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African American College Students Excelling in the Sciences: College and Postcollege Outcomes in the Meyerhoff Scholars Program

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Abstract: This paper describes and assesses the effectiveness of the Meyerhoff Scholars Program at the University of Maryland, Baltimore County (UMBC). The Program is designed to increase the number of underrepresented minorities who pursue graduate and professional degrees in science and engineering. Until 1996 the program admitted African American students exclusively, and the current study focuses only on students from that group. The Meyerhoff students have achieved higher grade point averages, graduated in science and engineering at higher rates, and gained admittance to graduate schools at higher rates than multiple current and historical comparison samples. Student survey and interview data revealed that a number of program components were viewed as being especially important contributors to students' academic success: Program Community, Study Groups, Summer Bridge Program, Financial Support, Program Staff, and Research Internships and Mentors.© 2000 John Wiley & Sons, Inc. J Res Sci Teach 37: 629–654, 2000

In a world increasingly driven by technology, living the American Dream requires more advanced education than ever. Literacy and skills in science and technology are becoming increasingly important; in fact, our economy's future appears tied, at least in part, to the strength of a technology-based workforce. More than three decades ago, the United States Government made a commitment to help African Americans achieve educational parity with the White majority. Although the commitment remains intact, the goal remains unattained (National Task Force on Minority High Achievement, 1999).

In 1986, only 1.1% of American citizens receiving doctorates in science, engineering, and mathematics (SEM) were African Americans, even though African Americans represent 12% of the United States population. In 1992, the percentage receiving SEM doctorates was 1.2%, and by 1995 it had increased to only 2.0% (NSF, 1996a, 1996b), despite the fact that proportionately higher numbers of African Americans aspire initially to science graduate degrees than do Caucasians (Elliott, Strenta, Adair, Matier, & Scott, 1995).

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The Process of Leaving Science Majors

Minority students cannot earn graduate SEM degrees if they do not first achieve and persist in these disciplines at the undergraduate level. The process underlying achievement and persistence in SEM, which begins in the first semesters of college, has been investigated by a number of researchers. Many freshmen with declared or intended SEM majors attend large, lecture-based, fast-paced, hierarchically formatted classes (cf. Wineke & Certain, 1990). These classes are part of a system within the SEM disciplines that limits access to degrees by ''weeding out'' those whose academic abilities are allegedly not equal to the challenge (Massey, 1992; Seymour & Hewitt, 1997). These classes are frequently described as difficult, unmotivating, and unrelated to whatever initiated a student's intrinsic interest in science (Duderstadt, 1990; Treisman, 1992; Gainen, 1995). Even many well-prepared and bright students receive very low grades in these classes. Low grades in freshman classes usually mean the student has not developed the academic foundation required for success in subsequent classes. In addition, poor performance can have a negative effect on self-esteem, reduce a student's initial intrinsic interest in science (Seymour & Hewitt, 1997), and decrease the probability a second SEM course will be taken (Sabot & Wakeman-Linn, 1991).

African American Science Students

Two reasons are generally invoked to explain why so few African American college students persist and achieve within the SEM weed-out system. First, African American families have lower incomes than their White counterparts, making college tuition a difficult hurdle (e.g., Astin, 1982, 1990). Financial need frequently makes off-campus work a necessity, and this is negatively associated with college persistence in general (Callan, 1994), and success in SEM programs in particular (Garrison, 1987). However, a natural response to this challenge, financial support, has not appreciably increased the number of African American SEM baccalaureate recipients.

The second reason frequently invoked to explain the lower persistence rates of African Americans in SEM majors is their apparent competitive disadvantage in academic background. Black freshmen have lower SAT scores, lower high school grade point averages, and lower participation in advanced high school math and science courses than their Asian and White peers (Willingham, Lewis, Morgan & Ramist, 1990; Ramist, Lewis, & McCamley-Jenkins, 1994; Elliot, et al., 1995; Gandára & Maxwell-Jolly, in press). These factors have a strong and consistent positive relationship with freshman performance in quantitative (math and science) classes (e.g., Willingham et al., 1990; Elliot et al., 1995).

However, every year large numbers of African American students with high SAT scores, impressive high school GPAs, and success in high school honors math and science courses leave the science pipeline (cf. Seymour & Hewitt, 1997). In addition, many studies have reported that SAT scores are less predictive of performance for Black than for White students (e.g., Breland, 1979; Willingham et al., 1990; Ramist et al., 1994; Bowen & Bok, 1998). African American students with respectable SAT scores who underperform provide evidence that factors other than pre-collegiate preparation and native ability work to depress minority achievement and persistence. These factors may include academic and cultural isolation, motivational and performance vulnerability in the face of negative stereotypes and low expectations for performance, peers not supportive of academic success, and perceived and actual discrimination (cf. Garrison, 1987; Nettles, 1988; Allen, 1992; Steele & Aronson, 1995; Seymour & Hewitt, 1997; Gandára & Maxwell-Jolly, in press).

Enhancing SEM Achievement and Persistence for Highly Able African American Students

What can be done to facilitate strong SEM course performance, persistence in SEM majors and subsequent entrance to SEM graduate programs for highly able African American students? Consistent with extant research, influencing the following four sets of factors linked to student academic success appears especially important: academic and social integration, knowledge and skill development, support and motivation, and monitoring and advisement (cf. Hrabowski & Maton, 1995).

Academic and social integration appears critical to the success of African American SEM majors, including highly able ones. Black students have a higher probability of becoming academically and socially isolated on majority white campuses and in SEM majors than do White or Asian students (Nettles, 1988; Seymour & Hewitt, 1997). Research suggests that contact with faculty outside the classroom, and the development of mentoring relationships, including with minority faculty, can decrease academic isolation, and contribute to positive outcomes (Nettles, 1988; Hilton, Hsia, Solorano, & Benton, 1989; Redmond, 1990; Allen, 1992; McHenry, 1997; Seymour & Hewitt, 1997). Furthermore, increasing the number of like-minded, highly able Black student peers can substantially enhance peer academic and social support, reduce perceptions of racism, and increase cultural comfort in SEM classes—contributing to SEM academic persistence and success (Garrison, 1987; Nettles, 1988; Fries-Britt, 1994; Brazziel & Brazziel, 1997; Gandára & Maxwell-Jolly, in press).

Knowledge and skill development represent a second important focus for programmatic action. Involvement in peer study groups, for example, consistent with Uri Treisman's pioneering work, has been shown to result in enhanced technical knowledge mastery and course performance for SEM minority students (Treisman, 1992; Bonsangue & Drew, 1995; Kosciuk, 1997; Seymour & Hewitt, 1997; Gandára & Maxwell-Jolly, in press). Furthermore, strong study habits, time management skills, analytic problem-solving capacity, and the willingness to use available department and university resources have been linked to positive academic outcomes (Hilton et al., 1989; Atwater & Alick, 1990; Gandára & Maxwell-Jolly, in press).

Support and motivation represent a third set of factors linked to high levels of success in SEM majors. Appropriately, financial aid continues to be one of the cornerstones of African American student support (Gandára & Maxwell-Jolly, in press; Hilton et al., 1989), and in the case of SEM scholarships, can be made contingent on high levels of SEM course performance. However, due to the difficult nature of introductory and advanced science and mathematics courses, and the attractiveness of other majors, various other sources of support and motivational influence appear necessary as well to enhance SEM minority student persistence and performance (Seymour & Hewitt, 1997). These include high faculty expectations for African American student success, hands-on research experience, academically supportive friendship networks, involvement with faculty, tutoring, and emotional support during times of stress and difficulty (cf. Hilton et al., 1989; Seymour & Hewitt, 1997; Gandára & Maxwell-Jolly, in press).

