

# Extended Abstract – Precollege Engineering Participation among First-Year Engineering Students

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**Abstract** - In this extended abstract, we present the preliminary results of a study examining the effects of precollege engineering programs and activities on first-year engineering students. Students in a first-year engineering program at a large public university were asked to fill out a survey detailing their experiences with engineering prior to college. The students indicated the settings where they encountered engineering prior to college, named and described the various activities that they participated in and the approximate amount of time they spent doing each activity. Participants also provided demographic information.

Preliminary results show that at least thirteen percent of students enrolling in first-year engineering classes at the university have had significant exposure to engineering prior to college. High school classes are the most common way that students are exposed to engineering content, followed by extra-curricular activities, middle school classes, and summer camps. While the majority of respondents reported participating in one or two different activities, some reported participating in as many as nine different precollege engineering programs or activities. Students interested in each of the major engineering disciplines responded to the survey; however interest in several disciplines were reported at very different rates than their proportional representation at the university.

This survey represents the first part of a multi-year, NSF-funded study of the effects of precollege engineering programs on first-year engineering students. The results of the survey were used to select a sample of students to interview about their experiences, and analysis of these interviews will be used to construct an instrument to measure the effects of precollege engineering activities in a larger sample population of first-year engineering students.

*Index Terms* – Precollege Engineering, Surveys, College transition.

## INTRODUCTION

Deployment of and participation in K-12 Engineering is growing. The proliferation of formal and informal engineering learning opportunities within the K-12

educational system, the development of educational standards and national assessments focused on engineering [1]-[2], and general support for the inclusion of engineering content at the K-12 level [3] will result in increasing numbers of students matriculating into college engineering programs with significant prior exposure to engineering. In addition to the mathematics and scientific knowledge long recognized as important prerequisites to engineering study, greater number of students will arrive with knowledge, skills and conceptions directly associated with engineering. As the number of students with precollege experiences continues to grow, university engineering programs need to understand how they can best address this changing demographic.

Despite the growing prevalence of precollege engineering programs, research on the effects of participation in these programs on the experiences of students that go on to major in engineering is extremely limited. As a first step in addressing this gap, we created a survey to identify the types and extent of exposure to precollege engineering activities among the first-year engineering students at Purdue University.

## METHOD

Based on existing research on the types of precollege engineering programs [3]-[4], we identified six different potential settings for precollege engineering activities. These were elementary school classroom, middle school classroom, high school classroom, extracurricular activity, summer camp, and university-sponsored precollege engineering activity. We also provided an “Other” option to capture experiences that the students did not believe fit into any of the predefined categories. For each category, the students could list up to four different activities. For each activity, they were asked to provide a name, a brief description of the activity, and the amount of time that they spent on the activity over the course of a year. There were three options for amount of time: one day/less than 10 hours, 10 to 40 hours, and over 40 hours. The respondents also indicated their first choice of engineering discipline and family members or friends who were engineers.

In addition to asking about their engineering experiences, we also asked students to provide demographic and background information. This included gender, race/ethnicity, number of semesters at Purdue, and high

school zip code. International students were not included in the survey.

Prior to administering the survey, we asked for feedback from all of the investigators and advisory board of the project sponsoring this research. We made minor changes mostly to the flow of the survey based on this feedback. We administered the survey online via Qualtrics, and sent a link to the survey to all students who were enrolled in first-year engineering classes in the Fall 2012 or Spring 2013 semesters. Survey data were collected for approximately two weeks in January of 2013. Subsequently, we downloaded the data for analysis using Microsoft Excel.

## RESULTS

Figure 1 shows the settings where the survey respondents encountered engineering prior to attending university. High school classes were the most commonly reported setting, followed by extracurricular activities. Respondents indicating “Other” reported activities like summer internships, hobbies, and conversations with parents. Respondents could indicate exposure to engineering in multiple types of activities, and indicated participating in as many as six different settings.

