

Engineering Student Interest in Future Work Abroad

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Abstract—This Work-in-Progress paper explores the global work interests of engineering students. Expectancy-value models indicate that interest in working abroad should motivate students to develop global competencies due to utility value. Further, Social Cognitive Career Theory indicates that student interest in international careers may be influenced by personal and environmental factors. This exploratory research used convenience samples of data. In a national survey (17 institutions, 2305 responses), 58% of the engineering students had some interest in living internationally as a factor important in their future careers. Student interest in living in a developing country was higher among female students, decreased with rank in college, and differed by both discipline and institution. Student interest in living in a developed country was higher among female students and varied among institutions. Among incoming first-year civil, architectural, and environmental engineering students at one large public institution, 76-94% had some interest in working on projects outside the U.S. during their career. The results show significant student interest in traveling or living abroad for work. Future research should explore how college experiences influence these global work interests and whether they translate into motivation for learning global competencies.

Keywords—global; international; work interest

I. INTRODUCTION

There has been a push to increase the global competencies of engineering students [1,2]. Students with these competencies will be able to effectively work on international teams, which are becoming increasingly common [3]. While specific global competencies have not been fully defined, a number of elements are commonly cited [4-6]. These include: knowledge and appreciation of other cultures; effective cross-cultural communication; teamwork with diverse individuals; understand global economy; awareness of regulatory and ethical requirements across countries. Global issues are acknowledged to a limited extent under ABET accreditation requirements [7]. Some disciplines include global competencies within the Body of Knowledge (BOK) of the profession, including civil engineering [8], environmental engineering [9], and the NSPE [10]; the BOK for Chemical Engineers [11] and Software Engineering [12] do not include outcomes related to global competencies.

Two theories are relevant to grounding this study. Expectancy-value theory (EVT) [13] posits that motivation for learning, and more specifically educational choices and performance, will be impacted by one's expectancy of success

and subjective task value. Values encompass four areas, with utility value being relevant in this study. If a student had a career goal to work in global settings, this would lend utility value to developing global competencies. The EVT model includes factors that influence goals, across socialization factors and previous experiences. Thus, the EVT model supports research questions around factors that influence future goals related to international work settings. EVT has been previously applied in engineering education studies (e.g. [14], but not specifically in regards in global work interests.

Social Cognitive Career Theory (SCCT) [15] is also relevant in grounding this research. This theory situates career choice goals within a framework of interests that are influenced by learning experiences and person inputs. Thus, this model supports research questions around the career goals of students for international work settings or experiences, and if these goals differ based on learning experiences (e.g. engineering major or institutional factors) or person inputs such as gender or location of upbringing.

Little previous research was found that specifically addressed the global work interests of engineering students. A small study of first-year civil engineering students at a single institution found strong interest in 2011 [16]. In a qualitative study of students who had participated in a global engineering program, interest in living abroad in the future was reported among numerous outcomes [17]. Studies of college students generally have found high student interest in international careers (e.g. 80% moderate to high interest [18]). A 2004 study reported that 60% of Canadian undergraduate business students "considered pursuing a global career with multiple international assignments" [19]. Similar studies with engineering students were not found.

II. RESEARCH QUESTIONS

This research explored the extent that engineering students were interested in working outside the U.S. at some point in their career. Student interest in living abroad in countries with high or low development status was evaluated. Sub-questions explored whether global work interest varied by gender, rank, discipline, or institution.

III. RESEARCH METHODS

This exploratory research used two convenience samples of data to probe the research questions. The preliminary findings would indicate whether further research is warranted.

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The first data source was a survey that was distributed in spring 2013 to students in all engineering majors at 17 institutions; the majority of the institutions only invited undergraduate students to participate in the survey. The third question on the survey asked students to consider qualities personally important when thinking of their future engineering job, denoting the relative importance of eight job characteristics by distributing ten points among these categories. Three job categories related to living location: domestic, international in a developed country, and international in a developing country. The other categories were: salary, helping people, working on industrial/commercial projects, working on community development projects, and own your own business (be self-employed). There were 2305 survey responses. Demographic questions were located at the end of the survey including gender, university currently attending, engineering major (check all that apply), college rank, and did you grow up primarily outside of the U.S. Additional information on the survey methods have been published [20].

