

## **AC 2010-2224: AN ASSESSMENT OF LONG-TERM IMPACTS OF THREE ON-CAMPUS K-12 ENRICHMENT PROGRAMS**

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# **An Assessment of Long-term Impacts of Three On-Campus K-12 Enrichment Programs**

Abstract: Research suggests that exposure to STEM activities during the K-12 years stimulates interest in STEM careers and pursuing post-secondary education. This study examines three K-12 engineering enrichment programs and their influence on college enrollment and graduation rates for past participants of the programs. The programs, conducted by a large public university in the mid-Atlantic, target women and underrepresented minorities and draw most of the program participants from the surrounding economically disadvantaged counties. The first program is week-long summer day camp targeting middle school students. The second is a year-long program hosting two events each semester targeting minority sophomores and seniors. The third is a 2-week overnight summer camp for junior and senior women. To assess the long-term impact of these programs on interest in engineering, we performed telephone surveys of former participants. For each group of participants, a ten-year period was selected which corresponded to current college-age students. During the holidays, undergraduate assistants called home telephone numbers and asked former participants or their parents about enrollment in college, in engineering, and impact of the program. Overall, 582 former participants were identified, and we collected responses from 93 of them. We found that this method works relatively well for high school programs, but the middle-school program had a low response rate due to family relocations and low recollection of the program itself.

## **Introduction**

Although there has been significant increase of women earning engineering baccalaureate degrees, growing from 0.4 percent in 1966 to slightly over 20 percent in 2004, the numbers have plateaued since then <sup>1</sup>. Underrepresented minority (URM) groups earning baccalaureate degrees have increased from 11.5 percent in 1990 to 20.9 percent in 2004 <sup>1</sup>. Anthropological studies indicate that access to capital-rich settings, particularly enhancement programs, contribute to better academic performance for students. Students who participate in such programs remain in school longer and enter college in greater numbers <sup>2</sup>. Based on the findings of this and similar research, several K-12 engineering enrichment programs were developed by the College of Engineering at a large state university in the Southeast with objective of influencing pre-college students to attend college, specifically the host institution, and to major in engineering. This paper describes the programs and the assessment procedures for evaluating the impact of these programs.

The primary objective of these K-12 programs is to increase the students' interest in the field of engineering to the extent that they will be more interested in pursuing a degree in the subject. However, it is difficult to assess whether the programs do have that impact on the future intentions of the students. The purpose of this study is to evaluate how well these programs have met their objective, and to demonstrate our method for others running and evaluating similar programs. The following questions were addressed:

1. Did participation in the program influence the students to attend college?
2. Did participation in the program influence the students to major in engineering?

## **Methods**

### ***Setting and Participants***

The Center for the Enhancement of Engineering Diversity (CEED) within the College of Engineering at Virginia Tech is responsible for increasing the number of underrepresented minorities and women enrolled in engineering. To accomplish this objective the CEED office implements several programs targeted at such students. Among these are three K-12 programs geared to encourage students to pursue post-secondary education (preferably at the host institution) in engineering; the names of the programs are the Imagination and C-Tech<sup>2</sup> summer camps and the Pre-College Initiative.

The Imagination summer camp is a week-long day camp for rising 7<sup>th</sup> and 8<sup>th</sup> grade students. As a day camp, Imagination gets most of its participants from the surrounding counties.

Imagination summer camp, originally called the Academic Enrichment Camp, was first offered in the early 1980's. During the camp the students participate in several hands-on activities that run by volunteering engineering professors and expose the students to engineering concepts. Most of the underrepresented minorities that attend the camp come from the Roanoke City and Martinsville school systems. To accommodate the increasing number of applicants, the camp is run twice each summer on consecutive weeks for a maximum of 45 students each week.

The Pre-College Initiative (PCI) was started in Fall 1993 by the student chapter of the National Society of Black Engineers (NSBE); the CEED office co-sponsorship began in 1998. The goal of PCI is to increase the number of African-American students who are prepared to enter college, ideally majoring in engineering, math, science, and other technical disciplines. Most PCI participants are from surrounding high schools. The PCI activities take place on several weekends throughout the school year including an overnight stay with NSBE members (current students). The program conducts science and engineering-based activities and provides seminars to get familiarized with the college admission and financial aid processes. The number of participants annually varies from 40 to 150 participants.

