Defining Features of Exemplary Programs That Attract Young Minority Women to Engineering and Science

(Study funded by The National Science Foundation Grant CDA 89-54181)

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ABSTRACT

Studies have shown that minority women are particularly underrepresented in engineering and science, but in order to reach this pool of talent, the special concerns that affect young minority women must be recognized and programs that deal with these concerns must be developed. One such program offered at The George Washington (GW) University and funded by the National Science Foundation (NSF) from 1989 through 1993, utilizes computer technology and cooperative learning in a university setting to interest young minority women in engineering and science careers. As a result of the success of the GW/NSF program, a two-day working conference of experts was convened to determine the characteristics of exemplary programs that focus on this population. Outcomes from the conference included a criteria checklist, a program planning and self-evaluation guide, and suggestions for a national clearinghouse of information about exemplary programs designed to attract young minority women to engineering and science.

INTRODUCTION

The work force in the year 2000 will require many more scientists, engineers and mathematicians. New jobs which require a highly trained, technically competent work force are being created at the same time the engineering and science work force is aging. Compounding the increased need is the fact that there is a diminishing interest in science and engineering among the traditional talent pool. While the reasons for the decline are numerous and include cultural as well as demographic changes[1], the national imperative to educate math and science professionals is immediate and unconditional. An obvious solution to this dilemma is to recruit more students, but the traditional population source of white males is no longer an adequate or dependable source. However, other sources for high quality professionals are available if we are creative and sensitive enough to develop them [2].

One untapped reservoir includes the minority female members of our society. Typically women and minorities have not pursued careers in science, engineering and technology. By the end of high school, while 52% of boys think they would enjoy being a scientist, only 29% of the girls think this way [3]. Perhaps more indicative of this problematic situation is the pipeline issue. While there are roughly equal numbers of boys and girls at the sophomore level in high school, only about 25% of the males and 8% of the females express an interest in science an interest in natural science and engineering. After the first year of college, 50% of the those males still have a preference for science and engineering while less than one third of the girls continue to make that

choice [4]. Unfortunately, the percentages continue to drop, with those for girls dropping more rapidly than those for boys.

Numerous studies have demonstrated that preadolescent girls show superior aptitude for mathematical concepts and operations when compared to their male counterparts. Some researchers have found, however, that during early adolescence an explicit disinterest in math and science is developed in young women because of social pressures [5]. The result is a stagnation of inherent ability and the retarded development of subsequent skills necessary to undertake college studies involving math or science. The fact that social attitudes become fixed during the junior high and early high school years clearly suggests that efforts to influence young women's attitudes about future careers, personal abilities, and professional role models should occur during the early teen years. Attitude changes are required at this time to ensure that a curricular track is chosen which provides an adequate academic background for careers in math, science or engineering.

Addressing the Problem

Young women of color have special needs that must be met in order to provide them access to science and engineering education. Typically these girls do not have access to science or engineering activities or hobbies in their neighborhoods. Role models in science and engineering are rare. Parents of minority girls often do not have a college education nor do they see the need for supporting one for their daughter(s). Their family income is often limited. Additionally, family responsibilities and cultural and peer values impinge on the girls' opportunities to pursue science and engineering[6].

A number of exemplary programs have been developed to address these critical national issues. One such program offered at The George Washington (GW) University and funded by the National Science Foundation from 1989 through 1993, takes a unique approach in drawing young minority women to computer science, engineering, and science careers. In this project young women with potential ability are given the opportunity to use the latest computer technology to engage in scientific inquiry in cooperative teams under the guidance of computer science professionals and science teachers. So engaged, these young women have learned about both science and computers, but perhaps most importantly, they have come to view themselves as scientists.

Each year 24 minority female students from the 9th and 10th grades and 6 high school science teachers are selected from public and independent schools in the greater Washington, D.C. area. The project is based upon two ideas about students and teachers. Female students with potential ability in the sciences can be motivated to prepare for the fields of computer science, engineering or other sciences by working together in cooperative teams to develop a science project using computer-based hypermedia technology and by exposure to role models in the field. Similarly, by participating in a program that encourages high school science teachers to be facilitators, mentors and researchers with a group of young women, the teachers become more aware of the specific motivational issues related to encouraging young women to prepare for the fields of computer science, engineering or other sciences.

At the time of preparation of this paper, the Minority Women's Project had completed the first two years and had received additional funding from NSF to be extended for two more years. In the project evaluation participants gave high ratings to the technical program using computers, the residential aspect of the program, the experience of working on teams, and the field trips[7].