Finally, monitoring and advising, if available on a regular, ongoing basis, can help students make wise academic decisions in selecting coursework, position themselves for graduate study, and prevent or limit the influence of emerging academic or personal problems. Consistent monitoring can help ensure regular assessment of a student's academic and social situation, and early warning signs of academic or personal problems (Gandára & Maxwell-Jolly, in press). Advising and feedback, including but extending beyond discussion of important academic requirements, can provide students with valuable input about their strengths, weaknesses, options, and potential consequences of various strategic plans of action (Glennan, Baxley &

Farren, 1985). Taken together, personalized monitoring and advising can help ensure that no student leaves or is unable to succeed in the SEM major because that student was not offered appropriate academic, psychological, and social resources and advice (Seymour & Hewitt, 1997).

Those universities committed to supporting African American and other underrepresented minority students in SEM majors strive to create environments which help to ensure student success. When this commitment is not made, we lose qualified African American SEM students to other majors, or from higher education totally. The Meyerhoff Scholars Program at University of Maryland, Baltimore County was developed in response to the low levels of performance and persistence of well-qualified SEM African American students on that campus. The program developers sought to incorporate multiple components addressing the broad range of factors linked in the literature to minority student success—that is, academic and social integration, knowledge and skill development, support and motivation, and advising and monitoring. The immediate goal of the program was to effect substantial increases in qualified Black students' SEM course performance, completion of major, and entrance into SEM graduate programs; the longer term goal was to increase the number of African American scientists.

The Meyerhoff Scholars Program

The Meyerhoff Scholars Program began as a collaboration between philanthropists Robert and Jane Meyerhoff and the University of Maryland, Baltimore County in 1988. The Meyerhoffs provided $500,000 for a program to address the lack of African Americans, especially male African Americans, in the science, math, and engineering pipeline. Letters soliciting nominations were sent to principals and guidance counselors throughout Maryland requesting their ''best and brightest.'' Forty nominations were received that year and 19 male African American students became the first Meyerhoff Program students. (Among those accepted, Meyerhoff Scholars receive a free tuition, room and board scholarship while Meyerhoff Finalists receive somewhat smaller, partial scholarships. Both Scholars and Finalists are included in all analyses in the current study.) The following year, the program admitted women. Currently, between 40 and 60 Meyerhoff students are selected each year from over 1,400 nominations and applications from across the nation.

The academic criteria necessary for acceptance into the Meyerhoff Scholars Program have been increasing steadily over the years. The 1998 entering cohort of African American Meyerhoffs had mean SAT-Math scores of 657, mean SAT-Verbal scores of 623, and a mean high school GPA of 3.77. Prospective Meyerhoff students cannot have received lower than a B in any high school science or math course, and many have completed a year or more of calculus in high school. Preference is given to those who have taken advanced placement courses in math and science, have research experience, and provide strong references from science or math instructors. Additional criteria include a commitment to stay in the sciences and a desire to ''give back'' to the communities from which they came. The program's web site is: http:\www.umb.edu.

In 1996, the Meyerhoff Scholars Program was recognized nationally with the Presidential Award for Excellence in Science, Math, and Engineering Mentoring. The program incorporates 14 different components, briefly described below.

Financial Aid. The Meyerhoff Program provides students with a comprehensive financial package including tuition, books, and room and board. This support is contingent upon maintaining a B average in an SEM major.

Recruitment. The program currently receives approximately 1,400 nominations and applications each year. The top 100–150 applicants and their families attend one of the two recruitment weekends on the campus. This weekend provides an opportunity for faculty, university administrators, program staff, and current students to meet the applicants under both formal and informal circumstances, and to give incoming students a chance to interact with potential peers, faculty, and staff.

Summer Bridge Program. Once selected for the program, Meyerhoff students attend a mandatory pre-freshman Summer Bridge Program, and take courses in math, science, and African American studies. They also attend social and cultural events. The purposes of the Summer Bridge Program are to prepare students for the new expectations and requirements of college courses, and to provide social opportunities for interacting with peers, faculty, and staff.

Study Groups. Group study is strongly encouraged by the program staff, as it is viewed as an important part of succeeding in SEM majors. Study groups promote academic support and create opportunities for social support and interaction.

Program Values. Program values include support for academic achievement, seeking help from a variety of sources, peer supportiveness, high academic goals (with emphasis on Ph.D. attainment and research careers), and giving back to the community. Beginning at the recruitment phase, the shortage of African American science Ph.D.s is discussed, and the importance of achieving a research-based Ph.D. is emphasized. An M.D. degree is considered a disappointment given the program's focus on producing Ph.D. level researchers, and students know this.

Program Community. The Meyerhoff program provides a family-like social and academic support system for students. Students live in the same residence hall during their first year, and are required to live on campus during subsequent years. In addition to peer connectedness, students are in continual contact with program staff, who are highly accessible and involved in student life. Program students and staff meet in large ''family'' meetings on a regular basis.

Personal Advising and Counseling. The program employs full-time academic advisors and other staff members who monitor and advise students on a regular basis. When students do poorly in a key science course, program staff strongly encourage students to retake the course. Counselors are not only concerned with academic planning and performance, but also with any personal problems students may have.

Tutoring. The program staff strongly encourages Meyerhoff students to either tutor others or be tutored to maximize academic achievement. Tutors are regularly identified from within and outside the program.

Summer Research Internships. Each student participates in summer research internships. These internships allow the hands-on opportunities that maintain intrinsic interest in SEM careers and also create opportunities for mentoring relationships.

Faculty Involvement. Key SEM faculty and department chairs are involved in the recruitment and selection phases of the program. As time permits, these faculty and department chairs also participate in social activities, presentations, and informal and formal

discussions with Meyerhoff candidates and students. Many faculty provide opportunities for student lab experience to complement summer research assistantships.

Administrative Involvement and Public Support. The Meyerhoff Program is supported at all levels of the university, including ardent support from the President. Over the years the program has generated a substantial amount of public recognition and support.

Mentors. Each student is paired with a mentor who is a professional in an SEM occupation. Mentoring environments can create excitement about and active involvement with science.

Community Service. All students are encouraged to take part in a community service activity, which often involves volunteer work with at-risk Baltimore youth. This component helps concretize the program value of ''giving back'' to the larger community.

Family Involvement. Parents are included in social events, and kept advised of their child's progress. The parents have formed the Meyerhoff Family Association which serves as a mutual support program.

Initial Findings and Current Study

Initial findings, focused on freshman year outcomes, are promising. Hrabowski & Maton (1995) compared students in the first three UMBC Meyerhoff Program cohorts to a UMBC historical (pre-Meyerhoff) sample of African American students who met the entrance requirements of the program (and a subsample matched on gender, high school GPA and SAT scores). The Meyerhoff students had significantly higher overall GPAs and SEM GPAs freshman year than did the historical comparison students. In addition, their grades in critical ''gateway'' freshman-year courses—calculus, physics, and chemistry—were significantly higher than those of the historical samples.

Despite the promising nature of this initial report, it had several limitations. First, time-linked historical effects—such as changes in the university and societal environments—may have accounted for the better Meyerhoff student performance relative to the historical African American student sample. Second, the comparison group did not go through the same selection process as the Meyerhoff students did. Third, key longer term goals of the Meyerhoff Program, including graduation in SEM majors and acceptance to SEM graduate school, were not assessed.

The current study builds upon and extends our previous research. The overarching research question is whether the Meyerhoff Program has a positive, longer term impact, and if so, which factors appear to contribute to program effectiveness. Academic outcomes after 5 years are assessed for the first three coeducational cohorts of Meyerhoff students. Specifically, we examined bachelor-level retention and graduation rates in SEM major, SEM GPA, overall GPA, and SEM graduate and professional school admission rates for the Meyerhoff and comparison students. Meyerhoff student performance was compared to that of two different African American student samples: (1) SEM students who had been offered Meyerhoff scholarships, but chose instead to attend other institutions, and (2) a historical cohort of academically comparable SEM students at UMBC. We also included both historical and current Caucasian and Asian samples to investigate their performance in relation to their African American peers. It is believed that the multiple comparison samples, taken together, allow us to test the Meyerhoff program's efficacy in a relatively comprehensive way.

