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ABSTRACT

Recently established mathematics and science intervention models, designed to increase participation and achievement of Hispanics, women, minorities, and disadvantaged postsecondary students, are reviewed to identify successful organizational designs and key elements. Organizational designs include collaboration between school district, college, or university and industry; college consortium arrangements to work on special projects; institutional block programs to provide academic and student support services to a cluster of math and science students; and student/faculty mentorship. Twenty-six key elements of models designed for Mexican Americans as a main target group are: high level administrative support, departmental commitment and support, collaborative organizational design featuring early student identification and progressive intervention, active staff participation, use of role models, close faculty and counselor contact with students, contact with parents, strong administrative leadership, use of program advisory committees, staff incentives, early recruitment of high ability students, measurable objectives, long-term goals, high student expectations and use of incentives, practical "hands on" learning experiences, development of communication skills, use of ethno-related math and science concepts, use of student learning communities, parental involvement, visits with practicing scientists and mathematicians, remedial/enrichment activities, long-range multiple-source funding, data collection for program evaluation, formative and summative evaluation, quality-verification and replicability, and documented student outcomes. (NEC)

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ELEMENTS OF SUCCESSFUL MATH AND SCIENCE MODELS

FOR MEXICAN AMERICAN STUDENTS

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Elements of Successful Math and Science Models for Mexican American Students

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The jeapardous condition of math and science education for Mexican American students is illustrated in figures which reveal the group's underrepresentation in undergraduate and graduate degree recipients in these fields. In 1981, Hispanics comprised less than 3% of the bachelor's, less than 2% of the master's, and less than 1% of the Ph.D's in each of the following field categories: physical science, mathematics, computer science and life science (Malcom, 1983). Hispanic student representation in these fields is so low, it lags behind that of blacks, a group whose own participation level is abysmally low (Malcom, 1983; McNeh, 1983).

A myriad of student- and institution-related factors have been cited which appear to account for this unacceptable level of participation. Student-related factors include low socio-economic status, academic deficiencies and negative attitudes toward math and science (Estrada, 1983; McCorquodale, 1983; Commission on the Higher Education of Minorities, 1982; Rendon, 1982, 1983). Institution-related factors are noted in the lack of curricular materials which demonstrate the importance of math and science in everyday life, stimulate student interest and involvement, and cultivate problem solving and critical thinking skills. Further, the nation's classrooms suffer from inadequate facilities and lack laboratories and instruments needed to provice state-of-the-art teaching in math, science and technology. (Malcom, 1983; National Science Board Commission on Pre-College Education in Mathematics, Science and Technology, 1983). Exacerbating the problem are teacher shortages, a lack of Mexican American faculty and staff in the nation's colleges and universities, ignorance and/or insensitivity about Hispanic culture and attitudes, lack of encouragement (especially in the early grades), and a lack of training for teachers and counselors who work with students with academic deficiencies and negative attitudes about math and science (Vetter, 1983; Rendon, 1982; Friedlander, 1979).

As of late, a number of math and science intervention models have been designed to increase the participation and achievement of Hispanics, women, minorities and disadvantaged students. This paper reviews the organizational designs of some of the most successful math/science models and describes the components and key elements of models designed for Mexican Americans as a main target group.

Organizational Designs of Math/Science Models

Of the models presently available, organizational designs include: 1) collaboration between a school district, college or university and industry, 2) consortium arrangement, 3) institutional cluster program and 4) student/faculty mentorship. A myriad of other activities have also been developed.

Collaborative Arrangements

Some of the most successful models have an organizational design involving collaborative partnerships between schools and colleges with support from business and industry. These programs allow for early identification of students majoring in math and science so that they may be motivated and prepared to enter and be successful in college-level programs. Perhaps the most replicated model of this type is California's Mathematics, Engineering, Science Achievement or MESA program. MESA is designed to work with high school minority students who are interested in careers requiring a year of college and mathematics. The program requires that students study college preparatory mathematics, science and English each year and offers tutoring, counseling, career development and incentive awards that encourage academic achievement. MESA centers are located at universities with strong engineering and physical science departments.

