ADOPTING A K-12 FAMILY MODEL WITH UNDERGRADUATE RESEARCH TO ENHANCE STEM PERSISTENCE AND ACHIEVEMENT IN UNDERREPRESENTED MINORITY STUDENTS

By

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and

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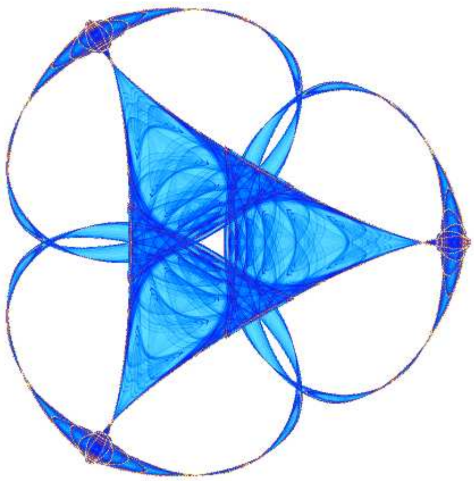

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Title: Adopting A K-12 Family Model With Undergraduate Research To Enhance STEM Persistence and Achievement In Underrepresented Minority Students

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Abstract: K-12 education has identified an important need for culturally relevant practices among underrepresented minority (URM) students in the classroom. Research has shown that URM students perform better in multicultural learning environments that place an emphasis on addressing both the student's social and academic needs. Accordingly, Central State University, a Historically Black College and University in Wilberforce, Ohio, has adopted a K-12 classroom family model for its Benjamin Banneker Scholars Program (BBSP). The program consists of 6 activities for students majoring in Science, Technology, Engineering and Mathematics (STEM) fields. BBSP scholars participate in: (1) an academic learning community, (2) a living, learning community, (3) mandatory mentoring, (4) the campus honors program, (5) professional development workshops and graduate school visits, and (6) STEM research on and off-campus. Of the above activities, participating students ranked undergraduate research/internships as having the largest impact on professional preparedness for a STEM career and/or graduate studies. This paper will discuss how the family model was implemented in a college environment and the impact undergraduate research has had on increasing the academic performance of URM students in STEM.

Introduction

The importance of increasing Science, Technology, Engineering and Mathematics (STEM) Ph.D.s in the United States has heightened dramatically in the last decade. Increasing the number of STEM Ph.D. recipients among underrepresented minorities (URM) is of even greater importance to maintaining a culturally diverse workforce. National concerns over the "STEM Pipeline" have led to additional funding at all levels to recruit and retain more students in STEM fields. Yet very few of these initiatives have significantly increased the number of URMs, particularly African Americans, in STEM fields. Freshman STEM majors (Social Sciences excluded.) made up 21.5% of all college freshmen in 2006. Of this group, African Americans comprised 20.9% compared to 20.5% for Caucasians. However, 2007 graduation statistics cite African Americans as receiving only 7-8% of STEM bachelor degrees bestowed by U.S. institutions, compared to 64% of the Caucasian cohort. Further, African American STEM graduation rates have been largely flat since 1998 (NSF, 2010). STEM numbers are not rising among URMs, either in advanced degrees or in the workforce in general (HLC, 2010).

Founded in 1887, Central State University (CSU), located in Wilberforce, Ohio, is a Historically Black College and University (HBCU) and open access institution of 2400 students with a mission to equip its students with the necessary academic and professional skills for a degree and professional career in any field. 95.3% of the student body is African-American, and over 59% come from families whose income is below the poverty level (HLC, 2010). 14.2% are pursuing STEM degrees in biology, chemistry, computer sciences, education (STEM fields), engineering, mathematics, water resources management, and/or social and behavioral sciences.

Nestor-Baker and Kerka (2009) defined 7 challenges regarding recruitment and retention for URM students: lack of academic preparation, low confidence levels, the "Imposter Syndrome" (e.g. Everyone understands but me.), unrealistic expectations (e.g., passing with little effort), lack of community, environmental alienation, and financial need. To address these problems, CSU has placed an emphasis on strengthening its academic support programs, including development of the Benjamin Banneker Scholars Program (BBSP) which uses effective practices from K-12 classrooms as well as early undergraduate research experiences (Jones et al., 2010) to enhance student success, increase retention and graduation rates in STEM, and provide a transition into STEM careers or graduate studies.

Program Background

Sponsored in 2008 by the National Science Foundation (NSF), BBSP was developed as an expansion of the NSF-funded Scholarships for Academic Recruitment and Retention Program (SARR) offered from 2002-2006 at CSU, and a second program, offered from 2005-2008, funded by the Department of Education's Minority, Science and Engineering Improvement Program (MSEIP). SARR's purpose was to provide academic scholarships to increase the retention and graduation rates of students majoring in Computer Science, Engineering, and Mathematics. SARR's retention goal was 64%. Of the 94 scholarship recipients, 44 graduated, 35 are currently enrolled, 7 transferred, and 8 dropped out of school. SARR demonstrated that scholarship recipients were 84% more likely to stay in school and graduate than non-SARR participants. Although SARR successfully addressed students' financial needs, it lacked a mentoring component to prepare students for professional careers.

