Assessing the Pro-STEM Impact of an Intensive Summer Program on Secondary Students' Interests in Transportation Careers

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Abstract – The University of Alabama in Huntsville (UAHuntsville) is part of the Federal Highway Administration's Summer Transportation Institute (STI) program to encourage secondary school students to explore a career in the Transportation field. The STI is an intensive four week program that exposes students to careers in science, technology, engineering, and mathematics (STEM). A survey was administered at the conclusion of the 2010 STI to find out more about the students' educational background, demographic characteristics, educational plans, career aspirations, family support for education, and impressions of the STI. The goal of the survey was to determine if the STI program positively influences students' educational and career choices and whether students attending the STI can be shown to have a higher probability of pursuing a STEM major in college. The analysis in this paper reviews the initial findings from the STI completion surveys and how the program affected the students.

Keywords: Longitudinal STEM Programs, Engineering Education

INTRODUCTION

The University of Alabama in Huntsville has been a host site for a Summer Transportation Institute Program (STI) which is funded by the Federal Highway Administration's National Summer Transportation Institute program (NSTI) [5]. The STI is designed to introduce middle and high school students to careers in the transportation industry, construction, science, technology, engineering, and mathematics (STEM). The overall goal of the program is to increase the number of students that eventually enter these career fields. The rising mean age of construction industry workers and shortage of skilled workers has led to concern about the United States' capacity to keep pace with the demand for infrastructure expansion [Welch, 7]. Increased efforts have been made to help bridge this gap by educating and encouraging all STI participants to consider opportunities for skilled individuals in the construction industry and other science, technology, engineering, and mathematics fields.

The STI is a four week program that occurs in the summer. During the program, students are engaged in hands-on sessions, laboratory assignments, computer training, field trips, and presentations from professionals, which are all designed to increase awareness and the likelihood that they will choose a career in a STEM subject, particularly within the field of transportation. Hands-on activities include building bridges, building rockets, and a lab involving electrical sensor kits. Experts from industry also make presentations explaining how they use STEM in their careers and how exciting their careers are. Students also are taken on field trips to the U.S. Space and Rocket Center [6] and other places where they can experience STEM first hand. The STI is designed to convey the excitement associated with STEM and its relevance to success in transportation careers. In addition, the program provides development that allows the students an opportunity to gain insight as they sharpen their overall academic skills.

The effectiveness of the STI cannot be officially measured until the students choose their careers and enter into the workforce. The purpose of this research is to try to assess the effectiveness of the program by surveying current students and analyzing their perceptions of the program. We also collected additional information that allowed us to

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look for other factors that could be impacting the career choices of today's youths. The results of this analysis are presented in this paper.

BACKROUND

In 2006, President George W. Bush announced the American Competitiveness Initiative [4]. This initiative was to provide funding by the federal government to support educational development and progress at all academic levels in the STEM fields. Also, in 2006 the United States National Academies expressed a concern about the declining state of STEM education in the United States [COSEPUP, 2]. One of their top recommendations was to enlarge the pipeline of students prepared to enter college and graduate with STEM degrees. Several programs have been developed to address these concerns under these initiatives.

There have been a declining number of students interested in going into careers in science, technology, engineering, and mathematics (STEM), especially careers in transportation related fields. "There is growing concern that the United States is not preparing a sufficient number of students, teachers, and practitioners in STEM" [Kuenzi, 3]. This is complicated more by the fact that 'Baby Boomers' are rapidly approaching the age of retirement. Over the next several years the gap between the number of jobs available in STEM disciplines and the number of people trained to field those jobs is expected to grow significantly. The STEM workforce is one on which the nation will depend on for innovation and economic prosperity [1]. Thus, increased efforts must be made to help to bridge this gap by motivating and encouraging students to consider these opportunities.