Minority students are eligible to apply for a MESA summer program during the 10th grade. To remain the program, students are required to enroll in college-preparatory mathematics, English and science, to maintain an above average GPA and to participate in student meetings, study and tutoring sessions, field trips and a summer enrichment program. MESA includes a Parent Advisory Organization. Parents attend field trips, host student groups, attend information workshops and transport students to study sessions. MESA receives funding from private foundations, industries and universities which house the project.

Other examples of school/college partnerships include the High Technology High School at San Antonio College, the San Antonio Independent School District Biomedical Program, The South Texas Engineering Mathematics and Science (STEMS) program at Texas A&I University in Kingsville, The Transitional Summer School Program at the University of Houston and the Professional Development Program at the University of California at Berkeley.

Consortium Arrangement

Another type of organizational design involves a consortium of colleges which organize themselves to work on a special project. A model using this design is represented by the Border College Consortium's Math Intervention Project funded by the Ford Foundation. The consortium is comprised of six community colleges located in border communities in Texas, Arizona and California. Among the most successful activities developed by the colleges include: 1) conducting research studies, 2) developing a math tutorial program, including a tutor training packet, 3) creating a math anxiety course, 4) developing a math articulation model to analyze high school math courses for content and objectives in order to evaluate student math preparation, 5) creating video tapes of math lessons for tutorial use, 6) examining the validity and reliability of math placement tests, 7) developing self-paced courses and 8) conducting resource sharing activities with technological institutes. Advantages of this design include sharing of workable concepts and collaborating on issues of mutual interest which allow consortium members to adopt, integrate and institutionalize particularly successful model activities from one institution to another.

Institutional Cluster Program

Still another type of design is an institutional block program where academic and student support services are provided to a cluster of math and science students. A sense of community which fosters camaraderie among students, faculty and staff is created to allow for encouragement and support. The models feature intensive academic and student support services to improve performance and retention. These activities include the use of student study groups, tutorial services, study skill development, instructional sessions in chemistry, math, reasoning and problem solving, academic and career advisement. Examples of this design are the Engineering and Computer Science Educational Laboratory at UC-Irvine and the Minority Engineering Program at UCLA.

Student/Faculty Mentorship

Some models feature a student/faculty mentorship where students work with an experienced faculty member who serves as a mentor. Examples of this type of design include the Biomedical Research for Ethnic Minority Students and the Honors Undergraduate Research Training Fellowship Program at New Mexico State University. A distinguishing feature of this design is close student-faculty contact. In an apprenticeship situation, students conduct research and are involved in activities such as writing manuscripts for lay magazines and peer-reviewed journals, developing grant proposals and presenting papers at scientific meetings.

Other Activities

Of course, there many other activities and programs that have been developed. Among them include brochures and videotapes developed for parents and students through the Parental Involvement Project, a collaborative activity between Texas Southmost College and the Brownsville Independent School District. Brochures, conferences, scholarships and social activities to encourage women to participate in math and science fields have been developed by the Women and Engineering Office at the University of Arizona. The next section examines key elements of successful math science models.

Key Elements In Successful Math/Science Models

What makes math and science models successful? A study of several models conducted by Rendon (1985) revealed what program directors felt contributed to the success of their programs as well as what minority scientists and mathematicans indicated could be done to improve the quality of presently available models. The overall measure of program success was the ability to increase the participation and achievement of minority students in math and science-based fields. The following elements were identified as representing internal mechanisms of educationally powerful models.

1. High level administrative support. Successful math/science intervention models reflect the mission, or overriding school or college philosophy, and receive high level administrative support from the President and Chief Administrative Officers. The implication is that institutions need to carefully examine their role in serving Mexican American students, women and other minorities and the importance given to addressing the underrepresentation of these groups in math and science-based fields. Successful math/science models are those which reflect these issues as institutional priorities worthy of commitment and support at the senior administrative level.

2. Departmental Commitment and Support. In the most successful intervention strategies, the activities implemented are those which are central to the goals, objectives and priorities of the math/science department. When models for minority students are articulated in the department's policies and objectives, faculty avoid being peripherally involved and become active, committed constituents in the model. It is important that the ownership of the project be placed with the entire department to ensure faculty involvement and commitment and to facilitate the institutionalization of the program within the department.