MSEIP allowed for the establishment of an Integrated Molecular Lab (IML) within the Department of Natural Sciences. The purpose of the MSEIP grant was to create an environment where students could conduct hands-on molecular research in course laboratories and in conducting undergraduate research (UR). Each year, students increased their use of the IML in coursework and UR. Student progress was monitored by the senior exit exam (See Figure 1.). As predicted, there was a measurable increase in learning that correlated with the number of courses or UR spent in the IML. Although MSEIP provided active learning, it, too, lacked the social structure needed to develop students into scientists.

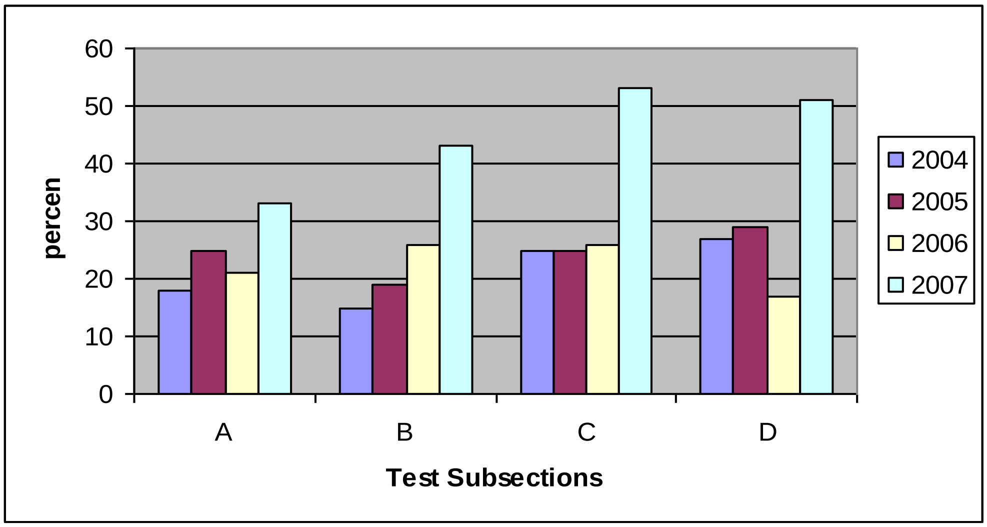

Figure 1. Senior exit exam data. From 2004(no IML) to 2007 (3 years using the IML), student scores rose an average of 45% in (A) Molecular and Cellular Biology, 65% in (B) Molecular Biology and Genetics, 53% in (C) Organismal Biology, and 47% in (D) Evolution and Ecology.

BBSP provided what both SARR and MSEIP did not --structured academic and social support. BBSP's goals were to increase the number of high performing students in STEM, and provide several mentoring activities, thereby increasing the retention and graduation rates of students in STEM. Program criteria required students to have a cumulative 3.0 GPA and to major in a STEM field. The demographics of students participating in the program appear in the tables below.

Table 1: BBSP Academic Demographics			
Cohorts	**Year Recruited**	**Rank**	**Majors**
Cohort 1	Spring 2009	7 Sophomores	4 Biology*; 1 Chemistry; 1 Mathematics;1 Environmental Engineering*
Cohort 2	Fall 2009	2 Juniors 3 Sophomores 8 Freshmen	4 Biology ; 2 Chemistry; 2 Computer Science; 2 Environmental Engineering; 3 Manufacturing Engineering 2 Environmental Enginee3 Manufacturing Engineering

*Denotes a double major.

Table 2: BBSP Socio – Economic Demographics					
Cohorts	**Year Recruited**	**Rank**	**Ethnicity**	**Gender**	**# Who Received Financial Aid**
Cohort 1	Spring 2009	7 Sophomores	7 African- American	1 Male; 6 Females	7
Cohort 2	Fall 2009	2 Juniors 3 Sophomores 8 Freshmen	12 African- American; 1 Interracial	4 Males; 9 Females	13

Program Design and Activities

The campus climate at an HBCU is unique. Research has shown that HBCUs provide a more nurturing and supportive environment (Allen, 1992; Fleming, 1984) for students than higher education institutions in general. This environment "buffer[s] and/or solve[s] many of the social, psychological, and academic difficulties peculiar to campus life" (Davis, 1991). Such environments build students' self esteem, increase their academic competence, develop their social skills, and provide advice and strategies to adapt to an academic/professional climate (Davis, 1991). Given the shortage of URM STEM majors nationally, it is imperative, to create an even stronger support system for STEM majors that increases students' success rate of earning a STEM degree. BBSP provides such a supportive environment for its participants through the leadership of the Principal Investigator and six Learning Community Coordinators (LCC) who are also STEM faculty who meet with participating scholars at monthly BBSP meetings.