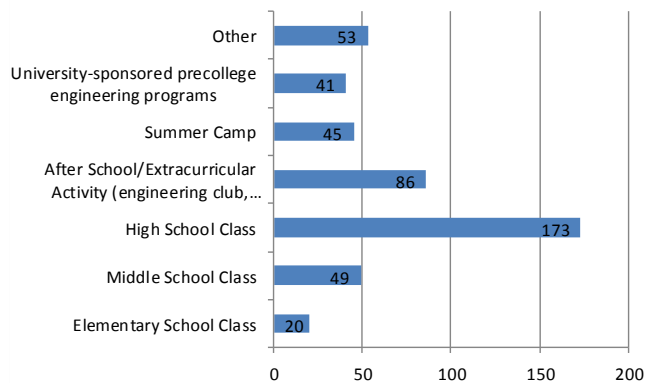


FIGURE 1

FREQUENCY OF PARTICIPATION IN DIFFERENT TYPES OF PRECOLLEGE ENGINEERING ACTIVITIES. (N=247)

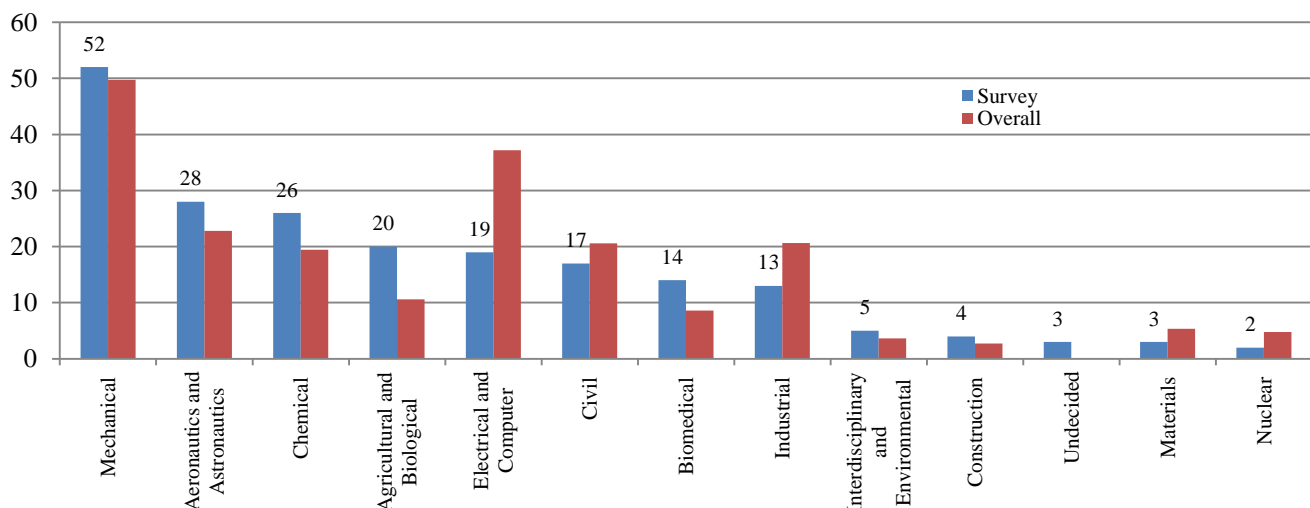


Figure 2 shows the number of different activities reported. While the majority of respondents indicated participating in four or fewer activities, as many as nine different activities were reported.

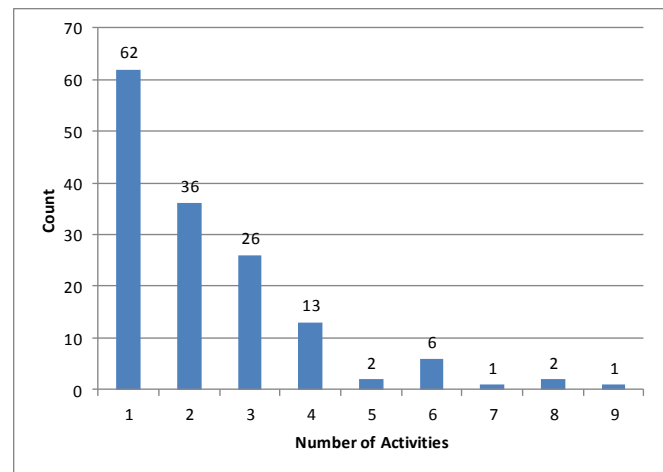


FIGURE 2

NUMBER OF ACTIVITIES PER RESPONDENT. (N=149)

Figure 3 shows the intended engineering major of survey respondents, along with the proportional representation of each of the majors at Purdue. While interest in many of the majors was reported at rates similar to their representation at Purdue University, several majors were different. Aeronautics and Astronautics, Chemical, and Agricultural and Biological Engineering were all reported at higher rates than their representation at the university, while Electrical and Computer and Industrial Engineering were reported at lower rates. The low interest in Electrical and Computer Engineering reported by the respondents was particularly surprising given the prevalence of precollege classes and robotics competitions that expose students to electronics.