3. Collaborative Organizational Design Featuring Early Student Identification and Progressive Intervention. The most effective models appear to be those which link a school with a college or university in a collaborative effort to increase the pool of minorities in math and science based fields. A distinguishing feature of these models is their close working relationship with corporate sponsors. The sponsors not only contribute to project funding; they serve in an advisory capacity to identify community training needs, act as consultants, facilitate visits and field-trips to industrial sites and arrange for internship situations where students can get "hands-on" experiences. These models feature early student identification and intervention. Students may take concurrent classes in school and college and may attend enrichment programs designed to upgrade math, science, study and communication

skills. By providing early intervention and long-range, in-depth learning experiences, students are able to make early career decisions, and to channel their interests and coursework into tangible activities provided within the program.

4. Active Staff Participation. In the most successful models, faculty, counselors and administrators are actively engaged in different aspects of the total program. For example, the staff is involved in structuring project goals and objectives, advising students, contributing to the evaluation process, and ultimately ensuring the overall success of the program.

5. Use of Role Models. At their best, faculty, counselors and administrators serve as role models for non-traditional students. Most project directors feel that Mexican American students need to be surrounded by professionals they can not only look up to, but who can provide encouragement, inspiration and expertise to enhance persistence and the acquisition of math and science skills. The implication is that when possible, Mexican American role models should be used. Otherwise, training for the non-Hispanic professional staff should include the recognition of socio-economic, familial, and cultural differences which distinguish Mexican Americans from other student groups.

6. Close Faculty and Counselor Contact with Students. Because faculty and counselors are key role models, opportunities exist for close, daily interactions with students in and out of the classroom environment. Along with teaching necessary skills and concepts, faculty may serve as advisors/mentors who provide constant reinforcement to students.

Counselor/ student interactions are enhanced when counselors conduct reach-out efforts to identify and encourage potentially successful Mexican American males and females to participate in math and science-based fields of study.Program directors feel that counselors may educate students about different math and science related fields, salaries and educational requirements.Further, directors feel that students may be taught to write resumes and prepare for job interviews, assisted to transfer from high school to two- and four-year colleges and advised to take proper course sequences.

7. Contact with Parents. Many project directors feel that contact needs to be established with parents who fear or do not fully understand the system of higher education. In some cases, Mexican American parents who did not attend college or finish high school experience uncertainties about their children going to college. Parents may fear the unknown, or take alarm that their children will lose close ties with the family, culture or values. In these instances, it would

be helpful if counselors could orient parents as to the benefits that obtaining a higher education can have for their children's future. Also, counselors could advise and work with parents of Mexican American women who may feel that the family is reluctant to "let go" of them.

8. Strong Administrative Leadership. In successful models, project directors take the responsibility of exerting leadership to induce active participation of faculty, counselors, students and parents in the overall program. Moreover, administrators elicit institution and community support for the program. Without this support, a program tends to lose credibility and importance. The implication is that, administrators should communicate with institution and community representatives to inform them of the project's progress and accomplishments. Further, administrators should take the leadership to identify and make use of all available resources and funding opportunities which may keep the project alive.

9. Use of Program Advisory Committee. Many exemplary models make use of a program advisory committee comprised of institution and community representatives and parents that act as consultants or advisors who provide resources and expertise to the project. The advisory committee helps to foster interest, support and commitment for a project.

10. Staff incentives. Incentives for the professional staff are included in successful models in the form of recognition for excellence in teaching, extra compensation, release time and merit pay, among others.

11. Early recruitment of high ability students. Two important messages appear to emerge from most program directors about the type and level of students a model should target. The first is "get them while they are young." This message translates into recruiting and training students as early as elementary school and no later than the junior high school level, when students begin to make critical career decisions. The second message is "work primarily with high ability students." Most of the present models recruit and train minority students with above-average academic ability, which is certainly one important factor that can explain the model's success. It remains to be seen how future models can identify, recruit and train a broader pool of Mexican American students with less ability, but who show potential.

12. Measurable objectives. In successful math/science models, the program components are based on measurable entry and exit objectives which are well-identified departmental priorities that are articulated to staff, parents and students.