In addition, surveys and interviews with Meyerhoff students, and interviews with science faculty provided data for a process evaluation analysis. Using these data, we were able to discern which program components the Meyerhoff students perceived as especially important and why. Faculty perceptions of program impact on their departments and on the larger university were also examined.

Method

Research Participants

Primary Meyerhoff Sample. The 93 Meyerhoff students from the first three coeducational entering classes constituted the primary Meyerhoff sample in the current research. Of these participants, 15 began in 1990, 35 began in 1991, and 43 began in 1992. During the early years of the program, the minimum requirements for selection were an SAT-M score above 550, a combined SAT score of at least 1050 (not re-centered), and a high school GPA above 3.0. (In several cases, students with a high school GPA above 3.7, an SAT-M score better than 500, and a combined SAT score better than 1000 were accepted.) The Meyerhoff sample in the current study had a mean SAT-Math score of 633.9, a mean SAT-Verbal score of 548.9, and a mean high school GPA of 3.48. All students had declared majors in SEM (science, engineering, or math).

Non-UMBC ("Declined") African American Comparison Sample. One primary comparison sample (the "declined" sample) consisted of 35 African American students who were offered Meyerhoff scholarships between 1990 and 1992, but declined and attended other institutions. This sample included only students who took at least three SEM courses during their freshman year. Table 1 (top portion) describes the characteristics of the Meyerhoff and Declined samples.

Preliminary analyses indicated that there were more males in the Meyerhoff (53.8%) than in the Declined (34.3%) sample, $\chi^2\ (1) = 3.86$, $p < .05$. In addition, Meyerhoff students had lower SAT-Verbal (mean = 548.9) scores than the Declined students (mean = 581.1), $t\ (126) = -2.89$, $p < .01$. There were no differences on SAT-Math, high school GPA, number of freshman year SEM courses, year of entry, or full versus partial Meyerhoff scholarship offer. Given the potential importance of the differences in gender representation across samples, secondary analyses were performed on the three criteria variables for men and women separately.

UMBC-Based Comparison Samples

Full Sample. The full historical comparison samples consisted of 39 African American, 138 Asian, and 863 Caucasian students who attended UMBC before the Meyerhoff Program began in 1989, met the same admissions criteria as the Meyerhoff students, took a minimum of three SEM courses, and completed at least 10 SEM credits in their freshman year. The full current samples consisted of 88 Asian and 270 Caucasian students who entered UMBC between 1990 and 1992, met the same admissions criteria as the Meyerhoff students, took in their freshman year a minimum of three SEM courses, and completed at least 10 SEM credits. All current African American students meeting these criteria were Meyerhoff students.

The six groups differed significantly on a number of background and academic variables, including gender, SAT-Math, SAT-Verbal, and number of freshman year science courses. The

Table 1
Demographic, pre-college academic, and college descriptive variables for Meyerhoff and comparison samples

	Male (%)	SAT-Math	SAT-Verbal	High School GPA	Number freshman SEM Courses	Year of Entry	Full Scholarship Offer
Meyerhoff and (non-UMBC) Declined Comparison Sample							
Meyerhoff Students ($N=93$)	53.8*	633.9 (52.0)	548.9** (54.6)	3.48 (0.33)	5.3 (1.1)	1991.3 (0.7)	52.7%
Students who Declined Offer ($N=35$[a])	34.3	626.9 (48.9)	581.1 (56.9)	3.55 (0.37)	4.8 (1.5)	1991.3 (0.7)	54.2%
Meyerhoff and UMBC-Based Comparison Samples: Matched Subsample							
UMBC Historical Samples							
African American ($N=31$)	29.0	611.6 (46.3)	528.7 (72.1)	3.43 (0.34)	5.5 (1.9)	1984.5 (3.9)	n/a
Asian ($N=31$)	29.0	621.3 (40.6)	519.0 (73.4)	3.51 (0.28)	5.2 (1.3)	1985.2 (3.0)	n/a
Caucasian ($N=31$)	29.0	615.5 (41.1)	537.1 (51.6)	3.47 (0.28)	5.2 (1.5)	1984.8 (3.2)	n/a
UMBC Current Samples							
Meyerhoff Students ($N=31$)	29.0	611.6 (38.0)	543.2 (44.4)	3.49 (0.29)	5.4 (0.8)	1991.2 (0.6)	29.0%
Asian ($N=31$)	29.0	618.7 (45.0)	523.9 (70.6)	3.42 (0.32)	5.6 (1.1)	1991.2 (0.9)	n/a
Caucasian ($N=31$)	29.0	616.8 (40.6)	545.5 (71.8)	3.52 (0.28)	5.5 (1.2)	1991.2 (0.7)	n/a

[a] For Number Freshmen Year Science Courses, $N=24$.
**$p<.01$.
*$p<.05$.

historical African American group contained the fewest males (33.3%), the lowest SAT-Math scores (604.4), the historical Asian group the lowest SAT-Verbal scores (495.3), and the current White students the fewest freshman science courses (5.1). Due to these differences, the primary analyses of the UMBC-based comparisons focused on a matched subsample.

Matched Subsamples. Thirty-one matches, each containing six students, were generated resulting in a total matched subsample of 186 students across the six groups. The matching variables were Gender, SAT-Math, SAT-Verbal, high school GPA, number of freshman science courses, and (within time period) year of entry (see Table 1, bottom portion, for subsample means). All primary analyses were conducted on the matched samples, although parallel analyses were also conducted on the full sample, and findings reported when they differed.

Procedure

Non-UMBC-Based ("Declined") Sample. University transcripts were acquired for all of those students who had provided informed consent (usually at the point of applying to the Meyerhoff Program). Telephone calls to university registrars' offices provided information about major and graduation status for 11 students for whom informed consent was not obtained. Post-graduate information was obtained directly from students, family members, departmental records, or university officials. All post-graduate education information was confirmed (or in some cases clarified) by phone calls to graduate and professional school registrar offices.

UMBC-Based Samples. A computerized database was provided by the university for all UMBC students in the sample, and copies of all student transcripts as of Fall, 1997 were obtained as well. Information on post-graduate institutions selected by the historical and Meyerhoff African American samples was obtained in the same manner used with the declined sample—from students, family members, departmental records, or university officials. It was confirmed (or clarified) by phone calls to graduate and professional school registrar offices. In order to find out about post-graduate education for non-African American students, a mailed survey of all students in the sample was conducted in 1996 in conjunction with the UMBC alumni office, and followed up with two phone calls to non-respondents for whom phone information was available. Usable information was obtained from 450 alumni, representing 37% of the total sample.

Primary Researchers. The primary researchers are a Caucasian Professor of Psychology at UMBC, and the current UMBC President, an African American mathematician and founder of the Meyerhoff Program.

Measures

Demographic and Academic Background Variables. Ethnicity, gender, university entrance date, SAT scores (both math and verbal), and high school GPA were obtained from university application records. For students who applied to the Meyerhoff Program, scholarship status (full vs. partial scholarship offered) was also obtained.

Freshman Year SEM Major and Coursework. Freshman year records were reviewed to determine the number of SEM courses and credits attempted and completed, and whether the student had a declared SEM major. SEM courses and majors included were: biology, chemistry, computer science, engineering, mathematics, and physics.

Graduation Major, Last Major, or Current Major. Graduation major, last major (for those no longer in school who had not graduated), or current major (for those still in school) were obtained from university records. The outcome variable SEM major contained four categories: (1) SEM graduate; (2) likely to be SEM graduate (for those still attending school and pursuing an SEM major); (3) non-SEM graduate (for those who graduated in a non-SEM major; and (4) not likely to graduate in SEM (for those who had not graduated and were no longer enrolled, or who were still in school but pursuing a non-SEM major).

SEM and Overall GPA. SEM GPAs were hand-calculated from transcripts obtained in Fall, 1997. Only courses in the six SEM disciplines noted above were included. SEM GPA is an

important indicator of achievement in SEM per se, and an indicator of competitiveness for admission to SEM graduate school or a professional school. Overall GPA was the composite for all coursework taken. Consistent with UMBC practice, the highest grade received for a repeated course was used in all GPA calculations.