Howard (2001) conducted a study of African-American student perceptions of their instructors and instructor's teaching methods at 4 urban, U.S. elementary schools. Results showed that students preferred caring teachers and a family environment for learning in the classroom. BBSP found that such students continued to prefer similarly nurturing environments in college. For BBSP, familial bonds were easily formed because scholars had the same socioeconomic status, major, ethnicity, goals, and dreams, creating a feeling of peer support. Booker (2006) argued that a sense of belonging is one of the most significant factors for URM high school student achievement. Together, these bonds formed the foundation of the family model for BBSP. The 6 program activities (or traditions) created the family environment and were based upon Grantham and Ford's (2003) work on gifted URM high school students. The authors recommended the following strategies for academic achievement: positive reinforcement, mentors and role models, development of social skills, weekly or monthly meetings with counselors or advisors, small group sessions or communities, enrichment activities, and high expectations. BBSP incorporated all of these strategies.

In the first BBSP program activity, students participated in an academic learning community by taking at least two STEM courses with fellow scholars. As a result, scholars formed study groups more easily and were more comfortable asking each other for help with their classes. In the second program activity, scholars participated in a living, learning community by residing in the Honors Dormitory on campus (75% of the scholars shared a room with another scholar; some of the scholars were non-traditional students who lived off-campus.). Taken from the post-program survey, below are some of the scholars' reflections on these activities:

"I knew other students [in my classes], so it was easier to form study groups."

"We used each other as resources. If we had tests or homework problems, we helped each other."

The students formed a smaller community by major when they met with their LCC's at monthly meetings, which was the third program activity. The 1 hour monthly meetings consisted of rituals -- program announcements, student highlights, and an advising session—that provided the framework of a family gathering. During the advising session, LCC's tracked student progress, provided advice for course registration, study tips for STEM courses, and information about research opportunities. Scholars and LCC's also shared family traditions like going out to eat and attending campus events together. Chapman (1987) added that the student-faculty relationship is the strongest indicator of student success. As a result, the LCC's became surrogates for student participants, often acting as mother, father, sister, brother, counselor, etc., to create a family atmosphere. Further research has shown that a student's desire to learn increased if the student knew that someone—a parent, teacher, guardian—cared about his/her education and future (Noddings, 1992; Ellis, 2008; Somers et al., 2008). The LCCs and the PI made it clear to scholars that they and CSU cared very much about their success. The student responses below acknowledge the effectiveness of these roles:

“It [monthly meetings] gave us a chance to talk about our struggles and get advice on how to be successful”

“I felt like someone believed in me and that I could actually stick through something even when I truly believed I couldn’t.”

“I really enjoyed the meetings and conversations, because they really were encouraging and made me want to succeed.”

The purpose of culturally relevant pedagogy is to create an atmosphere where students can reach their full potential. By setting high expectations, students are more likely to work harder to meet those expectations (Ladson-Billings, 1994). Thus, BBSP required all participants to maintain a cumulative 3.0 GPA, and to increase the GPA each year the scholar was in the program. If qualified, scholars were also encouraged to participate in the Honors Program (Students had to have a 3.2 GPA to participate, so this fourth activity was optional). Additional academic support--such as tutoring and counseling--was also provided through BBSP by request, but was not mandatory.

In the fifth program activity, BBSP required all scholars to attend two professional development workshops and two graduate school visits offered through the Center for Student Opportunities (CSO), a student support program on campus. The professional development workshops focused on career skills such as resume writing and communication skills. Transportation was provided for 6 graduate school visits held at colleges and universities across the country. In the sixth activity, scholars were required to apply to at least 1 STEM research experience. Scholars applied through CSO, which had partnerships with national STEM institutions and organizations, or through their LCC. These last two activities developed in students a scholar's character, professional presence, and professional preparedness for a STEM career or graduate studies.

Failure to complete the required activities resulted in a reduction of the student's academic scholarship. Scholars only received a scholarship amount equivalent to the requirements met while in the program. Hill (1995) explained that URM students performed best in an authoritative and nurturing environment that imitated home life, where discipline and compliance to rules and policies was expected. Howard (2001) reiterated this, explaining that students understood that rules were put in place to protect them and guide them into making better independent decisions. Students understood that following the rules was very important in BBSP.

Of the 6 program activities above, the post-program survey revealed that scholars felt that internships and/or UR had the largest impact on their professional preparedness.

Undergraduate Research

The concept of UR as a tool for training scientists was believed to have originated at MIT in 1969 (Carter et al., 2009), based on the graduate school model of "master-apprentice." In 1998, the Boyer Commission Report challenged American universities to make research-based learning the standard for science education. Seymour et al. (2004) conducted a 4-college study on student perceptions of the benefits of summer UR experiences. Hunter(2006) aligned student perceptions alongside faculty perceptions from the same group. The three largest student perceived gains were increased confidence in the ability to do research (25%), thinking and working like a scientist (24%), and improvement in communication skills (17%). Faculty ranked student perceived gains as: thinking and working like a scientist (23%), becoming a scientist (20%), and increased confidence in the ability to do research (19%). The reviews by Seymour et al. (2004) and Hunter et al. (2006) focused on mainstream students and not URM. Further, both reviews focused only on the benefits of summer programs.

