2006-2425: A PATHWAY TO SUCCESS: INCREASING MINORITIES IN ENGINEERING THROUGH THE PRE-COLLEGE PIPELINE

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A Pathway to Success: Increasing Minorities in Engineering through the Pre-College Pipeline

Abstract

Several researchers have indicated that African American college student numbers are rising in higher education. However, issues in preparedness to enter college and little knowledge of the university system remain extant with many minority groups. Also, these underrepresented groups are less likely to enter science-related fields. Thus, it is critical that administrators in higher education and other stake-holder groups develop incentives to encourage, support, and assist pre-college underrepresented students to pursue degrees in the science, technology, engineering, and math fields (STEM).

This paper focuses on a pre-college program targeted towards African American pre-college students and sponsored by the Virginia Tech chapter of the National Society of Black Engineers (NSBE) and the College of Engineering's Center for the Enhancement of Engineering Diversity (CEED). The objectives of this paper are two-fold: 1) to describe the structure and implementation of the pre-college program, and 2) to discuss the impact of the pre-college program on the student participants. Since 1999, approximately 500 students have participated in the pre-college program. Phone interviews were conducted to collect data on these participants. The results of these phone interviews provided data on the number of participants who have completed high school, enrolled in college, pursued an engineering degree, graduated from college, and pursued a graduate degree. In conclusion, this paper discusses the impact this pre-college program has on the future enrollment of these pre-college students in higher education and in the STEM fields.

Introduction

Over the past decades, researchers have indicated that African American college student numbers are rising in higher education.[5,2] The American Council on Education (ACE) report indicates that enrollment among African American students grew to nearly 1.8 million students between 1991 and 2001. This is a 37 percent increase; however, issues in preparedness to enter college and little knowledge of the university system remain extant with many minority groups. Also, these underrepresented groups are less likely to enter science-related fields.[8,4,7] Several factors that impede minority groups' academic success before college exist, prolonging or even precluding their graduation from college.

One at-risk factor associated with pre-college students is academic under preparedness. Hick's research indicates that pre-college students may be perceived as having (a) poorer academic and social preparation, (b) lower self-confidence, and (c) inadequate parental support.[6] These issues were carefully examined in first generation students. Another at-risk factor associated with pre-college students is their unrealistic picture of what college entails. It is believed that inaccurate perspectives about the university's complex systems can be a devastating and challenging experience, particularly for African Americans and other minorities entering STEM fields. [3]

Many studies have examined non-cognitive variables to better understand student academic achievement. These studies have several the following experiences in shaping the pre-college student's academic success at the university. The experiences are (a) cultural awareness, (b) personal values, (c) interpersonal skills, and (d) career objectives.[1,9] These experiences are important issues to examine when working with pre-college students due to the students' different experiences within secondary education. Therefore, pre-college students' adaptation to a college environment may vary depending on their encounter with higher education.

Thus, it is critical that administrators in higher education and other stakeholder groups (i.e. faculty, staff, etc.) develop incentives or programs to encourage, support, and assist pre-college underrepresented students. Specifically, administrators can help underrepresented groups to pursue degrees in the STEM fields.

This paper focuses on a pre-college program targeted towards African American pre-college students and sponsored by the Virginia Tech chapter of the National Society of Black Engineers (NSBE) and the College of Engineering's Center for the Enhancement of Engineering Diversity (CEED). The objectives of this paper are two-fold: 1) to describe the structure and implementation of the pre-college program and 2) to discuss the impact of the pre-college program on the student participants. In conclusion, this paper discusses the impact this pre-college program has on the future enrollment of these pre-college students in higher education and in the STEM fields.

History

In spring of 1992, Virginia Tech's Office of Equal Opportunity and Affirmative Action held an internal competition for funds to support programs aimed at increasing the diversity of Virginia Tech's faculty, staff, and students. The competition was open to the entire campus and a broad range of programs were proposed. The student chapter of NSBE was successful in obtaining $2,500 to support a new initiative, the Pre-College Initiative Program (PCI). PCI is a NSBE national initiative and all student chapters are encouraged to develop and implement programs to encourage high school African American students to pursue undergraduate degrees in engineering.