Computers and Technology at Virginia Tech (C-Tech<sup>2</sup>) began in 1997 as four-week residential summer camp targeting rising junior and senior high school women. Over the years, the program has been scaled down to a two-week experience and has exposed 430 pre-college women to the breadth and depth of engineering as a major and career. During the two-week program, 30 in-state and out-of-state participants live in a residence hall, eat their meals in a campus dining facility, and attend hands-on workshops, seminars, and tours related to all degree granting departments in the College of Engineering, other STEM related colleges, and additional

academic support and student services offices on campus. Ideally, the goal of C-Tech<sup>2</sup> is to recruit participants to apply to and enroll in the College of Engineering at the institution.

Since the beginning of these programs, there have been approximately 3,500 attendees with little, if any, overlap of attendance among the programs.

Ideally, a comparison with a control group of students who did not attend these or similar programs would provide a better evaluation of their effectiveness but finding such a control group is prohibitively challenging, given the length of time that has elapsed since our participants attended the programs.

### ***Sample***

With a twenty-year history to consider, the list of attendees was limited to those students that would now have reached college age and would most likely still be available to be contacted at the home phone numbers provided on their program applications. The list of Imagination (middle school) attendees used was deliberately longer than the list of PCI and C-Tech<sup>2</sup> (high school) attendees as we expected that few of these students would still be available at phone numbers that were at least five years old. This resulted in a list of 177 Imagination attendees, 289 PCI attendees and 116 C-Tech<sup>2</sup> attendees.

### ***Data Collection***

The principal data source for this assessment was a telephone survey conducted with a subset of the attendees of the engineering enrichment programs. Permission to contact the participants for the telephone surveys was obtained from human subjects (IRB) review (#05-568). We first checked the university student databases to determine whether potential participants attend(ed) the institution for engineering or other degrees. Then, phone calls were made to home phone and cell phone numbers of other past attendees to ask about current college enrollment. Verbal consent was obtained prior to beginning the interview, and the age of the participant was verified to be over 18 years old; minors were not allowed to participate. Seven undergraduate assistants used the prescribed telephone script (Appendix A) to conduct the surveys. Of the list of 582 past attendees of the three enrichment programs, 93 participated in the survey. The others had disconnected or changed numbers, did not answer the phone, or declined to participate. In all, 67 PCI participants, 15 Imagination participants and 11 C-Tech<sup>2</sup> past attendees participated in the survey. Table 1 summarizes this information, along with calculated response rates.

**Table 1: Summary of Programs and Participants**

Program Name	Program Format	Target group	Program Participants	Survey Participants	Response Rate
PCI	Several weekend events each semester	African American high school students	289	67	23.2%
Imagination	week-long day camp	Rising 7 <sup>th</sup> and 8 <sup>th</sup> graders	177	15	8.5%
C-Tech <sup>2</sup>	Four week residential camp	Rising high school junior and senior women	116	11	9.5%
Total			582	93	16.0%

**Results**

Results of the survey results for each program can be found in Tables 2-5.

Of the 93 survey participants, 80 percent (n = 74) had already completed high school. Of those who had not completed high school (n = 19), all except one was still attending high school. The majority of survey participants (74%) planned to attend college although only 24% planned to major in engineering.

**Table 2: Aggregated Results of Survey**

**Section 1: High School Information**

	Yes	No	No answer
Have you completed high school?	20% 19	80% 74	0% 0
If yes, do you plan to attend college?	74% 69	5% 5	21% 19
If yes, do you plan to major in engineering when you go to college?	24% 22	24% 22	52% 49

**Section 2: College/University Information**

	Yes	No	No answer		
Are you enrolled in a college/university?	69% 64	28% 26	3% 3		
	Institution	Other	No answer		
If yes, where?	19% 18	49% 45	32% 30		
	Yes	No	No answer		
Did you consider coming to the Institution?	69% 64	24% 22	7% 7		
	Eng	Science	Other	No answer	
What is your major?	24% 22	11% 10	31% 29	34% 32	
	Graduated	< 4 years	> 4 years	No answer	
When do you plan to graduate?	2% 2	60% 56	21% 19	17% 16	
	Work	Grad Sch	Other	Undecided	No answer
What are your plans after graduation?	28% 26	15% 14	7% 6	20% 19	30% 28

Of those who finished high school, 89 percent (n = 66) went on to attend a two- or four-year college; 30 percent (n = 22) majored in engineering, and 14 percent (n = 10) majored in other science-related subjects. Not all survey participants said where they went to university or college. However, of those who reported, 24 percent (n = 18) of high school graduates went on to attend the institution and 61 percent (n = 45) went to other tertiary institutions.