A WORKING CONFERENCE

As a result of the success of the GW program, funding was provided by the National Science Foundation (NSF) to convene a working conference to study exemplary programs to determine how such programs can be expanded and institutionalized. Twenty experts who direct or who are involved in programs that address the issue of attracting minorities and women to engineering and science were invited to participate in a two-day working conference held on October 14-15, 1991 at the IBM Decision Support Center (DSC) at Bethesda, Maryland. The panel was drawn from corporations, educational institutions, professional associations, foundations, government institutions, and volunteers.

The purpose of the working conference was twofold: to look at programs in general to determine what characteristics constitute exemplary programs and to look at the GW program in particular to investigate the possibilities of expanding the current program beyond the NSF grant period. The conference was structured to draw on the collective expertise of the participants to examine what constitutes exemplary programs, how information about them can be disseminated, how such programs can be replicated to wider audiences, and what funding sources are available for such programs.

An IBM DSC Facilitator led the group through a series of exercises using the computerized tools available on the DSC system. Each participant sat in front of a computer and entered responses to a series of questions. The responses were sent anonymously and simultaneously to the system. The process was interactive in that participants were able to view their own answers as well as the answers of other participants and to respond with additional ideas or information.

Defining an Exemplary Program

The conferees were asked a series of questions that related to programs that attract women and minorities to engineering and science such as: What programs are addressing the issues of attracting young minority women to careers and studies in engineering and science? How do they differ from or complement the GWU/NSF program? How can information about exemplary programs be disseminated? Can exemplary program be replicated in other communities? If so, how? What are the criteria for success? What key partners need to be involved? What communities would make good replication sites? What are the financial needs of such programs and how can the source of resources be identified?.

The first session was a brainstorming activity in which participants were asked to describe programs with which they were familiar that attracted women and minorities to engineering and science. From the data entered about existing programs, a list of 47 characteristics of existing programs was generated. While the characteristics ranged from those which described participant selection criteria to spin-off activities, the majority of the characteristics centered on the program environment .To determine which characteristics are essential to exemplary programs, the participants were asked to rank the characteristics according to their importance to an exemplary program using a ranking scale of 10 (essential), 5 (important), or 1 (not important). The first 23 characteristics, shown in Table 1, received a group mean score of 7 or more and were rated as the most essential characteristics for exemplary program.

RECOMMENDATIONS

Conference Follow-Up

Participants were asked what should be done with the information generated at this conference, what kind of continuing partnerships, if any, should be established, and what follow-up, if any, should be done as a result of this conference. There was

unanimous agreement that the data gathered should be put together into a report for dissemination. It was felt that there should be follow-up discussions and sessions scheduled at national conferences such as Women in Engineering Program Advocates Network (WEPAN). A newsletter was proposed as a vehicle for disseminating future information about related projects and conferences.

Table 1: Characteristics of Existing Exemplary Programs Ranked from 1 to 10

Ranking	Characteristic	Ranking	Characteristic
9	1. follow-up	8	13. career related field trip
9	2. high expectations	8	14. use of computers
9	3. role models	8	15. teacher training
9	4. career counseling	7	16. student professional development
9	5. fun	7	17. effective recruitment
9	6. mentoring	7	18. bridge activities (K - 12)
9	7. parental involvement	7	19. past student interest/ experience
8	8. partnerships	7	20. community involvement
8	9. bridge program (pre college)	7	21. professional volunteers
8	10. cooperative learning	7	22. open-ended activities
8	11. strong evaluation criteria	7	23. real science opportunities
8	12. replicability		

Model Program Guide

From the data generated by the conference a number of features were identified that should form the core of any program designed to encourage and enable young minority girls to pursue science and engineering. These features combined with the suggestions on how best to disseminate and replicate good programs can serve as guidelines for designers in planning programs. Figure 1 illustrates a Program Planning and Evaluation Guide derived from the data. The guide includes demographic and descriptive data and a checklist of characteristics necessary for an exemplary program. One feature of the guide is the list of additional characteristics needed for programs directed at high school girls to acknowledge the special needs that exist for them. This guide can be used to gather data about existing programs and to plan new programs.

Need for National Clearinghouse

The conference attendees noted the difficulties in disseminating and coordinating information about existing programs directed toward women and minorities in science and engineering. In identifying the need for a national clearinghouse of such information, they noted that a university setting in the Washington, D.C., would be an appropriate setting for such an endeavor. This location would enable the clearinghouse to capitalize on the wealth of information and resources in the greater Washington area and would provide access to the U.S. Congress, officials in government agencies and other policymakers who are often responsible for funding such programs.

There are four major activities for such a clearinghouse: resource identification and collection, facilitation of program dissemination and replication, facilitation of formation of local partnerships or alliances, and establishment of a national network. In the role of a typical clearinghouse, this clearinghouse would be the repository of data collected and generated about existing programs. Such data might include program descriptions, packets of information about how to develop and run programs, and video tapes showing actual programs in action. The clearinghouse should also utilize the most current forms of communication, such as the National Research and Education Network

(NREN), for information dissemination. It could sponsor seminars and presentations for legislators, policymakers, and officials from government agencies to make them aware of the need for and the existence of exemplary programs.