VT-NSBE proposed a Saturday program designed to educate students about the pursuit of a Virginia Tech (or other) undergraduate degree beginning with high school academic requirements through to the application and financial aid processes. Beginning in fall semester 1992, the PCI program has continued to grow and expand. In 1999, CEED and VT-NSBE formed a collaborative effort to create the academic year program that exists today.

Structure

The PCI program is structured around a combination of academic and social activities. This program is designed to strengthen students overall academic knowledge while raising their academic and career aspirations. The students experience exciting hands-on science, math, and engineering activities. In addition, students experience on-going visits to Virginia Tech's campus where they learn about the admissions process, college preparation and college life in

general. The program consists of several events: PCI Kickoff Weekend, Parents and Students Day, Academic and Cultural Awareness Day, Design It Competition, and the Closing Banquet. Each PCI event occurs over a weekend during the academic year.

PCI Kickoff Weekend

The program begins with a weekend event in October, allowing the students to stay overnight on Virginia Tech's campus. Seniors have the opportunity to stay with a college student in their residence hall to sample the residential living of college life. All other students were housed in a local hotel. The following day the PCI students participate in various activities, workshops, and seminars.

Parents and Students Day

The second program takes place on a Saturday in November and includes both PCI students and their parents/guardians. The parents and students are separated into two groups. The main focus of this program is to encourage and support parental commitment for their children's education.

The parents participate in a series of workshops learning financial aid, admissions and other processes of higher education and how to provide a supportive network for their children's education.

This event engages the parents in a variety of sessions designed to provoke them to think about their children's post-secondary education. The parents are given step-by-step instructions to help their child make informed decisions about his or her education. The parents also participate in Virginia View, a workshop providing the parents with numerous materials ranging from websites to find information about colleges to salaries for different types of professional jobs. In keeping with this theme, an accomplished and inspirational speaker speaks to the parents about breaking down barriers for students of color and highlighting success strategies parents can implement to increase their child's opportunity to obtain a higher education degree.

During the parent's workshops, the PCI students are engaged in an interactive design project to stimulate enthusiasm about engineering and science. For example, we had two activities planned for the students. The first was a Boat: Sink or Swim Project where a NSBE volunteer presented relevant physics concepts and explained how these concepts should be applied to the activity. The students are then divided into groups where they are given the necessary materials to design and construct a boat out of marshmallows, toothpicks, and aluminum foil.

The second project is the Take-Apart Lab, which is led by a Virginia Tech professor who teaches this same lab to college freshmen. The professor provides a brief introduction and distributes a guide including questions for the students to answer. This lab is more challenging than the first; the students seemed pleased with themselves knowing that freshmen engineering majors have to do this exact same lab that they are doing.

Academic and Cultural Awareness Day

The third event takes place in early February. The students are given the opportunity to learn about cultural awareness through various activities such as skits, discussion forums, quiz bowl and other activities. At the close of second event, the PCI students are presented with a packet of questions on African American history in preparation for the third program, Academic and Cultural Awareness Day. These questions pertain to the Academic Quiz Bowl. The students are also told to create a poster presentation on an African American in the STEM fields for the poster board competition.

A general outline of the program starts off with encouraging academic excellence with an African American jeopardy-style quiz bowl. The students are separated into a total of six groups. Within these groups, teams compete against each other in a bracket style tournament. Each team is awarded various prizes. This sets the stage for entertainment and a finale of the PCI students performing their Black History skits. In an effort to promote cultural awareness, several organizations performed for the students. For example, the Virginia Tech chapter of the National Pan-Hellenic Council (NHPC) performed a Unity Step. Finally, the PCI students performed their Black History skits. Prior to departure, the PCI students are asked nominate students for various awards to be presented at the Closing Banquet.