13. Long-term, multi-year goals. The goals of successful models are usually long-term and multi-year. Even when interventions occur as early as the elementary or junior school level, the program allows for continuity and increased depth of experience as the student progresses from school to college.

14. High Student Expectations and Use of Incentives. Successful math/science models build high student expectations and include student incentives to encourage them to perform at their best. In some programs, students receive academic excellence awards, are named to a list of honor students, or receive jackets, pens, calculators, and the like in recognition of academic achievement.

15. Practical, "hands on" Learning Experiences. Many models include "hands-on" learning experiences such as the use of laboratory equipment and exposure to computers or participation in an apprenticeship program with an active and successful scientist or mathematician.

16. Development of Communication Skills. While programs strive to develop student math and science skills, it is well recognized that reading, writing, speaking and listening skills are critical to solving problems, researching and presenting scientific concepts. Communication skill development is thus built into exemplary math/science models.

17. Use of ethno-related math and science concepts. Some minority scientists and mathematicans feel that students can benefit from the use of ethno-related math and science concepts to enhance student pride and motivation. For example, many Mexican American families use curanderos or faith healers and view curanderismo, the practice of folk medicine, as an alternative health care system. These practices can be integrated in the teaching of surgery, pharmacy, or chemistry. Further examples include examining the Azetc calendar to introduce concepts in astronomy and analyzing the nutritional value of tortillas,which comprise an essential element of the Mexican American diet.

18. Use of Student Learning Communities. Student isolation and passivity are eradicated in some models through the use of student learning communities, faculty personalized counseling, tutorial assistance, orientation, and the creation of student networks and study groups. The learning communities facilitate the building of a sense of camaraderie among students and professional staff and foster support, encouragement, involvement and affiliation which are critical to student achievement and retention.

19. Parental Involvement. Successful models incorporate parental involvement as parents may be used to encourage students to take math and science courses and to enter these career fields. Also, parents can provide tutoring, guidance and moral support which can contribute to student retention. Successful models involve parents in advisory groups, field trips, and information workshops, among other activities.

20. Visits with Practicing Scientists and Mathematicians. Opportunities may be provided to students to talk to other Mexican American students already enrolled in math and science fields and to visit with Hispanic professionals in a working environment.

21. Remedial/Enrichment Activities. Students who need to develop their math/science skills can profit from remedial or enrichment activities such as tutorial services, remedial work, etc. which may be offered during the summer or as a special component within a model.

22. Long-range, multiple-source funding. Most math/science intervention program directors feel that long-range funding is best, as opposed to "one-shot" one- or two-week strategies which yield limited outcomes. Further, successful models have incorporated multiple funding sources from corporations, industries, the institution and private foundations and federal government agencies.

23. Data Collection for Program Evaluation. Two major types of evaluative data are acquired and analyzed during the project: 1) intervention model objectives and 2) impact of model on program participants and the institution.

Data are collected for all pre-specified program objectives to determine if outcomes related to each objective have been achieved. Critical to this category are data related to: 1) student completion rates, 2) GPA's, 3) majors selected by students, 4) pre- and post-test scores, 5) achievement comparisons of Mexican American students with other ethnic groups, 6) student follow-ups after they leave the program (i.e., GPA's and persistence rates at other institutions, type of employment secured, etc.). To properly quantify this important data, it is essential that the program's objectives are written in a measurable format. It is expected that the intervention model may have a number of primary and secondary level effects on program participants and the institution as a whole. As such, special instruments or in-depth interviews may be used to obtain data related to: 1) parent and student attitudes about the program, 2) faculty, counselor and administrator perceptions about what worked and what didn't work in the program, 3) perceptions of the community about the program, 4) problems students and professional staff experienced while project was in progress, 5) sponsor attitudes and 6) student and institution-related factors which influenced achievement and persistence.

24. Formative and Summative Evaluation. In general, the professional staff, students and parents may be involved in formative evaluation, while an external consultant may review the model and prepare a summative evaluation of program accomplishments. Formative evaluation occurs while the program is in progress and functions as a continuous, self-correcting mechanism which gives the program staff the flexibility to monitor student progress and make modifications in teaching, counseling and tutorial strategies. A summative evaluation involves an end-of-the-year report summarizing the year's activities so that major accomplishments and program milestones may be identified and communicated to the institution, the general public and program sponsors.