The Meyerhoff Scholarship Program (MSP) (1988) developed a model intervention program for increasing URM students in STEM fields; however, it focused on the use of on-campus UR during the academic year. MSP data concluded that for the average African American participant, any on-campus research increased chances of pursuing a STEM Ph.D. by 21-38% (instrumented vs. non-instrumented estimates). Further, the data concluded that the structure and intensity of the program impacted student success. Student success rates increased, for example, when they participated in ongoing research projects and publicly presented their findings.

Jones et al. (2009) echoed the findings of Carter et al. (2009) but also included data on the benefits of student retention and persistence, finding that the most successful students were those involved in UR during the first 2 years of their academic programs. Recognizing this, STEM departments at CSU began making changes to major programs by incorporating early UR experiences. Academic integration emphasized social and academic involvement that were student-centered and increased faculty and student contact. The first curricular changes were pioneered in Biology; only this major is discussed below.

Biology Curricular Changes

The Biology Major at CSU implemented 4 curricular changes to support a student-centered focus on STEM. Changes included an added emphasis in career skill building, a UR requirement, and focused advising and mentoring. The major also employed Writing Across the Curriculum (WAC) in most major courses so that students learned scientific writing while preparing reports in manuscript format. At first, students wrote reports based upon rubrics, but these were successively removed as students reached higher level major courses.

Three classes were enhanced to support STEM career building skills. The first, Careers in Biology, was traditionally taken fall of the sophomore year. The class broadened student exposure to careers in biology through talks given by external experts that helped to identify student career interests. NIH Science Education LifeWorks Career Finder (science.education.nih.gov/ LifeWorks) was a course staple offering inventories of student personal skills and interests (using Career Finder) and suggesting careers that used those skills and interests. The course emphasized writing a scientific resume and featured talks by educators and scientists in a student's field of interest. All speakers addressed financial data, undergraduate course expectations, as well as internship opportunities. The traditional Biology Seminar was revamped to teach students how to find and use scientific literature. Students learned skills in designing and presenting projects orally and were evaluated by their peers and the instructor. The last curriculum revision was the addition of a Senior Capstone course.

Offered in the fall of the senior year, it prepared students for steps following graduation, such as writing cover letters, preparing for GRE, MCAT or other tests, and applying to graduate programs.

In 2005, the Biology program began actively integrating UR into its curriculum through the IML, and required majors to conduct a UR project (off or on-campus) as a graduation requirement. MSEIP had demonstrated that students tended to have more successful external research experiences after they had at least a year of hands-on on campus research. The UR model in BBSP thus integrated early UR experiences into each scholar's program of study.

Results & Discussion

Table 3: BBSP Results	Avg. Cumulative (Cum.) GPA	Avg. Cum. GPA of STEM Non-Participants	% on Dean's List ($3.0 \geq$ GPA)	% in Honors Program	% Retained in Discipline	% in UR	% in STEM Professional Society
Cohort 1 Spring (2009)	3.05	2.33	71%	71%	100%	71%	25%
Cohorts 1 & 2 (2009-2010)	3.2	2.24	55% (Fall) 50% (Spring)	70%	100%	50%	40%

To fulfill their UR requirement, 71% of the scholars in Cohort 1 conducted STEM research: 2 conducted research on-campus during the spring semester and 4 conducted research through summer internships at Wright Patterson Air Force Base, the Environmental Protection Agency, the University of Rochester, and James Madison University. Student reflections about their experiences appear below:

“EVERYTHING is going extremely well and I am learning so much!!!”

“It [my internship] was hands on, and I learned a lot of techniques.”

“I liked the connections we made with the university staff and students [during my summer internship].”

For 2009-2010, 100% of the scholars in Cohort 1 received continuing scholarships in recognition that they had fully met all program requirements. Four scholars from Cohorts 1 and 2 served as role models or tutors for CSO and/or other STEM departments. 35% presented their research at local or national conferences, and 50% of the scholars conducted STEM research through summer internships at the Ohio College of Podiatric Medicine, the University of Maryland, the University of Rochester (continuation of the Summer 2009 project), the University of Cincinnati, Wright State University (WSU), Avatec, Los Alamos National Laboratory, Metropolitan Sewer District of Greater Cincinnati, and NASA. (One scholar, who will enter her senior year at CSU in the fall of 2010, and who has conducted STEM research on and off campus since her freshman year, conducted research during the academic year at WSU and, given her success, was offered and accepted a full ride to WSU's graduate program in Biology.)

A comparison of cumulative GPAs showed that there were no significant difference between students who did and did not conduct UR. However, when the major GPA was examined to compare the impact of UR, students completing internships had an average major GPA that was 23% greater than students not performing internships. See Figure 2.