The design of these programs is critical in the efforts to increase the number of students selecting STEM careers. Some students are inevitably lost to the STEM profession when they elect to switch out of STEM to a different major. Getting a larger number of students into the pipeline and encouraging them to persist in STEM should allow more to emerge with STEM degrees and choose a career in this field. The STI program focuses on under-represented minority students as a largely untapped source of candidates for STEM degrees. A survey was developed that tries to measure the effectiveness of the STI. This information will be useful in making modification to the STI and similar programs designed to increase the number of students deciding to major in a STEM subject.

METHODOLOGY

Data was collected from the students attending the 2010 STI program at UAHuntsville at its conclusion. This is the initial phase of a longitudinal study where these students will be tracked throughout their career. That would permit the STI students to be compared to the general population to measure the effectiveness of the STI at encouraging them to pursue a STEM degree. The initial round of data collection consisted of surveys administered to the students participating in the 2010 STI program on the final day. The surveys were anonymous and asked a series of questions about the students' academic performance in various subjects; self-rating of mathematics skills compared to peers; personal aspirations for post-secondary educational achievement; parental aspirations for educational achievement; interest in studying engineering in college; interest in studying other scientific/technical subjects; assessment of whether the STI program assisted in the students' educational decision-making, and demographic characteristics. The education decision-making assessment consisted of asking the students whether the STI program helped them decide about going to college, about studying engineering, and whether they were more or less likely to pursue a college degree in engineering after attending the STI program. The demographic characteristics included the parents' highest educational level achieved, whether family members worked in engineering or science, number of siblings, family structure, primary language spoken at home, student age, student school grade level, race/ethnicity, and gender. Questions about student attitudes utilized a 5 point Likert scale. For example, the survey question assessing student likelihood of studying engineering had responses ranging from definitely yes, probably yes, maybe, probably not, definitely not, and not sure. Several questions ask students to provide a numeric answer (age, number of siblings, etc.) in which the answers have a semi-continuous ordinal answer. Some of the questions had categorical responses with a purely nominal scale. The data was consolidated and analyzed using M.S. Excel for data entry and manipulation, and Minitab 16 for statistical correlation analysis.

The data collected from the survey was coded so that each survey question represented a variable with an ordinal, nominal, or semi-continuous scale. Variables with an ordinal scale were then analyzed as though the code numbers were semi-continuous to see if any interesting trends in the data were apparent. Additional variables were created by recoding several of the original variables as binary values. For example, the variable measuring whether students

were more or less likely to pursue a college degree after attending the STI program was recoded to a value of "1" if the response was more likely or much more likely and to a value of "0" for all other responses. The parents' educational achievement variables were recoded to be "1" if the mother/father earned a college degree or a higher degree and a "0" if not. These additional variables allowed differences in the responses to be more sharply defined for comparative purposes. The race/ethnicity responses led to a set of binary dummy variables to break down the students' responses by individual race/ethnicity component. Several students indicated two or more racial/ethnic categories were applicable so each was handled as a separate category.

The data was analyzed using basic descriptive statistics (mean, standard deviation, range, etc.) and assessment of potential correlations between variables of interest. The data was also organized into tables to spot differences between students' responses when broken into separate race/ethnicity groups and/or by gender.

RESULTS

The sample consisted of 20 male and 20 female students between the ages of 12 and 17 with most around 14 years of age. All the students were members of underrepresented minorities. Most were African-American, one was Hispanic/Latino, and seven indicated they were biracial or multiracial (also selecting Caucasian, American Indian, or Pacific Islander as a secondary or tertiary racial identity). Two students declined to indicate their race/ethnicity. More than half of the students (55%) indicated they had an intact family structure and were living with both parents. The vast majority (70%) spoke English solely while another 20% indicated English was the primary but not the only language spoken at home. Only 25% of the students reported that neither parent had completed a college degree, 30% reported that one parent had completed college, and 45% indicated that both parents had earned a college degree. A substantial number of the students, 70%, had a family member who worked in engineering or science and 15% reported that an immediate family member was an engineer or scientist. The students generally had high aspirations for their educational attainment with 86% intending to pursue graduate school after college. Similarly, 85% reported their parents expected them to complete a college degree and 92% indicated their parents discuss their post-secondary education occasionally or regularly. Overall, the group of students that participated in the 2010 STI program at UAHuntsville had high educational aspirations which were supported by their parents. Most of the students reported high grades (A's and B's) in math and science. There was more variation in reported grades in reading, but overall the students indicated strong academic skills.