Graduate Education. The SEM graduate education outcome variable contained four categories: (1) in graduate school in a SEM program (includes M.D./Ph.D. programs); (2) in medical school or other SEM professional school; (3) still enrolled in SEM undergraduate major; and (4) no post-college education in SEM. This latter category includes students who did not graduate, those who graduated in a non-SEM major (unless follow-up indicated they attended medical school), SEM graduates who did not pursue graduate or professional education, and those who attended non-SEM graduate (e.g., Psychology) programs.

Process Evaluation

Process evaluation data were collected at various points of time, in various formats, from multiple subgroups of Meyerhoff students (e.g., freshmen; graduating seniors; all cohorts on campus) about their experience in the university and in the Meyerhoff Program. The process evaluation sample includes, but is not limited to, students in the 1990–1992 entering classes (i.e., 5-year outcomes study sample). The primary purposes of the process evaluation were: (1) to help establish which program factors were perceived as most important, through pre-designated survey items and through spontaneously generated responses to open-ended interview questions; (2) to identify negative aspects of the program (interviews); and (3) to suggest from the student perspective why various components of the program may be important (interviews).

In addition, a small sample of science faculty were interviewed, to assess their perceptions of program impact on their departments and on the university more generally. The primary purpose of these exploratory interviews was to suggest any areas of program impact beyond Meyerhoff student outcomes per se.

Content analysis was used to identify prominent themes in the student and faculty interview data. The qualitative results were intended to supplement, support, and enrich the quantitative survey data.

Quantitative Data. Anonymous quantitative process data were collected from different samples of students in the Meyerhoff Program: 1991 entering class in Spring, 1992 ($N = 30$), all students in Spring, 1994 ($N = 117$), graduating seniors in Spring, 1996 ($N = 22$), and all students in Spring, 1998 ($N = 140$). In each case, 80% or more of the targeted Meyerhoff students completed questionnaires. Each survey listed 17 factors encompassing the various identified program components. Students rated the extent to which each factor contributed to their academic success on 5-point, likert-type rating scales (i.e., 1 = not at all, 5 = large extent). To establish an overall rating, the means across the four administrations were averaged (i.e., independent of sample size a given year).

Qualitative Data. Semi-structured interviews focused on the Meyerhoff student experience were conducted on several occasions. In each case, the interviews were tape-recorded, and research confidentiality was assured. In the Spring of 1995, 24 Meyerhoff students from each of the then-current Meyerhoff cohorts were randomly selected. Two of the interview questions were open-ended and allowed students to describe spontaneously how the program aided them.

Specifically, students were asked (1) ''What has your experience as a Meyerhoff student been like at UMBC'' and (2) ''Do you feel your experiences at UMBC would be different without the Meyerhoff Program?'' The interviewer, a female African American graduate student, probed for references to specific examples.

In addition, a different female African American graduate student interviewed six graduating Meyerhoff seniors in the Spring of 1993 and three graduating seniors in the Spring of 1994 about their experiences in the Meyerhoff program. The questions chosen for analysis were: (1) ''What are the positive aspects of being in the Meyerhoff Program? The negative aspects?'' and (2) ''Have your experiences as a Meyerhoff student been similar to those of other African American students? Different from those of other African American students?'' Again, the interviewer probed for references to specific examples.

Each response to these questions was coded to indicate references to specific program components, and whether each reference was positive or negative. The percentage of students indicating a specific component as a strength or weakness was tabulated, and illustrative quotes selected.

Ten faculty from the Biology ($N = 4$) and Chemistry ($N = 6$) Departments who in the past few years have had one or more Meyerhoff students work in their research labs were interviewed by the first author in Fall, 1999. Faculty were asked in open-ended fashion their perceptions of the impact of the Meyerhoff Program on their departments, and on the university more generally. Interviews were tape-recorded, and confidentiality of responses was ensured. Questions focused on perceptions of both positive and negative areas of program impact. Content analysis was performed to assess primary interview themes.

Results

Declined Sample

Graduation Major. As expected, the Meyerhoff students demonstrated greater success in the SEM area than equally talented students who declined the Meyerhoff offer and attended other universities. As shown in Table 2 (top portion), the Meyerhoff students were nearly twice as likely as the Declined sample to retain and graduate in SEM majors, $\chi^2\ (3) = 27.8$, $p < .01$. The exact same pattern of findings appeared when analyses were conducted separately for male, $\chi^2\ (3) = 14.8$, $p < .01$, and female, $\chi^2\ (3) = 13.7$, $p < .01$, students.

GPA. Furthermore, a MANCOVA analysis indicated that the Meyerhoff students achieved significantly higher SEM GPAs than the Declined sample, $F\ (1,110) = 7.16$, $p < .01$ (Table 2, middle). Covariates included gender, SAT math and verbal scores, high school GPA, and scholarship status. Interestingly, there were no significant differences between the two groups in terms of overall GPA, $F\ (1,110) = 1.31$, ns. These findings suggest that the impact of the program is specific to success in SEM disciplines (i.e., the Declined students who switched to non-science majors did quite well in those majors).

Graduate and Professional School. Consistent with the higher rates of graduation in SEM majors and higher SEM GPAs, the Meyerhoff students were more likely to attend SEM graduate school, $\chi^2\ (3) = 18.3$, $p < .01$. As Table 2 (bottom portion) shows, almost half of the Meyerhoffs went on to SEM graduate school, whereas fewer than one in ten of the Declined sample did so. Interestingly, relatively equal numbers of Meyerhoff and Declined sample students were in medical school (non-M.D./Ph.D. programs). Overall, approximately 70% of Meyerhoff students

Table 2
Academic outcomes: Meyerhoff students and students who declined Meyerhoff scholarship offer (and attended another university)

	Not Likely to Graduate in SEM[a]	Graduated in Non-SEM Discipline	Likely to Graduate in SEM	Graduated in SEM Discipline	Total *N*
SEM Graduation Major					
Meyerhoff students	7 (7.5%)	5 (5.4%)	4 (4.3%)	77** (82.8%)	93
Students who Declined Meyerhoff Offer	3 (8.6%)	15 (42.9%)	1 (2.9%)	16 (45.7%)	35
	Actual SEM GPA	Adjusted[b] SEM GPA	Actual Overall GPA	Adjusted Overall GPA	
SEM GPA and Overall GPA					
Meyerhoff students ($N = 93$)	3.16	3.16** (0.43)	3.32	3.33 (0.35)	
Students who Declined Meyerhoff Offer ($N = 24$)	2.90	2.89 (0.60)	3.26	3.24 (0.44)	
	No Post-College SEM	SEM Major Still in College[c]	Medical School	SEM Graduate Program	Total *N* (Not Known)
SEM Graduate Education					
Meyerhoff students	23 (24.7%)	5 (5.4%)	22 (23.7%)	43** (46.2%)	93 (0)
Students who Declined Meyerhoff Offer	20 (58.8%)	2 (5.9%)	9 (26.5%)	3 (8.8%)	34 (1)

[a]SEM (Science, Engineering, Mathematics) disciplines included: Biology, Chemistry, Computer Science, Engineering, Mathematics, Physics.
[b]Means were adjusted for: Gender, SAT Math, SAT Verbal, High School GPA, and Scholarship Status.
[c]One student graduated in a SEM major, but has returned to college to pursue a second SEM major.
$^{**}p < .01$.

and 35% of Declined sample comparison students had entered SEM graduate or professional schools 5 years after entering college.

The same pattern of findings appeared when analyses were conducted separately for the male students, χ^2 (3) = 15.1, $p < .01$. For the female students, the results were not significant using the Pearson test, χ^2 (3) = 5.3, $p < .15$, although significance was achieved using the Mantel–Haenszel test of linear association, χ^2 (1) = 4.6, $p < .05$ (among Meyerhoff females, 25.6% were not in and were not likely to enter SEM graduate or programs, 4.7% were still in undergraduate science majors, 32.6% were in SEM professional schools, and 37.2% were in SEM graduate programs; the corresponding percentages for Declined sample females were 47.8, 4.3, 34.8, and 13.0%, respectively).

