Reconstructing the Family Model: Improving Student Success in STEM

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Introduction

As colleges and universities confront the challenge of recruiting and retaining underrepresented students in STEM (science, technology, engineering, and mathematics), this paper focuses on a unique program called the Benjamin Banneker Scholars Program (BBSP) that addresses the national challenges facing minority students’ success in STEM. Research suggests that the academic outcomes for minorities, particularly African Americans, are much higher in environments where students feel a strong sense of community (Howard 2001). The Benjamin Banneker Scholars Program addresses this and other needs by reconstructing the family model in the college environment.

Background

Central State University (CSU) is classified as a historically black college or university (HBCU). Founded in 1887 and located in Wilberforce, Ohio, it is devoted to providing a nurturing “environment focused on excellence in teaching and learning, research, and service” (centralstate.edu). CSU is an open-access institution with a mission of recruiting and preparing a diverse group of students for an educational experience that will provide the necessary foundation for a professional career in any field. Of CSU’s population, 95.3 percent is African American, and more than 59 percent comes from families whose income is below the poverty level (National Science Foundation 2008b). Its enrollment averages two thousand students.

With a 120-year legacy of excellence in producing skilled and qualified individuals for professional careers, CSU is the lead institution for graduating more African American students than all other public universities in Ohio.

Since 2002 CSU has awarded 7% of all bachelor’s degrees earned by African-Americans at public institutions in Ohio. In STEM compared to other public universities in the State of Ohio with the same programs, CSU has awarded bachelor’s degrees to African-Americans as follows: Computer Science (17%); Industrial Technology (10%); Industrial/Manufacturing Engineering (16%); Mathematics (28%); Biology (5%) and Chemistry (8%). These accomplishments are a result of an upgraded STEM infrastructure at CSU supported by federal funding from such agencies as the National Science Foundation (NSF), Department of Energy, Department of Education, NASA and others. (National Science Foundation 2008b)

Recognizing the need for student financial support, one NSF program, Scholarships for Academic Recruitment and Retention (SARR, 2002–2006), produced the most outstanding results. SARR was a scholarship program for computer science, engineering, and mathematics majors focused on improving student retention and graduation. (The retention goal was 64 percent.) Of its ninety-four scholarship recipients, forty-four graduated, thirty-five are currently enrolled, seven transferred, and eight dropped out of school. Through this program, scholarship recipients were 84 percent more likely than non-program participants
to graduate from CSU. Although SARR tracked student matriculation, it lacked a formal mentoring program that would provide additional student support. With the results from SARR, NSF quickly funded the Benjamin Banneker Scholars Program (BBSP). BBSP included all of the nurturing needed to ensure even greater success for minority students majoring in a STEM field.

The National Problem

African Americans and other minorities remain tragically underrepresented in STEM fields. National concerns over the “STEM pipeline” have prompted additional funding at all levels to recruit more students into STEM fields, but numbers have not increased significantly overall from these initiatives, especially for African Americans. NSF data from 2006 cited 21.5 percent of all freshman majoring in STEM (social sciences excluded). Of these majors, 20.9 percent were African American freshmen, compared to 20.5 percent of the Caucasian cohort. However, according to 2006 graduation statistics, African Americans received only 8.3 percent of STEM bachelor’s degrees conferred by U.S. institutions compared with 64.7 percent of the Caucasian cohort.

Further, analysis conducted by the American Council on Education (ACE) has determined that interest in STEM fields does not vary significantly among ethnic groups. Likewise, declaration of STEM majors is similar in all groups; in fact, African Americans have a slightly higher declaration of a STEM major as freshmen than does the general population. However, the numbers of African Americans (and members of other minority groups) completing undergraduate degree programs in four years is lower; typically, these students take five to six years to complete degrees.

According to a UCLA student survey, 30 percent of all students change majors during their freshman year. The same students cite gains in computer, public speaking, and writing skills yet describe losses in mathematical ability and the desire to achieve, as well as an overall inflated sense of their academic abilities when they entered college (Bettlinger 2009). Attrition rates for African Americans in STEM majors are reported at a higher rate than for the average student. African Americans receive only 9 percent of bachelor’s degrees and only 8.8 percent of degrees in STEM fields. Clearly, STEM numbers are not rising when considering diversity in both advanced degrees and in the workforce (Sasso 2008).