In order to test the premise that participating in the UAHuntsville STI encouraged students towards pursuing a STEM degree, the students were asked a series of questions about their interest in attending college, studying engineering/science/math, and whether they were aided in their decision-making by attending the STI program. The results showed some intriguing differences in how male vs. female students responded. Tables 1 through 4 show whether the 2010 UAHuntsville STI students were more likely, unchanged, or less likely to attend college, pursue an engineering degree, or study STEM topics in general after attending the STI.

Table 1 Percentage of Students interested in studying engineering in college by gender

Gender	Yes	Maybe	No or Not Sure
Female	30%	35%	35%
Male	35%	25%	40%

Table 2 Percentage of Students more likely to pursue an engineering degree after attending the STI by gender

Gender	More Likely	No Change	Not Sure or Less Likely
Female	55%	20%	25%
Male	50%	25%	25%

Table 3 Percentage of Students aided by the STI in decision about studying engineering, science, or math by gender

Gender	Yes	Maybe	No or Not Sure
Female	65%	5%	30%
Male	30%	50%	20%

Table 4 Percentage of Students aided by the STI in decision to go to college

Gender	Yes	Maybe	No or Not Sure
Female	65%	5%	30%
Male	40%	25%	35%

Table 5 shows a breakdown by gender of student responses when asked if the STI program aided them in deciding whether to pursue a degree in STEM.

Table 5 Number of Students aided by the STI in decision to go into STEM

Gender	No	Yes	Total
Female	7	13	20
Male	14	6	20
Total	21	19	40

A Pearson chi-square test of the students' gender vs. their perception of the STI aiding the decision to go into a STEM related discipline found a significant association (*p*-value 0.027) between them. The Fisher's exact test had a *p*-value of 0.056. The results show that a higher percentage of the female students reported that the STI experience had assisted them in making a decision about going into a STEM related career.

CONCLUSIONS

The vast majority of these STI students were focused on college and graduate school and expected to complete college degrees. They reported generally doing well in school and having parents supportive of their educational goals. The reaction to the STI program was positive overall. Most felt that it increased their likelihood of pursuing a degree in engineering. The STI program appeared to have a stronger pro-STEM influence on female student participants. The Pearson chi-square results were statistically significant, and they suggest this might be a useful line of future inquiry with more probing questions.

FUTURE WORK

Ultimately, longitudinal data will be required to determine if the students that attended STI earned engineering degrees at a greater rate than their peers who did not attend STI. There are certain important questions that cannot be answered from this initial phase of data collection. Were these students that were already drawn to engineering and likely to have majored in it whether they attended STI or not? What characteristics describe students whose probability of achieving an engineering degree can be increased the most by a pro-STEM intervention like STI? What aspects of the STI program are the most beneficial in engaging students' interest and attracting them to pursue a STEM degree?

In order to better answer these questions, the second round of data collection will focus on surveying the students as they enter the STI program about key demographic and attitudinal characteristics. Subsequent brief surveys will attempt to assess how the experiences of the program have or have not affected the students' perceptions of STEM and their ability to enter a STEM career path. By tracking students' responses through the different parts of the program and knowing what their baseline attitude was towards STEM, it is hoped that the effectiveness of the

UAHuntsville STI program can be measured. Another vital step is to evaluate what percentage of similar students that do not participate in the STI also choose to pursue a STEM degree

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