UMBC Comparison Samples

A similar pattern of findings emerged with the UMBC-based historical African American comparison sample as with the declined sample. In order to help rule out cohort effects due to the different time periods involved, the graduation major and GPA analyses keyed on comparing this historical black SEM sample with their historical Asian and White counterparts, and then examining whether the pattern was altered when the Black Meyerhoff students were compared with their contemporaries.

Graduation Major. In terms of graduation major, there was a significant difference across the six matched samples, χ^2 (15) $= 48.1$, $p < .01$. As Table 3 shows, all three historical samples had relatively equal rates of graduation in an SEM major. However, in a striking alteration of pattern, the Meyerhoff students were substantially more likely to retain and graduate in SEM majors than their contemporary Asian and White peers. The exact same pattern emerged for the full (non-matched) sample, χ^2 (15) $= 145.43$, $p < .01$, and also when separate full-sample analyses were conducted for males, χ^2 (15) $= 105.79$, $p < .01$, and females, χ^2 (15) $= 55.79$, $p < .05$.

GPA. The time period by ethnic group MANCOVA analyses revealed a statistically significant interaction for SEM GPA, F (2, 176) $= 6.78$, $p < .01$ (Table 4). Covariates included

Table 3
Graduation majors: UMBC historical (pre-Meyerhoff) and current comparison samples and Meyerhoff students: Matched Subsample[a]

	Not likely to graduate in SEM[b,c]	Graduated in non-SEM discipline	Likely to graduate in SEM[d]	Graduated in SEM discipline
Historical samples				
African American ($N = 31$)	8 (25.8%)	6 (19.4%)	0 (0.0%)	17 (54.8%)
Asian ($N = 31$)	8 (25.8%)	10 (32.3%)	0 (0.0%)	13 (41.9%)
Caucasian ($N = 31$)	13 (41.9%)	4 (12.9%)	0 (0.0%)	14 (45.2%)
Current samples				
Meyerhoff ($N = 31$)	2 (6.5%)	1 (3.2%)	0 (0.0%)	28** (90.3%)
Asian ($N = 31$)	10 (32.3%)	4 (12.9%)	4 (12.9%)	13 (41.9%)
Caucasian ($N = 31$)	14 (45.2%)	7 (22.6%)	1 (3.2%)	9 (29.0%)

[a]Students were matched on Gender, SAT-Math, SAT-Verbal, High School GPA, and Number Freshman Year SEM Courses Taken.
[b]SEM (Science, Engineering, Mathematics) disciplines included: Biology, Chemistry, Computer Science, Engineering, Mathematics, Physics.
[c]This category includes students who stopped before completing a degree and those who are still in school but are not pursuing a SEM major.
[d]This category includes students who are still in school pursuing a SEM major.
**$p < .01$.

Table 4
SEM GPA[a] After 5 years of college: UMBC historical (pre-Meyerhoff) and current comparison samples and Meyerhoff students: Matched subsample

	SEM[a] and overall GPA after 5 years of college			
	Actual SEM GPA	Adjusted[b] SEM GPA	Actual Overall GPA	Adjusted Overall GPA
Historical samples				
African American ($N = 31$)	2.59	2.64 (0.73)	2.80	2.84 (0.71)
Asian ($N = 31$)	3.00	2.96 (0.63)	3.23	3.22 (0.55)
Caucasian ($N = 31$)	2.94	2.94 (0.65)	3.14	3.13 (0.58)
Current samples				
Meyerhoff ($N = 31$)	3.17	3.16** (0.39)	3.33	3.30** (0.30)
Asian ($N = 31$)	2.87	2.92 (0.56)	3.13	3.17 (0.46)
Caucasian ($N = 31$)	2.84	2.79 (0.65)	3.12	3.07 (0.56)

[a]All biology, chemistry, computer science, engineering, mathematics and physics courses taken during the first 5 years of college were included in calculating the SEM (Science, Engineering, Math) GPA.
[b]Means were adjusted for Gender, SAT-Math, SAT-Verbal, and High School GPA.
**$p < .01$ (MANCOVA Ethnicity × Time Period interaction).

gender, SAT math and verbal scores, and high school GPA. Whereas the African American historical sample achieved significantly lower SEM GPAs than their Asian, $t = 2.31$, $p < .05$, and Caucasian, $t = 2.14$, $p < .05$, counterparts, the Meyerhoff students achieved SEM GPAs comparable to their Asian peers, $t = 1.76$, ns, and somewhat higher than their Caucasian peers, $t = 2.69$, $p < .01$.

Table 4 reveals a similar interaction pattern for overall GPA, F (2, 176) = 5.82, $p < .01$. Although the African American historical sample achieved significantly lower overall GPAs than their Asian, $t = 3.02$, $p < .01$, and Caucasian counterparts, $t = 2.37$, $p < .05$, counterparts, the Meyerhoff students achieved similar overall GPAs to their Asian peers, $t = 1.05$, ns, and somewhat higher overall GPAs than their Caucasian peers, $t = 1.90$, $p < .06$.

The same general pattern emerged for the full sample for the SEM GPA interaction F (2, 1481) = 9.83, $p < .01$, and for the overall GPA interaction F (2, 1481) = 9.34, $p < .01$. The historical sample of African American students earned significantly lower SEM GPAs and overall GPAs compared to their Asian and Caucasian counterparts. In contrast, the Meyerhoff students earned SEM GPAs and overall GPAs similar to or slightly higher than the current samples of Asian and Caucasian students.

Graduate and Professional School. Postcollege outcome analysis focused primarily on the two African American samples, because high quality data were not available for the Asian and Caucasian samples. Consistent with the higher rates of graduation in SEM majors and higher SEM GPAs, Table 5 shows that the Meyerhoff students were more than 10 times as likely than

Table 5
Graduate education outcomes for Meyerhoff students and historical African American comparison sample students: Matched subsample

	No post-college SEM[a]	SEM major still in college	Medical school	SEM graduate program	Total N known (Not Known)[b]
Graduate Education					
Historical African American students	22 (78.6%)	0 (0.0%)	5 (17.9%)	1 (3.6%)	28 (3)
Meyerhoff students	8 (28.6%)	0 (0.0%)	8 (28.6%)	12** (42.9%)	28

[a]This category includes students who stopped before completing a degree, those who graduated in a non-SEM (non-Science, Engineering, or Mathematics) major unless follow-up indicated they attended medical school, and those who graduated in a SEM major but did not pursue post-undergraduate degree education. Post-college SEM areas include Ph.D, M.S., and M.D./Ph.D. programs in biology, chemistry, computer science, engineering, mathematics, and physics. [b]"Total N Known" refers to all graduates for whom information about post-college education was available, plus all non-graduates. The "Unknown" subtotal (in parentheses) refers to all graduates in a SEM major for whom information about post-college education has not yet been obtained. The three Meyerhoff students matched to the three comparison students for whom information was not known were excluded from the analysis.
**$p < .01$.

the historical African American sample to attend graduate school in SEM fields, $\chi^2\ (2) = 16.5$, $p < .01$, and almost two times as likely to attend medical school. Comparable findings were obtained for the full sample, $\chi^2\ (3) = 50.0$, $p < .01$.

Unfortunately, the only source of comparable data for the Asian and Caucasian samples is based on survey data with a low return rate. Although these data should be treated with caution, it is noteworthy that the increase from the historical African American sample to the Meyerhoff sample in percent attending SEM graduate schools did not occur for the other groups. Specifically, 23.1% of the historical Asian sample returning surveys (total $N = 26$) and 24.3% of the Caucasian historical samples returning surveys (total $N = 300$) attended SEM graduate programs, whereas only 11.1% of current Asians (total $N = 18$) and 17.9% of current Caucasians (total $N = 106$) reported attending SEM graduate school. These findings are paralleled in the matched subsample, but sample sizes were extremely small (a range from 3 to 7 completed surveys for the four matched subsamples).