To address these problems, Central State’s Strategic Academic and Enrollment Management (SAEM) Plan calls for dramatic growth in enrollment—from a student enrollment of 1,766 in Fall 2006 to an enrollment of 6,000 by Fall 2016—with the strengthening of academic programs at the center of these efforts. The strengthening of academic programs will enhance student academic success, retention, and graduation in STEM, thereby not only enhancing current enrollment, but also attracting more students in the future to STEM. These institutional goals are reflected in [BBSP] which contributes to the SAEM goals by growing the number of STEM majors, and increasing the number of STEM graduates pursuing STEM careers and/or graduate study, while enhancing the STEM curriculum and corresponding academic programs. (Central State University 2008; National Science Foundation 2008a)

A 2009 report from the Ohio State University (Nestor-Baker and Kerka 2009) focuses more specifically on the difficulties facing recruitment and retention of minority students. Seven areas of concern are specifically mentioned: lack of academic preparation; low confidence levels in students (e.g., STEM subjects are difficult); imposter syndrome (e.g., everyone but me understands); unrealistic expectations (e.g., students hope to pass with little effort); lack of community; environmental alienation; and financial need. These are all areas that must be addressed in any program serious about not only recruiting, but also retaining, African American and other minority STEM majors.
The Benjamin Banneker Scholars Program

Funded in 2008, BBSP “is strengthening CSU’s STEM programs and broadening the STEM workforce by offering merit-based scholarships along with academic and other student support” (National Science Foundation 2008a) to students with a 3.0 GPA and 21 on the ACT. The program’s objectives are to increase the number of high-performing students in STEM and to increase the retention and graduation rates of students in STEM. There are two cohorts of students. The first cohort (eight students) started in the spring of 2009, and the second cohort (ten students) started in fall 2009. Together, there are eighteen Banneker scholars. All scholars are grouped in academic learning communities and living learning communities; receive professional development through workshops, internships, research opportunities, and graduate school visits through the Center of Student Opportunities (CSO); attend monthly advising and mentoring meetings; and participate, if qualified, in the honors program. Together, these activities address the seven concerns mentioned in the Ohio State University report and provide the family structure needed to ensure student success.

BBSP is designed to create a family atmosphere. Howard (2001) has reported that minority students, particularly African Americans, flourish in environments that are caring and safe and that provide mental and emotional support. No environment provides that better than the family. With any family, there is a parent or other responsible adult providing discipline and boundaries as well as love and support. An extended family provides the same aspects, but with more flexibility. Further, there are activities experienced together that strengthen these bonds and create a solid, supportive relationship among all members.

The BBSP activities are as follows.

- **Academic learning communities.** All of the scholars are placed in classes with fellow BBSP scholars. An emphasis is placed on grouping students together in STEM core classes.

- **Living learning communities.** All of the scholars live together in the honors dormitory on campus.

- **Academic support.** Alternative resources for tutoring are provided by request for the STEM core classes. Peer and faculty tutoring are available in each STEM department, in addition to university resources.

- **Mandatory advising.** Dedicated faculty called learning community coordinators (LCCs) are assigned to students majoring in their field of study and meet with scholars on a monthly basis to discuss semester grades, academic challenges, future goals, and other personal matters.

- **Mandatory professional development.** Through the Center of Student Opportunities (CSO) students can receive tutoring; attend workshops and seminars on study skills, communication skills, writing statements of purpose and resumes, and so on; have access to research opportunities, internship placement, and scholarships; and participate in graduate school visits.

- **Honors program.** If qualified, the Banneker scholars can also participate in the university’s honors program, which requires participants to attend an honors seminar and earn honors credit in one or more courses per semester.

- **Other financial support.** All Banneker scholars are eligible for other scholarship opportunities offered in the STEM departments and CSO.

In regard to the program’s structure, the principal investigator serves as a mother; the director of the Center of Student Opportunities serves as a father; his assistant is a second mother; and learning com-
Community coordinators (BBSP student advisers) serve as parents or extended family members. Within this family model, other influencing factors include mentorship, student leadership on campus, undergraduate research, and campus or community service.

**Major Findings**

**Academic Learning Communities**

In spring 2009, the pre-program survey for cohort 1 showed that 85 percent of the participants felt that learning communities (LC) were good for student success and would enhance their academic performance. Students commented that LCs provide for healthy competition among peers; allow students to take classes with other hardworking and high-achieving students; provide an atmosphere of success; allow students to learn information about other classes, professors, and so on; and allow students to study and work with their peers and to hear other students' perspectives about lectures. After participating in the learning community, 86 percent of the students attributed their semester success to the LC. In the spring, the average GPA for the Banneker scholars was 3.05, while the average GPA for STEM majors not participating in the program was 2.33. In the fall 2009 pre-program survey, 70 percent of the scholars had never participated in a learning community, but 80 percent believed that the learning communities were good for student success and would enhance their performance in STEM courses.

**Living Learning Communities**

In regard to campus housing, due to the late announcement of the award in the fall of 2008, the Office of Residence Life was unable to relocate all of the scholars into the same dormitory in the spring of 2009. The pre-program survey captured student opinions about campus housing and living together. More than 50 percent believed that campus housing would enhance their academic performance, and 75 percent believed that living with other scholars would increase their performance in the fall of 2009. In the fall of 2009, the Banneker scholars lived together in the honors dormitory on CSU’s main campus, and 60 percent of cohort 2 students felt that living together would enhance their performance.