25. Quality-verification and replicability. Most project directors feel that models should emphasize careful and comprehensive documentation and user-oriented packaging of all quality-verified project components to facilitate successful implementation of practices and materials from one institution to another. The model should strive to be replicable and portable so that other institutions with similar student populations will be able to adopt or adapt it.

26. Documented Student Outcomes. The importance of a well-organized, systematic means of collecting data to determine a project's outcomes is well-recognized by project directors. In the final analysis, an intervention model is only as good as the documented results it achieves. For example, when a model can document increases in Mexican American student enrollment, graduation, GPA"s, and overall retention, it is possible to say the program had successsful outcomes. Moreover, proper documentation of student outcomes makes it possible to identify the most successful math and science intervetions that work with Mexican American students. Periodic reports of program progress and an end of the year report which summarizes major accomplishments, project milestones, and overall student outcomes should be made available to project participants, the community and other institutions with similar student populations and program sponsors who usually like to know what they are getting from their investment.

Conclusion

Despite student and institution related factors which restrict access, persistence and achievement in math and science-based fields, the current interest to train minorities, women and non-traditional students has promising consequences for Mexican American students. First, several school and college initiatives to identify, recruit and train minorities have achieved favorable results. Second, most of those programs are replicable and portable so that other institutions may adopt or adapt the key components and elements which make them successful. The projects offer evidence that administrators, faculty, counselors and parents can play a vital role to insure that concrete school and college initiatives are developed to allow Mexican Americans to join a new generation of scientific and technological experts.

REFERENCES

Commission on the Higher Education of Minorities. Final report on the higher education of minorities. Los Angeles: Higher Education Institute, Inc., 1982.

Davis, B.G. & Humphreys, S. Evaluation Counts (N.S.F. Report, Grant Number SED-8016785). Oakland, California, Mills College, 1983.

de los Santos, A.G. Hispanics in community colleges. Tuscon: University of Arizona, Center for the Study of Higher Education, January, 1980.

Estrada, L. The dynamic growth and dispersion of the Latino population. Paper presented at AAHE Southwest Regional Forum, San Diego, California, April, 1983.

Friedlander, J. Developmental mathematics. In ERIC Junior College Resource Review, Los Angeles, California, August, 1979. (ERIC Document Reproduction Service No. ED 172 894).

MacCorquodale, P. Social influences on the participation of Mexican American women in science. (N.I.E. Final Report 6-79-011). Tuscon, Arizona, University of Arizona, May, 1983.

Malcom, S.M. An Assessment of programs that facilitate increased access and achievement of females and minorities in K-12 mathematics and science education. Washington, D.C. Office of Opportunities in Science, American Association for the Advancement of Science, April, 1983.

McNeh, I. Demographic imperative: Implications for educational Policy. Report of the forum on "The Demographics of Changing Ethnic Populations and their Implications for Elementary-Secondary and Postsecondary Educational Policy," June 8, 1983.

National Center for Education Statistics. The condition of education for Hispanic Americans. Washington, D.C.: U.S. Government Printing Office, 1980.

National Science Board Commission on Pre-college Education in Mathematics, Science, and Technology, Today's problems tomorrow's crises. October, 1982.

National Science Board Commission on Pre-college Education in Mathematics, Science, and Technology, Educating Americans for the 21st century. 1983.

Rendon, L.I. Chicano students in South Texas community colleges: A study of student and institution-related determinants of educational outcomes. Unpublished doctoral dissertation, University of Michigan, 1982.

Rendon, L.I. Mathematics education for Hispanic students in the Border College Consortium. Laredo, Texas: Border College Consortium, 1983. (ERIC Document Reproduction Service No. 242 451).

Vetter, B. Supply and dema. d for science and mathematics teachers. In T.L. Goad & G.M. Hinkel Teacher shortage in science and mathematics: Myths, realities and research. Summary of a conference sponsored by The National Institute of Education, Washington, D.C., February 10-11, 1983.