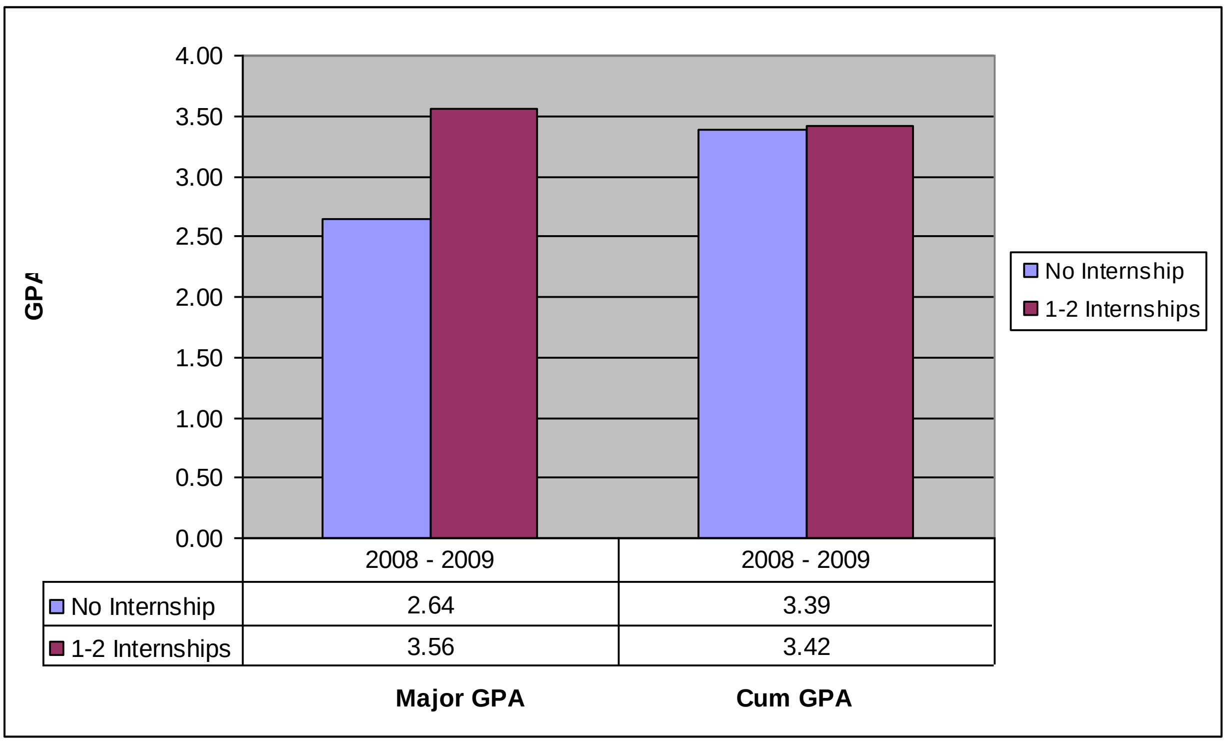

Figure 2. Comparison of major GPAs in students conducting UR or not.

Conclusions

In summary, BBSP strongly demonstrates that culturally relevant practices used in K-12 classrooms can also be utilized with success in the college environment to increase student performance, retention and graduation rates for URM in STEM. As discovered in Allison and Rehm's 2006 middle school study, no changes needed to be made to the academic rigor of any STEM program. However, substantial changes needed to be made to the campus environment. For BBSP, through several mentoring activities, a more nurturing environment was created where students felt safe, comfortable, and supported. Furthermore, through early UR experiences, scholars were better prepared for their STEM courses and for subsequent external research opportunities. The 6 mentoring activities strengthened the scholars' academic portfolio, built self esteem, and developed their professional presence. In sum, the family model enhances students' successful transition to a STEM career and/or graduate program and can be duplicated at any institution.

Acknowledgements

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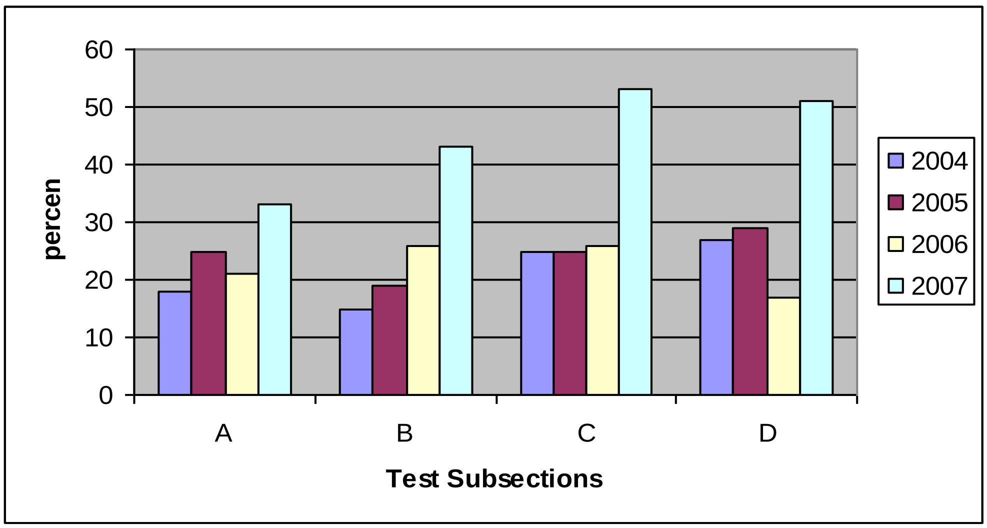

