty in four-year institutions, 6,786 part-time faculty, and 7,297 graduate teaching assistants. The percentage of part-timers and graduate assistants in mathematics in four year institutions is 73% of the full-time faculty (BMS, 1991). We should note the excessive use of part-time

faculty in mathematics departments in two-year institutions. Also, over 90% of the instruction by the faculty in two-year institutions is below the calculus level. However, since nearly 10% of U.S. students who receive a doctorate in the mathematical sciences began their undergraduate studies in two-year institutions, it is clear that these two-year academies are significant in enabling many students to get through the educational pipeline.

Of interest also is the fact that the two-year institutions seem to be clustered in the states with the largest numbers of minorities. Consequently, these states have the largest number of minorities enrolled in community colleges. California, Texas, New York, and Florida head both lists. California has over 2 million minorities in community colleges, and is the home of 25% of the nation's community college students, but less than 6% of the Black and Hispanic students transfer from the 109 community colleges into the nine-campus, University of California system. Also, of note is that of all Blacks and Latinos that go to college in the state of California, 80% of them are in the community college system (Rodriguez, 1991).

How are these colleges preparing Hispanics and Blacks and for what purpose? No doubt the two-year colleges in the state of California wish to set world-class standards that will guarantee unchallenged acceptance for the continuation of higher education in the California system. No doubt, these institutions realize that they

may be the only source of higher education that many of their students will ever see, and thus wish to prepare these students with the capability of meaningful choice for either continuing their education at a four-year college or for immediate employment.

Meaningful choice came to Dr. Richard Tapia, a Mexican American, when he completed his work at Harbor Junior College. Harbor Junior College prepared Dr. Tapia for the rigorous mathematics curriculum at UCLA. He received his Ph.D. in mathematics from UCLA in 1969 and eagerly acknowledges that his experience at Harbor Junior College was indispensible to his ultimate success in higher education. Dr. Tapia said that when he finished high school, he "wasn't ready for anything," but that the individual guidance and nurturing of the faculty, together with their quality of teaching paved the way, and was clearly superior to the interaction he subsequently received at UCLA throughout his baccaulaureate and doctoral studies. Now, he is Professor of Mathematical Sciences, and Chairman of Graduate Admissions for the Mathematical Sciences Department at Rice University.

Pamela Salazar, of the Hispanic Association of Colleges and Universities, referred to as HACU, estimates that only 10% of Hispanics nationwide transfer from two-year to four-year institutions. The goal of HACU is to increase the transfer rate to 25%. Alan Kirschner, United Negro College Fund's vice president for public policy, estimated that while nearly half of all Blacks

enrolled in college are in two-year institutions, those who are in two-year colleges are one-fifth as likely to earn a bachelor's degree as those who start out in a four-year school.

All of the studies that I have read reveal that at least one-third of the students in these institutions desire to continue their higher education to complete the baccalaureate; some estimates are as high as 75%. However, only 15% of the total number of minority students transfer from two- to four-year institutions, according to the Action Council on Minority Education in the book, **Education That Works.** Is this morally reprehensible? Is there a need to look further at the missions of the two-year colleges and the numerical targets set for these missions, or should we take a closer look at the percentage of minority students who matriculate into the colleges with the hope of transferring into four-year institutions?

One of the goals stated by the Action Council on Minority Education is to increase from 15% to 30% the total number of minority students transferring from two- to four-year institutions. If this goal is met by the year 2000, our country would be provided with a second wave of students who could become prepared to take on more of the jobs in education, mathematics, science, and engineering.

What kind of manner, then, is this two-year institution (if you please), and what role has it played and what role **should** it play

in the production of the future workforce, and in the production of Americans who will contribute maximally to the technological society of the 21st Century? The two-year colleges hold the key to increasing the pool of minorities in the mathematical sciences, including education, because they attract three times as many Blacks that are served at HBCUs and four times as many Hispanics as are served by Hispanic Serving Institutions, (HSIs) that are not two-year institutions.

Celestino Beltran transferred from a California community college into Loyola Marymount University. Although he was discouraged from studying engineering by a counselor who told him, "Mexicans don't make good engineers," he persevered and successfully completed the pre-engineering program. A product of a poor community in El Monte, California, just outside of East Los Angeles, and written off by the school system as uneducable, Beltran now has an electrical engineering degree from Loyola Marymount University in Los Angeles and is the president and chief executive officer of Comprehensive Technologies International, Inc. (CTI) in Chantilly, Virginia -- a technology and software development company with 510 employees and revenues of $33.4 million in fiscal year 1991.

Beltran speaks of his experiences at the community college with fond memories of a most rigorous program. When asked why only 15 of the 280 students who started the program with him completed it in two or three years, and only one other Mexican American, Beltran

asserted two major reasons: 1) students did not seem able to develop the ability to delay gratification -- they were not disciplined enough to go to the library every day as I did and to work with a study group, and 2) the mathematics classes were dry and uninteresting, so many students failed and thought they shouldn't take the courses over again. Beltran took three years to complete the two-year pre-engineering program because he failed trigonometry during the summer before he started the program; hence he was a year behind, mathematically. "The mathematics courses were very hard for me; so I studied with smarter kids, and practically lived in the library," said Beltran. When I took calculus, I spent numerous hours in the library reading about the concepts and procedures in many books until I could understand them. Now I want to tell other community college kids how to make it."

