Work in Progress - A Study on the Effectiveness of an Innovative Research Program for Urban High School Students

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Abstract - To increase minority high school students' interest in STEM, an innovative outreach program has been developed in the Center for Layered Polymeric Systems. The Polymer Envoys Program features a two-year research internship where local students are matched with graduate student mentors, and participate in STEM research beginning the Fall of their junior year and concluding the Spring of their senior year. A study is being used to determine the effectiveness of this program. Issues considered include initial selection of schools and student participants, experiences of program participants, related academic choices made during high school, and post-program choices made regarding college and major. Questionnaires and informal observations indicate that this program has had very positive results in its implementation to date. While many students initially indicated minimal experience with research and technical communication, within one year all made significant improvements. This change was self-reported on surveys, and observed in students' oral and written communication assignments. Additionally, positive changes were observed in students' academic and career aspirations through experiences in the program.

Index Terms – Minority students, pre-college outreach, research experience.

BACKGROUND

In the United States certain ethnic groups are underrepresented in science, technology, engineering, and math (STEM) fields. National Science Foundation[1] and Census Bureau[2] data show that, while the population of Blacks and Hispanics in the United States is 12% and 13%, respectively, in STEM undergraduate programs these groups only account for 8.5% and 7.2% of the student population. While these numbers have increased slightly over the past decade, they are still significantly lower than where they could be.

An issue that makes this under-representation more significant is that the number of American jobs in STEM fields is growing at a rate much faster than the production of new STEM degrees[3]. Therefore, it is important to consider how these underrepresented groups can position themselves to fill such positions. Many of these jobs will require college-level degrees, and students often must have an interest and show promise in pre-college math and science to allow themselves the opportunity to pursue college degrees in the STEM disciplines.

Pre-college enrichment programs are common methods to interest minority students at a young age toward STEM. Many universities have started such programs, but little educational research has been used to determine their success to date. McWhirter[4] found that Mexican-Americans expressed preventative attitudes, such as a feeling of not being smart enough, not being able to go to college, and not fitting in. Therefore, programs need to be developed to show the students that they are important, needed, and capable of success in STEM fields. Haensly and Lehmann[5] reported on the importance of giving students “voice” in their program for gifted minority adolescents through writing assignments. This voice made students more confident in and reflective of their academic choices.

PROGRAM AND STUDY OVERVIEW

To increase minority high school students' interest in STEM, the Polymer Envoys Program (PEP), an innovative outreach program, has been developed and is being piloted at Case Western Reserve University (CWRU) in partnership with the Cleveland Metropolitan School District (CMSD). This program features a two-year research internship where high school students are matched with a graduate student mentor, and participate in STEM research from the Fall of their junior year through the Spring of their senior year. Students work on projects in the Physics Department or the Macromolecular Science and Engineering Department through the Center for Layered Polymeric Systems (CLiPS). These projects are typically a small piece of the graduate mentor’s thesis, and give students hands-on experience in areas such as polymer chemistry, thermal and mechanical behavior of materials, and lasers. At least three times each year, students present their research at program-sponsored symposia. To give back to their community and recruit future program participants, students also create presentations to teach younger students and the general community about polymer concepts. Research and school support available to students through PEP includes the graduate student, program coordinator, faculty advisor, and tutors in math and science.

A study is being used to determine the short- and long-term effectiveness of PEP. The following questions are being addressed: (1) Are the high school selection and student selection processes appropriate to meet program goals? (2) How are a student's perception of and interest in STEM
affected by the research experience? (3) How does the experience affect the student’s perception of her or his technical abilities? (4) How does this program affect the number of urban students who go to college, and who pursue STEM degrees once there? An examination of question 4 has recently begun and limited data are available, but data on questions 1-3 will be described herein. By the FIE Conference, initial information on question 4 will be available.

The population for this study consists of PEP participants. Six to ten students are selected to participate each year, and all students are invited to participate in the study. Baseline and end-of-term surveys are used to determine the impact of PEP on participants. These surveys ask students for academic and attitudinal information so that changes over time may be tracked using multiple-choice questions with Likert-like scales (1=strongly agree, 3=neutral, 5=strongly disagree). Short answer questions also ask for students’ opinions on their aspirations, and feedback on research and program activities.

RESULTS AND RECOMMENDATIONS

Science coordinators in the CMSD’s central administration chose the initial PEP schools from which participants were identified. The key criterion was proximity to CWRU. While excellent students were identified at these schools, school and teacher commitment to and interest in the program were at times lacking. Therefore, in the second year of PEP, the school selection process was revised to allow all CMSD high schools to submit proposals if they wished to participate in PEP. This process was found to work very well because schools better understand the expectations and have committed to fulfill them. Inversely, current schools unable to meet expectations could choose to opt-out of the program.

In the first two years of PEP, 12 students were selected and started as sophomores (1), juniors (8), and seniors (3). Key selection factors include a student’s grades and interest in math and science, level of maturity, and enthusiasm toward PEP. While students of all levels have been successful, it has been found that juniors are the ideal level for new students. This is because the high school has known the students and the students have demonstrated academic success for a year and a half before the students apply to PEP. Then, the program has two years to work with students before they apply to college. The program has also learned the importance of explicitly stating the time commitment for student participants. While PEP expects students to be in the lab for 5 hours each week, organizers have found that students often have to choose between participating in the program, or in school sports or clubs. In the initial class, three students left PEP to participate in other school or job activities, while only one student in the second class left for that reason. Therefore, by making this expectation and potential choice clear to students initially, the students who participate are less likely to leave the program compared to students for whom this matter is not stressed. Since student matriculation into CWRU or other CLiPS higher education institutions is a key goal of the program, the number of seniors who choose to attend these institutions is a measure of the quality of student selection in PEP. Two of the current seniors in the program have been admitted to CWRU and will matriculate in Fall 2008, leading the authors to believe that student selection is successful.

Student evaluations indicate very positive results in the initial phase of PEP implementation. While many students initially indicated minimal experience with research and technical communication, all have made improvements. This change was self-reported on surveys (responses of 3.6 initially, to 2.3 after one year in program), and observed in the oral and written communication assignments completed by the students. Additionally, students’ academic and career aspirations have been affected through their experiences in the program. While most students initially expressed interest in becoming scientists and engineers and felt that they were capable of being in such fields (initial response of 1.9), through the program some became more interested in STEM careers (response of 1) and others became less interested (response of 2.8). While the program aims to excite students toward these fields, aiding a student in realizing that this is not her or his area of interest is equally important.

Based on these findings to date, three key recommendations are given for similar programs:

1. Schools need to have a choice on whether they are involved in this type of program to ensure necessary support for students and program activities
2. Students should begin in a program of this type in this type of school district as high school juniors
3. Multiple levels of support (teachers, graduate students, university faculty/staff, etc.) are necessary for student and program success

FUTURE WORK

Suitable comparison groups in the CMSD will be identified to better gauge PEP impact on participants. Three CLiPS partner universities have started PEP sites with local high schools, and future studies will investigate how similarities and differences among the programs impact key program outcomes.

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REFERENCES