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Table 2: BBSP Socio – Economic Demographics					
Cohorts	**Year Recruited**	**Rank**	**Ethnicity**	**Gender**	**# Who Received Financial Aid**
Cohort 1	Spring 2009	7 Sophomores	7 African- American	1 Male; 6 Females	7
Cohort 2	Fall 2009	2 Juniors 3 Sophomores 8 Freshmen	12 African- American; 1 Interracial	4 Males; 9 Females	13

Program Design and Activities

The campus climate at an HBCU is unique. Research has shown that HBCUs provide a more nurturing and supportive environment (Allen, 1992; Fleming, 1984) for students than higher education institutions in general. This environment "buffer[s] and/or solve[s] many of the social, psychological, and academic difficulties peculiar to campus life" (Davis, 1991). Such environments build students' self esteem, increase their academic competence, develop their social skills, and provide advice and strategies to adapt to an academic/professional climate (Davis, 1991). Given the shortage of URM STEM majors nationally, it is imperative, to create an even stronger support system for STEM majors that increases students' success rate of earning a STEM degree. BBSP provides such a supportive environment for its participants through the leadership of the Principal Investigator and six Learning Community Coordinators (LCC) who are also STEM faculty who meet with participating scholars at monthly BBSP meetings.

Howard (2001) conducted a study of African-American student perceptions of their instructors and instructor's teaching methods at 4 urban, U.S. elementary schools. Results showed that students preferred caring teachers and a family environment for learning in the classroom. BBSP found that such students continued to prefer similarly nurturing environments in college. For BBSP, familial bonds were easily formed because scholars had the same socioeconomic status, major, ethnicity, goals, and dreams, creating a feeling of peer support. Booker (2006) argued that a sense of belonging is one of the most significant factors for URM high school student achievement. Together, these bonds formed the foundation of the family model for BBSP. The 6 program activities (or traditions) created the family environment and were based upon Grantham and Ford's (2003) work on gifted URM high school students. The authors recommended the following strategies for academic achievement: positive reinforcement, mentors and role models, development of social skills, weekly or monthly meetings with counselors or advisors, small group sessions or communities, enrichment activities, and high expectations. BBSP incorporated all of these strategies.

In the first BBSP program activity, students participated in an academic learning community by taking at least two STEM courses with fellow scholars. As a result, scholars formed study groups more easily and were more comfortable asking each other for help with their classes. In the second program activity, scholars participated in a living, learning community by residing in the Honors Dormitory on campus (75% of the scholars shared a room with another scholar; some of the scholars were non-traditional students who lived off-campus.). Taken from the post-program survey, below are some of the scholars' reflections on these activities:

"I knew other students [in my classes], so it was easier to form study groups."

"We used each other as resources. If we had tests or homework problems, we helped each other."

The students formed a smaller community by major when they met with their LCC's at monthly meetings, which was the third program activity. The 1 hour monthly meetings consisted of rituals -- program announcements, student highlights, and an advising session—that provided the framework of a family gathering. During the advising session, LCC's tracked student progress, provided advice for course registration, study tips for STEM courses, and information about research opportunities. Scholars and LCC's also shared family traditions like going out to eat and attending campus events together. Chapman (1987) added that the student-faculty relationship is the strongest indicator of student success. As a result, the LCC's became surrogates for student participants, often acting as mother, father, sister, brother, counselor, etc., to create a family atmosphere. Further research has shown that a student's desire to learn increased if the student knew that someone—a parent, teacher, guardian—cared about his/her education and future (Noddings, 1992; Ellis, 2008; Somers et al., 2008). The LCCs and the PI made it clear to scholars that they and CSU cared very much about their success. The student responses below acknowledge the effectiveness of these roles:

“It [monthly meetings] gave us a chance to talk about our struggles and get advice on how to be successful”

“I felt like someone believed in me and that I could actually stick through something even when I truly believed I couldn’t.”

“I really enjoyed the meetings and conversations, because they really were encouraging and made me want to succeed.”

The purpose of culturally relevant pedagogy is to create an atmosphere where students can reach their full potential. By setting high expectations, students are more likely to work harder to meet those expectations (Ladson-Billings, 1994). Thus, BBSP required all participants to maintain a cumulative 3.0 GPA, and to increase the GPA each year the scholar was in the program. If qualified, scholars were also encouraged to participate in the Honors Program (Students had to have a 3.2 GPA to participate, so this fourth activity was optional). Additional academic support-- such as tutoring and counseling--was also provided through BBSP by request, but was not mandatory.

In the fifth program activity, BBSP required all scholars to attend two professional development workshops and two graduate school visits offered through the Center for Student Opportunities (CSO), a student support program on campus. The professional development workshops focused on career skills such as resume writing and communication skills. Transportation was provided for 6 graduate school visits held at colleges and universities across the country. In the sixth activity, scholars were required to apply to at least 1 STEM research experience. Scholars applied through CSO, which had partnerships with national STEM institutions and organizations, or through their LCC. These last two activities developed in students a scholar's character, professional presence, and professional preparedness for a STEM career or graduate studies.