**Mandatory Advising**

In the post-program survey for the spring of 2009, 88 percent of cohort 1 scholars felt that meeting with an adviser monthly was very beneficial because they were able to map out future goals, see their grades, create a plan of action, and share their struggles and celebrate accomplishments with their advisers. All of the scholars felt that advising and faculty mentoring were the most effective services offered through this program and had the biggest impact on their success. Classroom facilities ranked second, with 72 percent of the scholars attributing their success to these resources.

**Academic Support**

In the spring of 2009, 100 percent of the scholars used departmental tutors, faculty office hours, or professional services to increase their academic success. Seventy-five percent of those qualified participated in the honors program and earned honors credit in one or more of their courses. Prior to the program, 71 percent of cohort 1 scholars and 80 percent of cohort 2 scholars were familiar with CSO and its services. Of those students, 71 percent and 70 percent, respectively, received scholarships, 43 percent were placed in internships, 29 percent borrowed a text for class, and 14 percent (40 percent of cohort 2) participated in professional development workshops and received tutoring, a calculator, or extra assistance with classes. In the post-program survey for cohort 1, 75 percent of the scholars participated in graduate
school visits and professional development workshops, and 50 percent were placed in internships and research opportunities in the summer of 2009. In the fall of 2009, 80 percent of the scholars in cohort 2 were satisfied with the services offered by CSO.

**Financial Support**

All of the scholars received financial support from this program, the university, and other grant-funded programs offering scholarships, book vouchers, stipends, and so on. In the spring of 2009, 100 percent of the scholars received awards paying their full tuition, room and board, and other fees. In the fall of 2009, 89 percent of the scholars had all of these costs paid by BBSP and other support.

**Other Influencing Factors**

Mentoring is a critical component that guides the scholars’ academic performance and develops their character and professional presence. In BBSP, “mentoring is a process for the informal transmission of knowledge…and psychological support perceived by the recipient as relevant to work, career, or professional development” (Bozeman and Feeney 2007). In this family model, such mentoring exists in many ways. There is mentoring by the principal investigator and LCCs, peer mentoring between scholars, and peer mentoring between scholars and non-scholars. Examples include group outings with a “father” or “mother” (such as black male workshops and female STEM luncheons), one-on-one meetings with a “mother” or “father,” meetings of the principal investigator or LCCs with the scholars' real parents, shadowing of an LCC at STEM conferences or assisting with faculty research, group studying, common participation in internal and/or external organizations and societies, and more. With their mentors, students discuss their future professional careers, academic matters, personal matters, and family matters for support and advice.

Another critical factor is undergraduate research (UR), which plays a vital role in engaging students in the STEM fields. There is extensive literature supporting the positive effects of UR on retention and progression into graduate school (Nagda et al. 1998; Nnadozie, Ishiyama, and Chon 2001; Shellito et al. 2001). For example, at CSU, UR is incorporated into the biology and chemistry major programs as a graduation requirement, whether conducted on campus with faculty or through summer internships. Students taking a UR experience for course credit are more likely to be successful in obtaining an outside internship and reporting a positive experience. In the first cohort, 63 percent of the scholars conducted STEM research with a faculty mentor or external organization during the academic year or summer, compared to less than 30 percent of non-BBSP participants majoring in a STEM field. Thus, BBSP not only sparks student interest in research, but also retains that interest through successful research placements during the academic year and summers, with a refined education highlighting the value of such research.

Further, student participation in student organizations and/or societies, leadership in STEM classrooms as teaching assistants or tutors, and representation around campus at student events as role models contribute to increased self-esteem, more academic confidence, and an overall better character as a STEM professional.

**Summary**

In conclusion, a student’s environment strongly impacts his or her potential success. Particularly among minorities, a family atmosphere reinforced by supportive activities increases student success, and thereby increases student retention and graduation. In BBSP, 100 percent of the Banneker scholars in cohort 1 were retained in a STEM field from the spring to the fall of 2009.
It is necessary for faculty and administrators to continue to address and support the needs of minority students to improve the representation of minorities in STEM. With continued input from students and colleagues, BBSP can continue to adapt to the needs of the students, creating the best environment that will promote and advance student success in higher education.

References


Central State University. 2008. Ohio Board of Regents choose Ohio First: Diversifying Ohio in STEM (DO-STEM) grant proposal. Wilberforce, OH.


National Science Foundation. 2008a. Benjamin Banneker Scholars Program (BBSP) grant report. Wilberforce, OH: Central State University.


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