Celestino Beltran claims that he is one of many students who began his postsecondary education in the community college and "made it." He has a saying at his company that goes, "the best way to lead someone is to show him a future." Beltran believes that we must show the student what kind of job he/she can have, and how his/her thinking can improve. He sings praises to the community colleges and is quick to say that they are needed as a safety valve for those students who are talented and want to work hard, but who have limited financial resources, or who might need remediation. "I could not have afforded to spend a third year at Loyola Marymount,

but I could afford a third year at the community college, and because the community college had a strong link with [illegible]ount, I was ready for the upper division courses in engineeri[illegible]

Clearly, there is a need for a paradigm shift. We must change the set of rules that establish boundaries for who will be successful, and how they can become successful. Understandably, we are blinded by the tunnel vision of old paradigms; consequently, it is hard to see the value of the need for a paradigm shift, but a paradigm shift is necessary for this country to benefit from the human resources lodged into our two-year institutions. The importance of instruction that encourages practice in formulating problems, developing strategies for solving problems, and analyzing solutions for appropriateness cannot be overstated for all students.

Clarence Stephens, the creator of a successful undergraduate mathematics program at SUNY-Potsdam, where approximately 24% of the bachelor's degrees were in mathematics, stated: "We focus on the human factor, to change students' perception that mathematics is an almost impossible subject for students to learn and that only the most gifted can be expected to achieve any degree of success." Stevens asserts that students want to learn mathematics because of the supportive environment at SUNY-Potsdam.

IF YOU ALWAYS DO WHAT YOU ALWAYS DID, THEN YOU'LL ALWAYS GET WHAT YOU'VE ALWAYS GOTTEN.

By the year 2000, minorities will constitute one in every three American students. It has also been projected that from 1985 to the year 2000, over 21 million new jobs will be created (U.S. Department of Labor, 1988). These new jobs, even those not requiring a college education, will require basic skills in mathematics and the ability to reason. More than half of these jobs will require some education beyond high school and almost a third will require a college education. Thus, over the next ten years Americans must take significant steps to keep minorities in school and focused on the appropriate academic areas those jobs will demand. Hence, it is no longer just an educational issue, but indeed it has become an economic one as we consider who ultimately will be supporting American systems, such as social security.

A Vision

In the year 2000, as we take that flight into the future, I see the two-year colleges having strong articulation programs with four-year institutions, and those four-year institutions will include Historically Black Colleges and Universities, Hispanic Serving Institutions, and four -year tribal colleges. I see two-year institutions setting world-class standards, especially in the area of mathematics, that will guarantee unchallenged acceptance of two-year college students for the continuation of higher education in any university. I see four-year institutions accepting graduates from two-year colleges with marked enthusiasm, knowing that an

influx of these graduates will not devalue their institutions. I see remedial courses designed to ensure student success, i.e. small classes staffed with experienced, well-motivated and talented teachers, as well as with student mentors. I see two-year colleges in partnerships with HBCUs, HSIs, and majority institutions to produce more teachers of mathematics prepared to teach in urban school systems, and in heavily minority populated schools. I see two-year colleges identifying potential teachers of mathematics, chemistry, and physics, as well as potential engineers, and scientists, and working hard at strengthening these students, especially in mathematics. I see these students, perhaps during their second year, having joint enrollment in both the two- and four-year institutions that are in joint partnership. I see two-year institutions having numerical targets for transferability, and numerical targets for minorities to transfer into teacher education programs in the mathematical sciences, as well as in engineering, and other mathematics-based programs. I see mathematics faculty at two-year colleges asking themselves the question posed by Dr. Tilden Lemelle, the new president of the University of the District of Columbia, in his first address to the faculty: How does what we do prepare our students for living and for making a living? I see mathematics faculty in two-year institutions serving as mentors for students, especially minority students to help them see what is and can be for them -- to show them a future in the mathematical sciences. I see mathematics faculty in two-year institutions working closely with school teachers and faculty in four-year

institutions to strengthen programs and facilitate student transition. I see mathematics faculty providing good educational advising, serving to create and sustain mathematics clubs, and serving as the core change agents at the two-year institutions.

So then, **WHAT MORE CAN TWO-YEAR COLLEGES DO** to make mathematics work for minorities? I will recommend ten strategies on what we can do to make mathematics work for minorities.

Strategy I: Shift our paradigm, if necessary, to one which allows us to behave under the belief that all students can and must learn mathematics, and that minorities can succeed in mathematics and mathematics-based fields. Set high expectations for all students, and most of all make sure that students know these expectations.