Process Evaluation Results

The survey and interview process evaluation data revealed that a number of program factors were viewed as especially critical by students: Program Community, Study Groups, Summer Bridge Program, Financial Support, Program Staff, Research Internships and Mentors, and Campus Academic Environment. Each of these is briefly discussed below.

Program Community. "Being part of the Meyerhoff Program Community" was consistently rated on surveys as a primary contributor to academic success (mean across four administrations = 4.2, on a 5-point scale). Two specific facets of student involvement in the program, Study Groups and Summer Bridge Program, received similarly high ratings (means of 4.3 in each case). The survey results were strongly supported by the interview findings, in which students spontaneously generated the program component(s) perceived as important to their

success. Approximately 85% of the students interviewed cited facets of program community as the most positive aspect of the program.

A number of students emphasized the importance of the peer academic facet of the program community, as reflected in the illustrative quotes from two students below.

> Number one in my book is the support. Having other smart, talented African Americans around you at all times is an asset. In high school I didn't have that. I could count on one hand the number of smart, intelligent Black people that I could come to and say, "I'm having problems in this class . . . Maybe you can help me out, direct me to someone I can speak to."

> Without the Program, initially it would be much more difficult, at least academically. I would be much more alone going to classes. You know that there is a sort of net under you in case you fall.

Other students described the family-like nature of the program community, and the importance of friendship networks, as illustrated in the next three quotes.

"The Meyerhoff Program is like a family, and that adds a lot of support. There is a lot of help. You don't have to assume all the responsibility yourself at once."

"We always have what they call "family meetings" where we all get together. Students who have done well are praised. They can raise their hands and say what grades they have gotten in their courses. So there is a chance for all students to be recognized in front of the group for doing well."

"It would have taken me a while to become social with people. But in my first year of college, I knew about thirty people [Meyerhoff peers], so it was easy. I had friends. I didn't feel like an outcast."

The final two quotes focus on responsibility and pride associated with membership in the program community.

"I feel that it is my obligation to give something back, whether it be some test notes or class notes or solutions, things like that, to help out my little [Meyerhoff] brothers and sisters."

"When you go out in public, you're not only representing yourself, but you are representing the program. So you carry yourself with a little more pride, and a little more dignity."

Taken together, the interview excerpts illustrate how a critical mass of talented minority students can positively affect student academic achievement. In related fashion, they provide evidence that having a critical mass of such students on a campus enhances minority students' academic and social integration into the university environment.

Financial Support. Financial support was the most highly rated item over the years (mean $= 4.4$). Furthermore, nearly one fourth of the students interviewed specifically cited financial support as an important factor in their Meyerhoff success. The financial aid was described as liberating, for the students and their families. It was also perceived as a strong incentive to pay back the community and to avoid failure. Two representative quotes are included below.

"The financial support is a whole other aspect, because you don't have to worry about a whole lot of things . . . having to get a job if you couldn't afford college, or putting that burden on your parents . . . So, that's [a lot of stress] off your mind."

"You don't have to worry about money, like a lot of other students who have to take a job to get through school. The Meyerhoff Program, you just do your work and everything is taken care of for you, so you can concentrate completely on academics."

Program Staff. Program staff were consistently identified by students as central to their academic success (mean rating $=4.2$). Furthermore, support from the Meyerhoff staff was spontaneously mentioned by approximately two-thirds of the students interviewed. Students characterized the program staff as encouraging and supportive, concerning both their personal and academic lives. Staff monitoring of student academic progress was perceived as motivational. Staff knowledge of university resources guided students through and lessened the impact of personal, academic, and financial problems. Three representative quotes are included below.

"Meyerhoff Program staff will tell you if you're not doing well . . . They are really helpful in the sense that if you have a problem, they will listen to it. They'll push you to get good grades, and if you get good grades, you will be rewarded."

"[The Meyerhoff staff] are definitely committed to us. They want to make sure we're staying involved with our academics . . . staying in touch with other students in the program. They want to make sure that we're networking and that we're basically getting the most that we can get out of being here. They're constantly calling us or saying here's this activity or here's an internship I think you would be great for. That type of thing."

"The Meyerhoff staff really push you. You know they believe in you, and that helps you even more."

Research Internships and Mentors. Summer research internships were another program component rated by students as important contributors to their success (mean $=4.2$). These internship opportunities, and academic mentors more generally, were mentioned enthusiastically by approximately one-fifth of the students interviewed. The internships provide hands-on, meaningful research that gives students a realistic look at what scientists do. For many Meyerhoff students, these experiences have helped them confirm their desire to pursue the Ph.D. In fact, many of these students have either published in refereed journals with mentors or presented papers at professional conferences. Descriptions of research experiences from two students are excerpted below.

"The research experiences have been very valuable. I worked with Dr. Jones my first year, and he set a basis for everything that I was going to be using later on. Then Dr. Farkson—I presented at three difference conferences on the research that I did with him about myoglobin. Then I worked with Dr. Howard. He works in neuroscience, and his work was pretty interesting too . . . [Most valuable has been] the thinking process, how you go about trying to solve a problem, and all the different techniques you can use to get around problems. That, and all the contacts."

"Every summer I worked, I did research. My first year, I worked with Dr. Neeman. He is an African American, and one of the mentors for our program. We did basic stuff to help me along. When I did my research next year, [I found] it really did [help]. The next year, I worked with Dr. Stevenson; he took an interest in me. He really kind of molded me along, and he guided me a lot. He actually helped me to apply to Harvard. Then Dr. Brimmer, this year—he's a real big name at Hopkins, so it was good working with him and with his graduate students."

Some student responses suggested the special importance of a mentor who was African American, or in the case of female students, who was of the same gender.

"I was lucky enough last year to get an internship in a Black professor's lab. I feel like I got to know him pretty well. We just talked sometimes, you know, just about the future and stuff like that, ways that I could do things in the future, different directions I could take."

''[My mentor and I] talk about research, and about being a minority in science and being a woman, things like that. We've developed a good relationship, and [I've received] a lot of emotional support.''

Campus Academic Environment. Although not a component of the program per se, and not assessed directly in the surveys, more than one-third of the students interviewed spontaneously identified facets of the campus academic environment as important contributing factors to their success. Specifically, students emphasized that as Meyerhoffs they benefitted from high expectations from faculty and enhanced access to faculty, as revealed in the three quotes below.

''After faculty figure out that you're a Meyerhoff, I guess there's this underlying assumption that you're going to do well . . . there's a little more motivation in that class [when] he knows that I'm a Meyerhoff.''

''An advantage [of being a Meyerhoff student] is that we get to meet [faculty members] and they get to know us personally. So, if we have any problems we feel comfortable going up and talking to them and asking them questions.''

''It seems like everybody thinks that if you are a Meyerhoff, then you must be smart. I get that from teachers and people who just work here. It's nice attention. They seem to admire you a lot and they seem to have a genuine sense of caring for your education.''

Negative Aspects of the Program Experience. Both the survey and the interview results underscore the positive contribution of the Meyerhoff Program to student academic success. However, after noting positive facets of the program in the interviews, some students noted a few negatives as well. The first three students below focus on the difficulties involved in coping with high expectations, careful scrutiny, and high program status.

''Because the program is so popular . . . the faculty members recognize us more . . . when we get in their classes they may know us before we know them, and they may expect more from us because they know we're Meyerhoff students, so that can be a disadvantage.''

''I do kind of feel like I'm always being watched and sometimes I would like [not] having everyone looking to see how I do. There's just . . . no freedom.''

''Sometimes teachers will expect more from you than other people, plus, everyone [in the program] will know your grades, test grades and so forth. That's okay, that's part of the support system, but at times it can be real trying.''

The final student quoted below discusses alienation from other students on campus.

''The down side of it sometimes is that you feel alienated when you come to the campus, because you spent the summer together. You have already had a label placed on you and it reduces your chance of meeting people on an equal basis . . . that goes for White people and Black people.''