Failure to complete the required activities resulted in a reduction of the student's academic scholarship. Scholars only received a scholarship amount equivalent to the requirements met while in the program. Hill (1995) explained that URM students performed best in an authoritative and nurturing environment that imitated home life, where discipline and compliance to rules and policies was expected. Howard (2001) reiterated this, explaining that students understood that rules were put in place to protect them and guide them into making better independent decisions. Students understood that following the rules was very important in BBSP.

Of the 6 program activities above, the post-program survey revealed that scholars felt that internships and/or UR had the largest impact on their professional preparedness.

Undergraduate Research

The concept of UR as a tool for training scientists was believed to have originated at MIT in 1969 (Carter et al., 2009), based on the graduate school model of "master-apprentice." In 1998, the Boyer Commission Report challenged American universities to make research-based learning the standard for science education. Seymour et al. (2004) conducted a 4-college study on student perceptions of the benefits of summer UR experiences. Hunter(2006) aligned student perceptions alongside faculty perceptions from the same group. The three largest student perceived gains were increased confidence in the ability to do research (25%), thinking and working like a scientist (24%), and improvement in communication skills (17%). Faculty ranked student perceived gains as: thinking and working like a scientist (23%), becoming a scientist (20%), and increased confidence in the ability to do research (19%). The reviews by Seymour et al. (2004) and Hunter et al. (2006) focused on mainstream students and not URM. Further, both reviews focused only on the benefits of summer programs.

The Meyerhoff Scholarship Program (MSP) (1988) developed a model intervention program for increasing URM students in STEM fields; however, it focused on the use of on-campus UR during the academic year. MSP data concluded that for the average African American participant, any on-campus research increased chances of pursuing a STEM Ph.D. by 21-38% (instrumented vs. non-instrumented estimates). Further, the data concluded that the structure and intensity of the program impacted student success. Student success rates increased, for example, when they participated in ongoing research projects and publicly presented their findings.

Jones et al. (2009) echoed the findings of Carter et al. (2009) but also included data on the benefits of student retention and persistence, finding that the most successful students were those involved in UR during the first 2 years of their academic programs. Recognizing this, STEM departments at CSU began making changes to major programs by incorporating early UR experiences. Academic integration emphasized social and academic involvement that were student-centered and increased faculty and student contact. The first curricular changes were pioneered in Biology; only this major is discussed below.

Biology Curricular Changes

The Biology Major at CSU implemented 4 curricular changes to support a student-centered focus on STEM. Changes included an added emphasis in career skill building, a UR requirement, and focused advising and mentoring. The major also employed Writing Across the Curriculum (WAC) in most major courses so that students learned scientific writing while preparing reports in manuscript format. At first, students wrote reports based upon rubrics, but these were successively removed as students reached higher level major courses.

Three classes were enhanced to support STEM career building skills. The first, Careers in Biology, was traditionally taken fall of the sophomore year. The class broadened student exposure to careers in biology through talks given by external experts that helped to identify student career interests. NIH Science Education LifeWorks Career Finder (science.education.nih.gov/ LifeWorks) was a course staple offering inventories of student personal skills and interests (using Career Finder) and suggesting careers that used those skills and interests. The course emphasized writing a scientific resume and featured talks by educators and scientists in a student’s field of interest. All speakers addressed financial data, undergraduate course expectations, as well as internship opportunities. The traditional Biology Seminar was revamped to teach students how to find and use scientific literature. Students learned skills in designing and presenting projects orally and were evaluated by their peers and the instructor. The last curriculum revision was the addition of a Senior Capstone course.

Offered in the fall of the senior year, it prepared students for steps following graduation, such as writing cover letters, preparing for GRE, MCAT or other tests, and applying to graduate programs.

In 2005, the Biology program began actively integrating UR into its curriculum through the IML, and required majors to conduct a UR project (off or on-campus) as a graduation requirement. MSEIP had demonstrated that students tended to have more successful external research experiences after they had at least a year of hands-on on campus research. The UR model in BBSP thus integrated early UR experiences into each scholar's program of study.

Results & Discussion

Table 3: BBSP Results	Avg. Cumulative (Cum.) GPA	Avg. Cum. GPA of STEM Non-Participants	% on Dean's List ($3.0 \geq GPA$)	% in Honors Program	% Retained in Discipline	% in UR	% in STEM Professional Society
Cohort 1 Spring (2009)	3.05	2.33	71%	71%	100%	71%	25%
Cohorts 1 & 2 (2009-2010)	3.2	2.24	55% (Fall) 50% (Spring)	70%	100%	50%	40%

To fulfill their UR requirement, 71% of the scholars in Cohort 1 conducted STEM research: 2 conducted research on-campus during the spring semester and 4 conducted research through summer internships at Wright Patterson Air Force Base, the Environmental Protection Agency, the University of Rochester, and James Madison University. Student reflections about their experiences appear below:

“EVERYTHING is going extremely well and I am learning so much!!!”