Design It Competition

The Design It Competition is the fourth event for the year and takes place in March. This idea was implemented in 2003 at the suggestions of the students. The competition has students research and design a specific project designated by the PCI team. The design project performance is evaluated in a competition style environment for prizes. The intent of the March event is to expose the students to an engineering style approach to solving problems. The first Design It Competition will require the students to research and design a mouse trap car. The car will be required to travel eight feet and stop immediately inside of a one foot diameter circle. The students will be allowed to work in teams. Each student completing this task receives a prize. The students know that that the mouse trap cars are judged on the overall design and aesthetic appeal.

Closing Banquet

For the final program, the academic excellence and community service exhibited by our PCI students throughout the school year is acknowledged. Returning high school students are reminded of PCI plans for following year. Graduating seniors are acknowledged with a plaque, and they have the opportunity to share their experiences and testimony.

Implementation Overview

PCI packets containing information letters and applications are sent to surrounding high school guidance counselors and former PCI participants in late June. The packets are also sent to local clergy in efforts to involve students' community. The local Black Caucus and Black Graduate Student Organization were contacted to enlist their support. Numerous e-mails and phone calls from alumni were received asking for applications to be sent to prospective students.

Prior to the Kickoff Weekend, applications and letters of recommendation are submitted and reviewed for acceptance into the program. A letter is then sent to the accepted students outlining the events and the expectations of the program. At each monthly event, students have to register in order to receive materials for the various sessions. For example, at the PCI Kickoff Weekend registration, students received a welcome bag along with a binder filled with information on engineering majors, an SAT/ACT study book, scholarships and financial aid information and an agenda for the weekend.

Each year, the PCI Chair (a student NSBE volunteer) chooses a theme for the program. The program theme this year is "Paving the Path to Success One Step at a Time." In preparation for this event more than 30 NSBE volunteers help with registration, mentoring, and the overall organization for each weekend. Typically, twelve professional staff members from Virginia Tech who help the PCI students develop a positive attitude towards academic excellence and college preparation through various workshops.

PCI Program Analysis

Since 1999, 471 students have participated in the pre-college program. Phone interviews were conducted to collect data on these participants. One hundred sixty-seven students were contacted for the phone interview. The remaining participants were unavailable. Their phone numbers were either disconnected or changed. Out of the 167 students interviewed, 112 are currently enrolled in high school and 55 are high school graduates. Table 1 displays the interview questions used for this study. Current and past pre-college participants were asked questions about their PCI experience and attending high school and college. Section one of the survey consisted of eight Likert-type questions related to the participants' experience in the pre-college program. Sections two and three includes yes/no and short answer questions about attending high school and college.

Table 1. Phone interview questions

Section 1. PCI Experience

	1 Strongly disagree	2 Disagree	3 Neither agree or disagree	4 Agree	5 Strongly agree
I enjoyed participating in the PCI program.					
The PCI workshops helped me prepare for college.					
I took the PCI workshops seriously.					
The PCI workshops helped me explore becoming an engineer.					
The PCI workshops provided me knowledge to be successful in college.					
I was satisfied with my experience participating in the PCI program.					
The PCI mentoring program helped me prepare for college.					
My mentor provided me information to help me succeed in college.					

Section 2: High school information

	Yes	No
Have you completed high school?		
If yes, do you plan to attend college?		
If yes, do you plan to major in engineering when you go to college?		

Section 3: College/university information

	Yes	No
Are you enrolled in a college/university?		
If yes, where?		
Did you consider coming to Virginia Tech?		
Why or why not?		
Are you studying engineering?		
Did you consider coming to Virginia Tech?		
Why or why not?		
Are you studying engineering?		
What is your major?		
When do you plan to graduate?		
What are your plans after graduation?		

Open ended question

How has PCI impacted your high school, college/university, or life experience?