FIGURE 3

FIRST CHOICE OF MAJOR INDICATED BY SURVEY RESPONDENTS AND SCALED OVERALL DISTRIBUTION OF ENGINEERING MAJORS AT PURDUE UNIVERSITY.  
(N=206)

A significant number of respondents reported having family or friends that were engineers, as shown in Figure 4. Women make up approximately 22% of the undergraduate engineering population at Purdue but represent approximately 41% of the respondents, as shown in Table I. This is consistent with prior research that suggests that women tend to respond to surveys and higher rates than men [5]. Race and ethnicity representation, shown in Table II, were similar to their rates in the larger First-Year Engineering population, with White students somewhat overrepresented and Black and Hispanic/Latino student somewhat underrepresented in the survey sample.

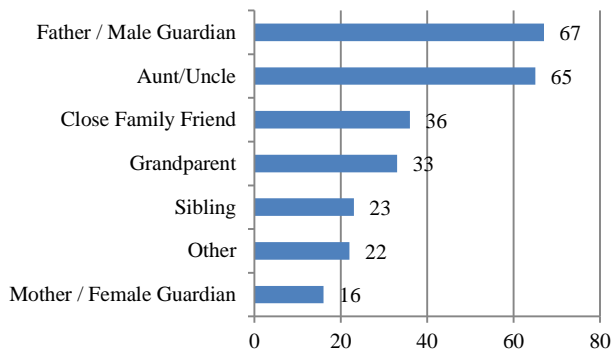


FIGURE 4

RESPONDENTS RELATIONSHIPS TO ENGINEERS

TABLE I

GENDER OF SURVEY RESPONDENTS (N=208)

	Count	Percent
Male	123	59%
Female	85	41%

TABLE II

RACE/ETHNICITY OF SURVEY RESPONDENTS (N=208)

	Count	Percent	Percent of First-Year Engineering Students
White	178	86%	80%
Asian / Pacific Islander	12	6%	7%
Multiracial/Other	10	5%	N/A
Hispanic/Latino	5	2%	5%
Black/African-American	5	1%	3%

## CONCLUSIONS

Purdue University has approximately 2500 First-Year Engineering students, approximately 1800 of whom are domestic students. With 247 survey respondents reporting exposure to engineering prior to college, this indicates that at least 13% of first-year engineering students recognize exposure to engineering prior to attending the university. Given that participation in the survey was by choice as opposed to a randomly chosen sample, it does not allow drawing conclusions about overall precollege engineering participation among first-year engineering students. Even given this limitation, the results of this survey indicate that a

significant number of students have been exposed to engineering prior to matriculation at the university.

Differences in major choice between students that have participated in precollege engineering activities and the overall student population suggest that precollege experiences may be influencing students' choices of major. While some disciplines like mechanical engineering and aeronautical engineering are well represented in precollege engineering curricula and outreach activities, others like industrial engineering civil engineering are much less common. The lack of interest in electrical and computer engineering among the survey is also surprising, and suggests that more work is needed to understand the relationship between precollege engineering experiences and choice of engineering discipline.

## FUTURE WORK

The results of this survey are the first part of a three-year study on the effects of precollege engineering on first-year engineering students. Using the responses to this survey, we have begun to interview a sample of students about their precollege engineering activities and how these activities have influenced their experiences in first-year engineering. This will allow us to explore the variation in students' experiences across a variety of differences such as the amount of exposure to engineering and the settings where they encountered engineering. These interviews will be analyzed and the results used to develop an instrument to measure the extent of the effects of precollege engineering activities in the larger student population across multiple universities.

## ACKNOWLEDGMENT

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