Strategy II: Set up articulation and collaborative programs with HBCUs, HSIs, as well as majority institutions to facilitate smooth transferability. Also, work closely with faculty in schools and four-year institutions to strengthen programs and facilitate student transition. You may want to examine the program, **Exploring Transfer**, directed by Dr. Janet Lieberman of Fiorello H. LaGuardia Community College, and Dr. Colton Johnson of Vasser College. A collaborative, voluntary program, this program emphasizes experiential education, collaborative structures, and the power of the site.

Strategy III: Make the teaching profession a glamorous and rewarding one -- one worthy, of the best students! Identify the best potential teachers among your ranks, provide incentives for them to go into the teaching profession, and provide them with the strongest possible program to prepare them for the four-year institutions. Have your pre-teacher education program designed like those in the connecting universities, and with appropriate support for student success. Develop a mechanism for joint enrollment in both the two-year and the four-year institutions. Bear in mind that today, only 9% of the public senior high school teachers of mathematics are minorities, which is evidence of a wide disparity between the supply of minority mathematics teachers and the proportion of minority students in virtually all states. Also, less than one-half of all public senior high school teachers of mathematics (47% with primary assignment) actually have a college major in mathematics.

Strategy IV: Intensify minority recruitment showing students the advantages of beginning their college work in a two-year institution, and of the ties that the two-year institutions have with four-year institutions. Be sure to let them know about ties to HBCUs and HSIs and majority institutions without steering them into specific schools. HBCUs may be especially receptive to developing strong ties in teacher education in mathematics and science.

Strategy V: Promote and communicate with appropriate minority communities research on accomplishments of minority mathematicians and scientists who began their college training in two-year institutions. Also, follow your own students, and have successful ones come back to the college and talk to the students.

Strategy VI: Restructure remedial courses for success, incorporating cooperative learning, peer tutoring and computer assisted instruction as supplements to traditional teaching methods. Have experienced, well-motivated, and talented teachers work with students in small classes, and promote group study inside and outside of the classroom setting.

Strategy VII: Set numerical targets for transferability of minority students. Also, prepare this group of students with the capability of meaningful choice for immediate employment in a technological society, bearing in mind that all workers should be prepared to adapt to emerging technology, or prepare them for the continuation of higher education. You might want to examine closely the success of Austin Community College in transferability. Approximately 9 out of every 10 students who transfer from Austin Community College to public colleges and universities are still enrolled a year later (survivability is nearly 40% higher than the statewide average). They claim that transfer success comes from paying attention to curriculum; courses at Austin Community College are similar in content, emphasis, and difficulty to those in

neighboring universities. Two-year college faculty have frequent contact with faculty at nearby universities. A program in place for nearly a decade brings Austin Community College onto the University of Texas campus two nights a week to university students. For those students, the university counts hours of enrollment at Austin Community College toward a student's minimum full-time enrollment obligation at the university.

Strategy VIII: Establish partnerships with industry, and give all students an opportunity to benefit from programs developed under these partnerships. In response to an industrial need, Seattle Central Community College developed a two-year biotech program. Together, industry leaders and the college faculty planned the course of study. Industry leaders also sat on the community college advisory boards and gave instruments and equipment to the college. College President, Dr. Charles Mitchell, said that it is hard for two-year colleges to keep up with advancing technology in isolation; hence, it is necessary to form partnerships with industry.

Strategy IX: Seek financial and human resources from government, especially agencies that are in need of mathematicians and scientists and those charged with improving mathematics and science education. Develop programs for increasing minority participation in science and mathematics, such as mentoring and career awareness

programs with agencies such as The National Science Foundation, Department of Education, and National Security Agency.

Strategy X: Promote the teaching and learning function in mathematics. According to the Mathematical Association of America's document, **A Call for Change**, "to adequately prepare students for the 21st Century, the nation's mathematics educators must create classrooms that recognize students and teachers as thinkers, doers, investigators, and problem solvers." Walter Massey tells us, "The most important factor listed by minority students at successful institutions was a supportive environment; the presence of mentors, study groups, science and mathematics clubs, good advising and remedial courses when needed." (Walter Massey).

In Conclusion

The role of two-year institutions to increase minority participation in the mathematical sciences cannot be overstated. This group of institutions is serving and will continue to serve a majority of the minority student population in college. You are uniquely positioned to determine, to a large degree, the success that we as a nation will have in increasing minority representation in the mathematical sciences, and for preparing minorities to make a productive life for themselves in the 21st Century. Two-year colleges have a wonderful opportunity to provide our country with a second wave of students who will become prepared in the

mathematical sciences and in education to take on the many jobs that will require mathematics and/or their ability to use current and emerging technology. It certainly is clear that any effort to recruit more majors in mathematics-based fields; to strengthen the undergraduate major in mathematics-based fields, and any effort to prepare students for life, and for making a living must be carried out in a manner that includes two-year colleges as a full partner. It is no longer a matter of good-will to merely allow for the emergence of talents from the growing population of minorities, but rather, it is in our best interest for two-year institutions, to actively encourage and sustain such an emergence for the survivability of our country, and of our way of life. The future rests with you. Thank you.

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