Table 2. Phone survey data

Section 1: PCI experience

	strongly disagree	disagree	neither agree or disagree	agree	strongly agree
I enjoyed participating in the PCI program.	1%	0%	11%	40%	48%
The PCI workshops helped me prepare for college.	1%	4%	14%	45%	36%
I took the PCI workshops seriously.	0%	3%	14%	36%	47%
The PCI workshops helped me explore becoming an engineer.	3%	9%	36%	24%	29%
The PCI workshops provided me knowledge to be successful in college.	1%	2%	12%	38%	48%
I was satisfied with my experience participating in the PCI program.	1%	1%	10%	37%	51%
The PCI mentoring program helped me prepare for college.	3%	7%	19%	31%	40%
My mentor provided me information to help me succeed in college.	7%	14%	22%	27%	30%

Section 2: High school information

	Yes	no
Have you completed high school?	33%	67%
Do you plan to attend college?	67%	0%

*Section 3: College/university information**

	Yes	no
Are you enrolled in a college/university?	93%	7%
Did you consider attending Virginia Tech?	67%	33%
Are you studying engineering?	11%	89%

**Percentage based on total number of students who have completed high school.*

Results

Out of the 471 participants in the PCI program, 35% (167) of the participants responded to the survey. Table 2 reports the results of these phone interviews. When evaluating the participants PCI experience, 87% (146) of the students enjoyed participating in the program, 81% (137) of the participants agreed that the workshops prepared them for college, 86% (142) of the participants agreed that the program provided them the knowledge to be successful in college, and 55% (88) of the students agreed that the PCI workshops helped them explore becoming an engineer. For the mentoring component of the PCI program, 42% (70) of the participants agreed that the mentoring program helped them prepare for college and 57% (94) of the students agreed that the mentor provided them information to help them be successful in college.

The majority of the phone interviews were conducted by students who are current participants in the PCI program. Sixty-seven percent (112) of the participants are currently enrolled in high school, while 33% (55) percent of the participants have completed high school. Of the 55 students who have completed high school, 93% (51) of the students are currently enrolled in college, 67% (37) of the students considered attending Virginia Tech, and 11% (6) of the students are pursuing a degree in engineering.

Discussion and Conclusion

It can be concluded that the PCI program serves as a feeder program for colleges. Over 90% of the students who have completed high school are enrolled in a two-year or four-year college. This high percentage can be a result of the students and parents' exposure to a college environment and preparation workshops on college admission and financial aid. Participating in the PCI program provides the students an ideal depiction of college, what to expect as a college student, and what to expect when applying for financial aid, grants, and scholarships to fund college. Although PCI participants are attending college, the goal of the PCI program is two fold: 1) to increase the number of African Americans enrolling in college and 2) to increase the number of African Americans students pursuing degrees in STEM fields. The study also revealed opportunities for improvement to help increase the number of students majoring in STEM fields.

The results of this study support the research findings that underrepresented groups are less likely to enter science or technology fields. [8,4,7] After being exposed to the field of engineering in the PCI program, only 11% of the PCI students enrolled in college are pursuing an engineering degree. Instead of engineering, PCI participants are selecting majors in business and communications. This low percentage enrolled in engineering can be a result of the level of exposure to engineering. Compared to other components of the PCI program, fewer students agreed that the PCI workshops helped them explore the possibility of engineering fields. In the future, the PCI program will focus on developing and implementing engineering workshops that encourage and motivate students to pursue college majors in the STEM fields.

The study also revealed that less than half of the participants believe that the mentoring program helps them prepare for college. Studies have concluded that mentorships act as an informal network to increase student success. To improve the number of students pursuing degrees in the STEM fields, the PCI program can enhance the mentoring component of the program. Currently the program is informal with mentor-to-mentee interaction via phone, e-mail, and mail.

Occasionally, the mentor and mentee interact at the weekend events. To improve the mentoring component of the PCI program, the program will develop more structured and monitored activities. In addition to the mentor-to-mentee interaction via phone, e-mail, and mail, mentors should attend and be involved with the PCI events to increase face-to-face interaction with mentees. This face-to-face interaction helps build trust and accountability between the mentor and mentee.

The 35% response rate in this survey is extremely good. However, we realize that we need to create better mechanisms to track the pre-college students (for example, on-line address update, postcard mailings to remind the students to update information, etc). Also, we recognize that we need to develop a stronger survey that will examine the other fields besides engineering. We have identified that a follow-up study will need to be conducted. In that study, the researchers can probe in greater depth why students choose the different STEM fields over other majors.

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