Faculty Interviews. The 10 science faculty interviewed were very positive about the Meyerhoff Program. As one faculty member put it, ''I think the Meyerhoff Program in many respects is a model program for recruiting students who are both minorities and really good.'' Another noted, ''The overwhelming majority, if not 100%, of the department is impressed and in favor of this program in its current form.''

Faculty members were asked to delineate any impact the program has had on their department and on the university. Two impacts emphasized were changed faculty expectations of African American science students, and ramifying effects on science at UMBC more generally. They also noted some potential negative aspects of the program.

Dramatic Change in Faculty Expectations of Black Student Performance. Most of the faculty interviewed reported a dramatic, positive change in perceptions and expectations concerning African American student performance in science as a result of the Meyerhoff Program. The first two quotes below are from faculty members who had been at UMBC many years prior to the start of the program; the third is from a faculty member who came to UMBC after the program had already been in existence several years.

''In the past, a student in your class who was Black was likely not to do well. The Meyerhoff program changed that almost immediately. As soon as Meyerhoff students started earning A's . . . becoming very insistent on going into research programs and being successful, all of a sudden you couldn't make that assumption. Looking for success rather than failure [in your Black students]. That's a big change. That's a big institutional change. That happened in my department and it happened throughout the institution.''

''When the Meyerhoff Program first started, the top three students in the class are these Meyerhoff Scholars . . . African American students. I was shocked. I said, wow, this is really something. You know, there are brains everywhere.''

''I've heard faculty say that before Meyerhoff the prejudice was always that a minority student would likely be a weak student. Now I think it's turned around to the point where a minority student is expected to be a high performing student.''

The next quote describes a faculty member's experience with the Meyerhoff students in his advanced seminar.

''Half the [advanced elective seminar] would fill up with Meyerhoffs. They were all hanging together. They study together. They are all smart people. It's just amazing to see them.''

Ripple Effect on Science at UMBC. A number of the faculty identified ramifying or ripple effects the Meyerhoff Program has had on science on campus more generally. The four quotes below emphasize, respectively, recruitment of non-Meyerhoff minority students, higher standards of class performance, Meyerhoffs as role models in the lab, and the developing multicultural composition of science at UMBC.

''The minority students who don't get into the program still want to come to our campus because they want to be around that type of person. They just want to be surrounded by minorities that care about education and are driven and trying to be the best people they can be.''

''The Meyerhoff students want to perform. They want to get that A. It enhances everybody's performance who cares about the course.''

''In the research lab . . . they are role models for [other minority students.]''

'' . . . A large number of Black kids who are interested in science—it's a good change. It's different. It's part of the whole multicultural environment.''

Potential Negative Impacts. Although each faculty member interviewed spoke positively about the influence of the Meyerhoff Program on their department, a number also identified some potential negative impacts. These focused primarily on ways in which the program affected students not in it. The first three quotes below emphasize feelings of jealousy and exclusion that the program may engender in some students.

''I wonder how common it is for gifted young non-Meyerhoff Black kids to feel that somehow they don't have the same status.''

''Fifteen percent of [UMBC science] students are the high performers. Of that 15%, 1% maybe are Meyerhoff students. The school goes out of its way to recognize them. [But] the other 14% are not in the Meyerhoff Program. These people need to be recognized. This is a negative

aspect. It's not that you don't want to publicize the Meyerhoff, but you want to recognize that the bulk of our really good students are not in the Meyerhoff.''

''We have students that are borderline, that don't get in. [The Meyerhoff Program may motivate some of these students] to go forth and do better and see what they can achieve [but] other people may develop jealousy about it, a very negative emotion to have.''

Finally, related to the above concerns, several faculty emphasized their desire that all UMBC science students eventually receive the services that the Meyerhoff Program provides its students.

''If [the program] has a negative effect on other students, I think it is that some students may feel overlooked. You can argue that after 200 years of discrimination, maybe that's okay for 50 or 60 years to go the other way. But I personally would like to see that we could expand to other groups.''

''The time management and support system that has been developed in the Meyerhoff Program I think helps these students a lot, to perform highly. I think that many of us wish that we could expand it to non-minorities. Provide the same services to other groups.''

Summary of Process Evaluation Findings

The process evaluation surveys pointed to a number of Meyerhoff Program components that appear especially important contributors to program effectiveness, including Program Community, Study Groups, Summer Bridge Program, Financial Support, Program Staff, Research Internships and Mentors, and Campus Academic Environment. The process evaluation interviews suggested some of the ways the components contribute to academic performance, indicated areas of additional program impact, and revealed several areas of potential concern.

Discussion

The achievements of the Meyerhoff students at the University of Maryland, Baltimore County provide evidence that a well-designed university-based intervention can increase the numbers of African American undergraduate college students who succeed in science, mathematics, and engineering. The Meyerhoff students were more likely to graduate in an SEM major, earn competitive SEM grade point averages, and enter SEM graduate programs than multiple comparison samples. Prior research has identified problems facing African American students in predominantly white universities, and in SEM majors, such as academic and social isolation, the weed out system, low faculty expectations, negative stereotype vulnerability, and perceived racism. These help explain why highly accomplished and bright African-Americans do not succeed in SEM majors (cf. Tinto, 1987; Nettles, 1988; Steele and Aronson, 1995; Seymour & Hewitt, 1997). Informal interviews conducted by the second author with well-qualified UMBC African American SEM majors in the years immediately preceding the development of the Meyerhoff Program indicated that they indeed often had comparable experiences. The process data collected over the past 7 years support the hypothesis that the Meyerhoff Program works because its components provide opportunities for overcoming these problems—by enhancing academic and social integration, knowledge and skill development, support and motivation, and monitoring and advising.

Academic and Social Integration

The Meyerhoff Program contributes to student academic and social integration in a number of ways. An intensive summer bridge program, and the fact that students live together in the same residence hall freshman year, help to build from the start a sense of connectedness and interdependence. Ongoing participation and membership in a peer community composed of like-minded, high achieving African American students deepens levels of social bonding, academic relatedness, and cultural rootedness. Study groups, program-wide meetings, and cultural events represent some of the specific participatory mechanisms contributing to academic and social integration. The accessibility and high levels of involvement of program staff, and of science faculty and university administrators (President's Office), appear to contribute powerfully as well.

Knowledge and Skill Development

The Meyerhoff Program contributes to knowledge and skill development through multiple channels. As a foundation for what is to follow, the intensive program recruitment process helps to ensure that students who enter the program have strong academic preparation, along with a commitment to pursue SEM majors. The summer bridge program's mathematics and science coursework, along with training in analytic problem solving and time management skills, provides a head start and conceptual underpinnings for later knowledge and skill development. Participation in program study groups, and the utilization of tutoring resources, contribute directly to strong course performance. In addition, Meyerhoff students have developed a test bank and a repository of class notes for key science courses to facilitate course content mastery and successful course outcomes.

Support and Motivation

The Meyerhoff Program can be viewed in part as a multifaceted, multilevel support and motivational system. Program scholarships free students from the need to take time away from academic pursuits in order to earn money, and simultaneously motivate students to perform well in their science courses, since scholarship continuation is contingent upon maintaining at least a B average in an SEM major. Key program values serve as a major source of motivation—emphasizing outstanding academic achievement, seeking help (tutoring, advisement counseling) from a variety of sources, supporting one's peers, and preparing for graduate study. These messages are consistently conveyed and reinforced in both public and private contexts, by program staff, by the university president (the program's founder), and by program peers. Summer research internships, many at prestigious national and international sites, along with research mentoring relationships developed with UMBC faculty, serve to further motivate students to achieve at high levels and pursue graduate study, and embed students in a network of social contacts and connections which directly contributes to such goals.

Monitoring and Advising

Meyerhoff Program staff intensively monitor students' progress each semester, sensitive to warning signs of academic or personal problems. As a result, emerging problems can be addressed quickly. The monitoring by program staff takes place through contact with both faculty and students—the latter occurs in the context both of formal meetings and informal

social and cultural activities. Action plans generated to address problems start with the individual, but may expand to involve family, peers, and faculty.