Most of the program attendees surveyed (69%) considered attending the institution, although only 19 percent (n = 18) actually did so. Among the programs, C-Tech<sup>2</sup> and Imagination had the highest percentage of former participants attending the institution with 73 percent (n = 8) and 47 percent (n = 7), respectively. Only six percent (n = 3) of PCI students enrolled at the institution, even though these participants were much closer to college age than middle school aged Imagination camp participants. However, most attended other institutions. All (n = 11) C-Tech<sup>2</sup> attendees, 93 percent (n = 14) of Imagination attendees, and 85 percent (n = 41) of PCI attendees enrolled in college/university after finishing high school.

**Table 3: PCI Results of Survey**

**PCI**

**Section 1: High School Information**

	Yes		No		No answer	
Have you completed high school?	72%	48	28%	19	0%	0
If yes, do you plan to attend college?	66%	44	6%	4	28%	19
If yes, do you plan to major in engineering when you go to college?	7%	5	21%	14	72%	48

**Section 2: College/University Information**

	Yes		No		No answer	
Are you enrolled in a college/university?	61%	41	36%	24	3%	2

	Institution		Other		No answer	
If yes, where?	5%	3	52%	35	43%	29

	Yes		No		No answer	
Did you consider coming to the Institution?	64%	43	27%	18	9%	6

	Eng		Science		Other		No answer	
What is your major?	9%	6	12%	8	33%	22	46%	31

	Graduated		< 4 years		> 4 years		No answer	
When do you plan to graduate?	3%	2	46%	31	28%	19	23%	15

	Work		Grad Sch		Other		Undecided		No answer	
What are your plans after graduation?	10%	7	16%	11	6%	4	27%	18	40%	27

**Table 4: Imagination Results of Survey**

**Imagination**

**Section 1: High School Information**

	Yes		No		No answer	
Have you completed high school?	100%	15	0%	0	0%	0
If yes, do you plan to attend college?	93%	14	7%	1	0%	0
If yes, do you plan to major in engineering when you go to college?	53%	8	40%	6	7%	1

**Section 2: College/University Information**

	Yes		No		No answer	
Are you enrolled in a college/university?	93%	14	7%	1	0%	0

	Institution		Other		No answer	
If yes, where?	47%	7	47%	7	6%	1

	Yes		No		No answer	
Did you consider coming to the Institution?	73%	11	20%	3	7%	1

	Eng		Science		Other		No answer	
What is your major?	53%	8	7%	1	33%	5	7%	1

	Graduated		< 4 years		> 4 years		No answer	
When do you plan to graduate?	0%	0	93%	14	0%	0	7%	1

	Work		Grad Sch		Other		Undecided		No answer	
What are your plans after graduation?	73%	11	13%	2	0%	0	7%	1	7%	1

A comparison among the programs of the choice to enter engineering or a science-related field shows similar results. Eighty-two percent (n = 9) of C-Tech<sup>2</sup> attendees and 60 percent (n = 9) of Imagination attendees went on to major in engineering or a science-related subject while only 21 percent (n = 14) of PCI attendees did the same. Although our sample size is too small to draw conclusions, these results support other research that shows that underrepresented minorities are less likely to enter science and technology fields<sup>3,4</sup>.

Most (69%) of the survey participants were still attending college/university, and 60 percent expected to graduate within four years of the survey. Most of those expecting to take longer to graduate (21%) were still in high school. Twenty-eight percent (n = 26) were planning to find a job after graduating college, 15 percent (n = 14) was planning to go on to graduate school, and 7 percent (n = 6) were pursuing other options, including military service and starting families.

Common reasons for considering attending the institution were that students liked the campus, the people and/or the majors/programs the school offered. While the enrichment programs do not determine any of these aspects of the institution, they do offer the students more exposure to

the campus and its people and inform students of the programs that the school offers, especially in the College of Engineering.