Bringing Young Minority Women to Engineering and Science

Program Name:_____
Program Site: _____
Contact Person_____Phone:_____
Program Format: After School_____ Saturday_____ Residential_____
Other(describe):_____
Number of participants program can accommodate: _____ Age :_____
How are participants recruited?_____
Ratio of applicants to acceptances into program: _____ Drop-out rate:_____
Geographical extent of program: _____
Cost per participant to run program: _____ Cost charged to participant: _____
Funding sources: _____
Partnerships or alliances created by program: _____
Community involvement in program: _____
For any program targeted for minority girls, identify how the program provides:

1) Fun for participants
2) High expectation that participants will succeed in program
3) Bridge activity to next level of involvement in science and engineering
4) Mentoring
5) Role models
6) Cooperative learning environment:
7) Field trips to labs, work environments, science museums
8) Parental involvement
9) Use of computers
10) Open-ended activities

In addition, for programs geared to high school girls, identify how the program provides:

1) College and career counseling
2) Internship opportunities
3) Student research opportunities
4) Opportunities to do "real science"
5) Development a network and peer support group among participants
6) Recognition of social barriers that inhibit participation in programs / future careers

Plan for follow-up after program: _____
Plan for evaluating program:_____
Involvement of teachers or teacher training provided: _____

Figure 1: Program Planning and Evaluation Guide

The clearinghouse could be a place where visiting scientists and scholars might come to study the problem and develop innovative materials. By facilitating the formation of local partnerships and alliances, the clearinghouse would assist individuals, businesses, associations, foundations, and other groups from local communities to establish linkages to work together to address the problem through programs designed to meet local needs. Similarly, by forming a national network, the clearinghouse would enable program leaders from the around the country to share ideas and successes with each other. It could provide a central teleconferencing location to connect scientists,

researchers, and program designers concerned about this issue with each other. The existence of a national clearinghouse will provide a focus for activity in this area, prevent duplication of effort, and assist in the generation of resources and funding.

CONCLUDING REMARKS

When examining issues related to under-represented groups in the workforce, often no differentiation is made between the various constituencies. There seems to be an assumption that their concerns and needs are similar [6, 8]. The conference described in this paper was purposefully designed to identify aspects of model programs that would address the special needs of a very targeted group - young minority women. Researchers and practitioners have shown that there is not a single answer to the challenge of increasing minority women representation in science and engineering. The model of exemplary programs developed here identifies the important themes and elements appropriate to this specific population.

This conference created a framework for identifying programs that work in attracting young minority women to science and engineering and for cultivating sustaining support for those programs. The lack of minority women in science and professional fields is a major social issue that needs to be addressed by business, education and government. Simply opening doors to once restricted career fields has not proven to be enough. The challenge is to identify programs that work in attracting this population to science and to cultivate sustaining support for those programs. It is then up to all interested parties - policymakers, educators, science and engineering professionals, parents, and the students themselves - to support and participate in these exemplary programs for young minority women.

REFERENCES

[1] Betz, N.E. "What stops women and minorities from choosing and completing majors in science and engineering?" Science and Public Policy Seminars. Washington, D.C.: Federation of Behavioral, Psychological and Cognitive Sciences, June, 1990.

[2] Tobias, S. *They're not dumb, they're different: Stalking the second tier.* Tuscon, AZ: Research Corporation, 1990, 6840 East Broadway Boulevard, Tuscon, AZ, 85710-2815.

[3] American Association of University Women, *Shortchanging girls, Shortchanging America.* Washington , D.C. January, 1991, AAUW Publications, PO Box 96793, Washington, DC 20090-6793.

[4] N. Levenson, Educational pipeline issues for women.*Computing Research News*, 11-13, October, 1990.

[5] S. Berryman, "Minorities and women in mathematics and science: Who chooses these fields and why?" Paper presented at the annual meeting of the American Association for the Advancement of Science, Los Angeles, May, 1985.

[6] C. Edwards. "Implications of the computer culture for women of color." *In search of gender free paradigms for computer science education* . The NECC Monograph Series, Eugene Oregon: International Society for Technology in Education, November, 1991.

[7] G. A. Austin. "Bringing young minority women to the threshold of science: Project evaluation." NSF CDA-8954181, The George Washington University, Washington, DC, March, 1992

[8] Matyas, M.L. and Malcom, S.M. *Investing in human potential: Science and engineering at the crossroads.* Washington, D.C.: American Association for the Advancement of Science, 1991.