The program employs its own academic advising staff, so that the Meyerhoff students receive specialized and in-depth academic advising on a regular basis. Students also benefit from advice offered by more advanced students in the program. Monitoring and advising begin with the summer bridge program, and continue throughout the student's undergraduate years, and includes a strong focus on preparation for graduate study. The intensive nature of monitoring and advisement, combined with high expectations for both academic performance and personal conduct, may sometimes leave students feeling a lack of privacy and a strong sense of pressure, as revealed in some of the interview excepts cited above. On the other hand, the advising and monitoring system increases the odds that major problems will be prevented or detected early enough to limit their impact, and helps to ensure a successful trajectory through the many stresses and challenges of college life in general and of demanding SEM majors in particular.

Research Basis and Program Generalizability

As reviewed earlier, extant research supports a link between the factors discussed above, addressed in various ways by the Meyerhoff Program, and minority student performance. The importance of academic and social integration for minority student success in SEM majors is consistent with the work of a number of theorists and researchers (e.g., Tinto, 1987; Nettles, 1988; Hilton et al., 1989; Allen, 1992; Seymour & Hewitt, 1997). Research supports the potential of various pedagogical strategies to enhance knowledge and skill development, such as the use of study groups to master difficult SEM material (Treisman, 1992; Bonsangue & Drew, 1995; Kosciuk, 1997). The centrality of a multifaceted support and motivational system encompassing financial, peer, and faculty components is consistent with available empirical research (Hilton et al., 1989; Seymour & Hewitt, 1997; Gandára & Maxwell-Jolly, in press). Finally, the importance of systematic monitoring and advising builds upon knowledge in the student advising and counseling area (cf., Glennan et al., 1985; Seymour & Hewitt, 1997; Gandára & Maxwell-Jolly, in press). Of note, a number of other nationally prominent SEM programs employ some of the same program elements as the Meyerhoff Program to influence the factors which influence minority student performance (cf. Gandára & Maxwell-Jolly, in press).

In the case of the Meyerhoff Program, the synergistic influence of these elements in a truly comprehensive program effort likely contributes to the striking program effectiveness observed. Such strong outcomes might not be possible if only a selected few, but not the full range, of key program components were present. This hypothesis is clearly an important one in need of future research.

Also of special note, the high level campus administrative support the Meyerhoff Program enjoys appears to be a critical component that has made a substantial difference in the implementation and ongoing effectiveness of the program at UMBC. It remains unclear to what extent intervention programs to improve minority performance and persistence in science can succeed when high level university administrators are not actively involved.

Limitations of the Study

The Meyerhoff Program appears to be among the nation's top producers of African American college graduates who enter SEM graduate programs (Brazziel & Brazziel, 1997; National Task Force on Minority High Achievement, 1999), and there has been a significant increase in the number of students graduating and entering graduate school since the three

cohorts examined in this study. However, entering graduate school is only a beginning. The long range goal of the Meyerhoff Scholarship Program is to produce substantially more African American Ph.Ds in science, engineering, and mathematics. Although we have documented that the Meyerhoff students are more likely to enter these graduate programs than are comparison groups, not enough time has elapsed to determine the number and percentage of students who complete doctoral degrees. To date, informal contact with students in these graduate programs indicates that many are making good progress, such as completing doctoral coursework, passing comprehensive exams, and becoming actively involved in dissertation research. We recently initiated a study to systematically document the graduate school experiences and outcomes of these students. An additional area of needed research, one currently in the planning stage, is the ''spillover'' effect of the program on non-Meyerhoff minority students and on science at UMBC, areas of impact suggested by some of the faculty interviewed.

The discussion above assumes that the Meyerhoff Program accounts for the students' success at UMBC. There are, however, alternative explanations. The in-depth selection process in the recruitment component of the program may yield students whose personal characteristics would ensure their success anywhere. Alternatively, students who are not willing to make this commitment may self-select out of the program, once faculty, staff, and administrative personnel make it clear that they are expected to achieve, persist to graduation and enter SEM doctoral programs. (Of note, however, the first year coursework of the students in the ''declined'' sample suggested their intent to pursue SEM majors.)

Furthermore, Elliot et al. (1995) believe that persistence and achievement in SEM programs are a function of a student's relative academic talent (operationalized as the SAT-Math score) compared to the other students at his or her university. They specifically suggest that Meyerhoff student scores are all among the top tercile of SAT-M scores at UMBC, virtually guaranteeing the students will graduate in their SEM major at this institution. In fact, although they are among the best students at UMBC, approximately 15% of Meyerhoff students do not have SAT-M scores in the top tercile of UMBC students. Importantly, this subgroup of students graduated in SEM majors at approximately the same rate as those in the highest tercile. In addition, White and Asian SEM majors, those with whom the Meyerhoff students most directly compete, have higher SAT-Math scores than do students in other majors at UMBC. When compared only to other SEM majors, approximately 5% of the Meyerhoff students are in the bottom tercile, 33% are in the middle tercile, and the remaining 62% are in the top tercile. Once again, a comparison of student graduation rates found virtually identical rates across all Meyerhoff tercile groups. A similar analysis of the Declined sample also does not support Eliot et al.'s hypothesis. Declined sample students with high SAT-M scores at less selective institutions were no more likely to graduate in SEM majors than were students with mid-level scores at very selective universities.

In summary, while we believe that the recruitment process and the relative position of the Meyerhoff students at UMBC may account in part for their success, we do not believe that they would achieve and persist at the current levels without the Meyerhoff Program. Indeed, the findings of lower academic outcomes from multiple comparison samples, together with the process evaluation findings, provide compelling evidence that the Meyerhoff Program accounts, at least in part, for African American student success in SEM majors at UMBC.

Conclusions and Implications

It remains abundantly clear that the roots of the science pipeline ''problem'' for African American students are in the often poorly funded, de facto segregated, inner-city schools that many attend, and the less than competitive programs into which many blacks are tracked in

suburban integrated schools. Although less well documented, this may be augmented and exacerbated by expectancy effects in the teacher–child interaction (cf. Rosenthal, 1994). Support for this hypothesis lies in the studies showing that even those African American students with math and science standardized test scores at the elementary school level similar to White counterparts, over time fall behind White children in these skills. By the time they reach high school, the gap has become wide enough that a smaller proportion of African American students are qualified to attend SEM programs in college (Gandára & Maxwell-Jolly, in press). Beyond schools per se, another extremely important factor is the family, which can have a critical impact on African American students' educational preparation, aspirations and success (Hrabowski, Maton, & Greif, 1998; Hrabowski, Maton, Greif, & Greene, in preparation).

The overall effect of substandard pre-college education has been a smaller pool of African Americans qualified for college work in SEM curricula. This is manifest in the lower number of African American SEM majors (Astin, 1993, noted that SAT-M scores are positively correlated with a student's intention to major in SEM) and their lower persistence rate (numerous studies document a positive relationship between SAT-M scores and achievement and persistence in SEM curricula).

At the college level, even the most talented African American students may experience enough environmental discomfort on majority white campuses to depress their academic performance. Research is widely divergent, but common discomfort themes involve SEM ''weed out'' systems, a sense of isolation in the sciences, negative stereotypes, low faculty expectations, and perceptions of racism. These issues make it more difficult for African American students, however bright they may be, to persist and perform at high levels in SEM fields.

Greater efforts should be made at the university level to ensure that promising African American students remain in SEM majors and become the next generation of researchers and mentors (cf. Gandára & Maxwell-Jolly, in press). This is especially critical given the recent reductions in minority entrance into SEM graduate programs, presumably due in part to perceptions of negative views toward minorities (i.e., anti-affirmative action efforts) in a number of states (cf. Malcolm, Van Horne, Gaddy, & George, 1998). Programs like The Meyerhoff Scholars Program, built on extant social science research, may be especially important for African American (and other minority student) success in the science, engineering and math disciplines in the years ahead.

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