“It [my internship] was hands on, and I learned a lot of techniques.”

“I liked the connections we made with the university staff and students [during my summer internship].”

For 2009-2010, 100% of the scholars in Cohort 1 received continuing scholarships in recognition that they had fully met all program requirements. Four scholars from Cohorts 1 and 2 served as role models or tutors for CSO and/or other STEM departments. 35% presented their research at local or national conferences, and 50% of the scholars conducted STEM research through summer internships at the Ohio College of Podiatric Medicine, the University of Maryland, the University of Rochester (continuation of the Summer 2009 project), the University of Cincinnati, Wright State University (WSU), Avatec, Los Alamos National Laboratory, Metropolitan Sewer District of Greater Cincinnati, and NASA. (One scholar, who will enter her senior year at CSU in the fall of 2010, and who has conducted STEM research on and off campus since her freshman year, conducted research during the academic year at WSU and, given her success, was offered and accepted a full ride to WSU's graduate program in Biology.)

A comparison of cumulative GPAs showed that there were no significant difference between students who did and did not conduct UR. However, when the major GPA was examined to compare the impact of UR, students completing internships had an average major GPA that was 23% greater than students not performing internships. See Figure 2.

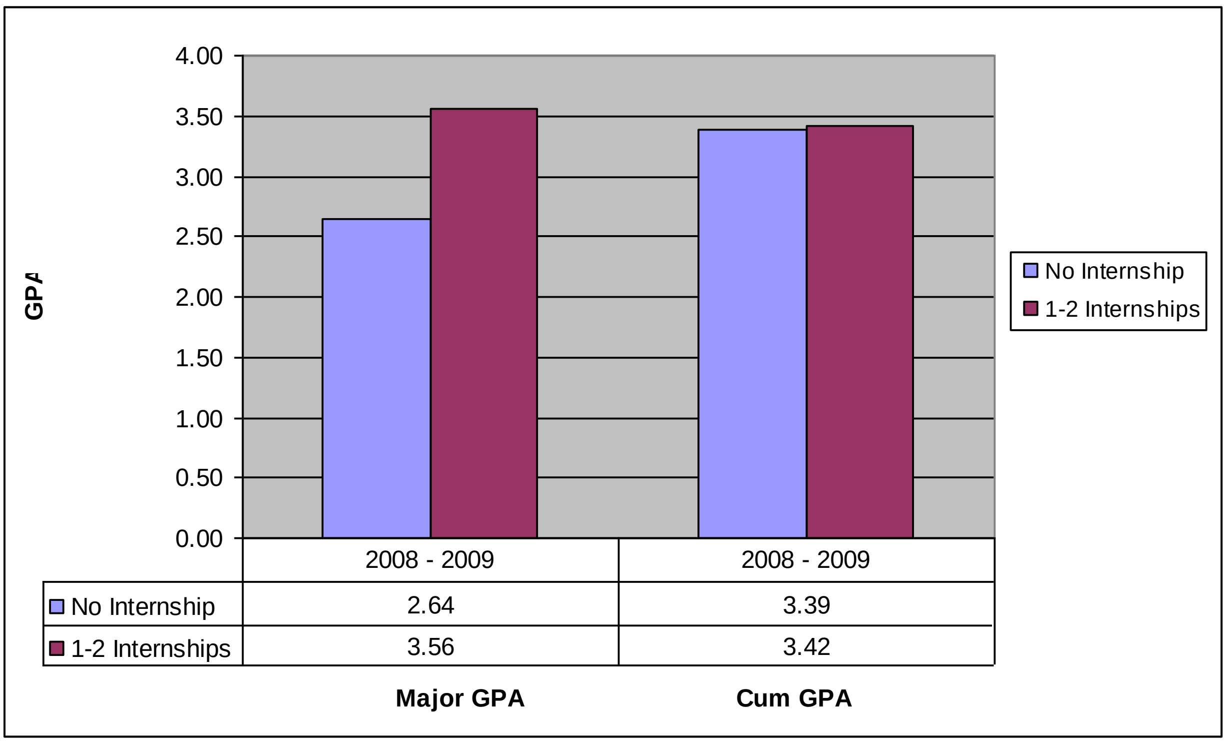

Figure 2. Comparison of major GPAs in students conducting UR or not.

Conclusions

In summary, BBSP strongly demonstrates that culturally relevant practices used in K-12 classrooms can also be utilized with success in the college environment to increase student performance, retention and graduation rates for URM in STEM. As discovered in Allison and Rehm's 2006 middle school study, no changes needed to be made to the academic rigor of any STEM program. However, substantial changes needed to be made to the campus environment. For BBSP, through several mentoring activities, a more nurturing environment was created where students felt safe, comfortable, and supported. Furthermore, through early UR experiences, scholars were better prepared for their STEM courses and for subsequent external research opportunities. The 6 mentoring activities strengthened the scholars' academic portfolio, built self esteem, and developed their professional presence. In sum, the family model enhances students' successful transition to a STEM career and/or graduate program and can be duplicated at any institution.

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