**Table 5: C-Tech<sup>2</sup> Results of Survey**

**C-Tech<sup>2</sup>**

**Section 1: High School Information**

	Yes		No		No answer	
Have you completed high school?	100%	11	0%	0	0%	0
If yes, do you plan to attend college?	100%	11	0%	0	0%	0
If yes, do you plan to major in engineering when you go to college?	82%	9	18%	2	0%	0

**Section 2: College/University Information**

	Yes		No		No answer					
Are you enrolled in a college/university?	100%	11	0%	0	0%	0				
If yes, where?	Institution		Other		No answer					
	73%	8	27%	3	0%	0				
Did you consider coming to the Institution?	Yes		No		No answer					
	91%	10	9%	1	0%	0				
What is your major?	Eng		Science		Other		No answer			
	73%	8	9%	1	18%	2	0%	0		
When do you plan to graduate?	Graduated		< 4 years		> 4 years		No answer			
	0%	0	100%	11	0%	0	0%	0		
What are your plans after graduation?	Work		Grad Sch		Other		Undecided		No answer	
	73%	8	9%	1	18%	2	0%	0	0%	0

In the open response item regarding the impact the program had on the student’s high school, college/university or life experience, participants frequently commented that the program gave insight into college life. Another common response was a better understanding of engineering gained from the program. While this exposure increased some students’ interest in engineering and decreased others, all of these students made better informed decisions. A few students also commented that the program helped them realize how much work it takes to excel in engineering and, therefore, helped them to be better prepared for the transition to college.

**Discussion and Conclusion**

It is difficult to draw strong conclusions on the results of this study as the small number of survey participants may have skewed the results, especially in comparing the results between the programs. Additionally, participants with positive experiences and continued success may have been more likely to participate in the survey, thus biasing the results. Nonetheless, these results indicate that a large percent of attendees of enrichment programs go on to enroll in college or



university. Given the wide range of experiences and exposures, it is impossible to determine the isolated impact of these programs, but the results provide important feedback for improving the programs in the future.

In interpreting all of these results, there are a number of confounding factors to consider. As early as middle school, students make math and science course decisions that impact their preparation for engineering. Thus, interventions at this level are needed, but the impacts of a specific intervention are nearly impossible to trace. Across the three programs, target groups are confounded with program formats. For example, PCI, which targets African American high school students in the local area, had the lowest percentage of alumni attending college. Is this because the activities are distributed during the school year, because they are high school students, because they are African American, or because they live very close to this particular university and may want to attend elsewhere? The literature cites an achievement gap between African-Americans and Caucasians, and this could be exacerbated by the institution's competitive admissions criteria. These results highlight both ways the program itself is falling short of meeting its goals, as well as the need for interventions with the target group.

Overall, the number of students that do major in engineering seems disappointingly low considering the objective of these programs is to increase the enrollment of underrepresented minorities and women in engineering, in particular. However, the comparison among the programs seem to indicate that C-Tech<sup>2</sup>, a women only program, is particularly effective in encouraging women to pursue engineering and other science-related fields. The fact that these attendees are rising juniors and seniors in high school, however, begs the question whether self-selection may be a factor here as well. By this point in their K-12 career most students have some idea as to what they are interested in studying in college. Their attendance in C-Tech<sup>2</sup> may be an effort to either reinforce existing interest in engineering or to pad a resume for college admissions.

The Imagination results are perhaps more indicative of the influence of the program on students' choice of major. The Imagination program caters to rising 7<sup>th</sup> and 8<sup>th</sup> grade students who are less likely to have made a strong career decision. The high percentage (53%) of these past attendees who end up majoring engineering indicates that participation in an engineering enrichment program early in one's K-12 career boosts the likelihood of pursuing an engineering or science-related major at the college/university level. Self-selection is again a concern, but the response rate and positive engineering responses are encouraging for this type of program and assessment.

The PCI program seems particularly ineffective in generating increased enrollment of African-American students in engineering. Perhaps an introduction of a similar program at the middle school level will provide the additional influence that the Imagination seems to have on this demographic group.

Further research on a larger group of past attendees of enrichment programs is needed to provide a more comprehensive assessment of the long-term impact of these enrichment programs on student educational and career choices.

## **Bibliography**

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**Appendix A: Telephone protocol (script) for PCI/Imagination/C-TECH<sup>2</sup> assessment**

Hi, my name is \_\_\_\_, I'm calling from the Institution with a few questions about the [PCI/Imagination/C-TECH<sup>2</sup>] program which was run by [coordinator].

Is [former attendee] available?

I'd like to ask you a few questions about [your] experience with this program. It should take no more than 20 minutes, and your responses will be anonymous. Would you like to participate?

*Section 1: 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 2: College/university information*

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

*Open ended question* [do not ask family members]

How has [PCI/Imagination/C-TECH<sup>2</sup>] impacted your high school, college/university, or life experience?