Chi-square tests were conducted to compare responses among demographic factors, not including “prefer not to say” responses. The responses from students who indicated multiple majors were recoded into single majors using the following precedence: biomedical, chemical and chemical/biological, environmental, electrical and electrical/computer, computer science & engineering, civil, mechanical (inc. aerospace). Other disciplines had small numbers of respondents (e.g. industrial, materials) and were not included in disciplinary comparisons. The 12 institutions with a student response rate greater than 20% or a 95% confidence interval less than 10% were retained in the data set for institutional comparisons. After recoding the data to the binary categories of no interest (0 points) or interest (1 or more points), binary logistic modeling was conducted using IBM SPSS v. 24. In these models, the independent variables were categorical, with the exception of rank that was ordinal (1=first-year, 2=sophomore, 3=junior, 4=senior and 5th year senior, 5=graduate students). Only the 1957 responses that included all of the demographic characteristics of interest (within the 7 disciplines, etc.) were included in the binomial logistic models.

The second data source to examine global work interests were surveys that were given to first-year (FY) students and senior civil engineering students attending a large public institution. The survey asked students to rate their level of agreement with the statement “I am interested in working on projects outside the U.S. during my career.” The response scale ranged from 1 to 7 (1-strongly disagree, 4-neutral, 7-strongly agree). This item was part of a longer survey that included items related to social responsibility and sustainability. The survey was administered to FY students enrolled in introductory courses for civil, architectural, and/or environmental engineering in fall semesters between 2012-2017 (survey not given in 2013). The seniors were enrolled in a required Professional Issues in Civil Engineering course in fall semesters of 2015, 2016, and 2017. The pre survey was given during the first week of the semester. A hard-copy was distributed during class. Response rates were high, ranging from 68-95%. In some cases, a post survey was also

administered during the last 2 weeks of the semester. Students were provided with a link to an online version of the post survey; response rates were 37-82%. FY environmental students in 2014 and 2015 were given a hard copy of the post survey; response rates were 95-97%. To determine if there were statistically significant differences in the pre- versus post-responses, paired t-tests were conducted. Due to low response numbers, Fisher’s exact tests were used to compare pre-survey data by gender and study abroad participation.

In three years the post-survey for FY students included an extended version of the global work interest question to gather more detail on the type and location of global work interests. The question asked, “Rate your level of interest in working on engineering projects in different parts of the world. Check all that apply for each scenario (more than one response per location is ok).”

One key limitation of the research is that much of the data originated from a single institution. The institution is a large, public, research-focused (R1) program [21]. There is a global engineering minor available to students, which replaced an International Engineering Certificate (started in 2003) and a Global Engineering Certificate (started in 2014). “Global” is also one of the three pillars in the College of Engineering’s strategic plan. There are short-term Global Seminar courses taught by engineering faculty. The percentage of international students among the engineering undergraduates has increased from 4% in 2011 to 12% in 2016. Within civil and environmental engineering, there is strong faculty support and student participation in Engineers Without Borders (EWB-USA), as well as a student chapter of Bridges to Prosperity (B2P).

IV. RESULTS AND DISCUSSION

A. Importance of Work Location Relative to Other Factors

In the national survey that explored future job qualities (n=2305 total respondents), 80% (n=1853) of the respondents placed some importance on where they lived; among those, 58% had some interest in living internationally (n=1080) and 52% preferred to live domestically. Among all respondents, 66% placed some importance on living in the US, 41% placed some importance on living internationally in a developed country, and 23% placed some importance on living internationally in a developing country; 17% had some interest in living in both international settings.

Demographic factors including institution, discipline, and rank impacted these work location ratings (Table I). This may be due to differences among the incoming attitudes of students or the socialization process that occurs around international work in these contexts. Differences by rank were small, with a decreasing trend in interest in living internationally in developing countries with increasing rank. This could be due to students with interest in living in developing countries transferring out of engineering, since the data were not longitudinal. Alternatively, as students’ progress through engineering they may become less interested in working in developing country settings, perhaps due to a better understanding of living conditions, salary differences, or

enjoying domestic internships. A third explanation is that incoming students in fall 2012 (who were first year students in spring 2013) were more interested in living internationally for work than peers who entered college in fall 2014 or earlier. Further research is needed to distinguish retention impacts versus individual change, and reasons individuals change.

TABLE I. PERCENTAGE OF STUDENTS ALLOCATING POINTS TO WORK LOCATIONS (BOLD = HIGHEST; ITALICS = LOWEST)

Group	n	Domestic	Internat'l developed	Internat'l developing
Grew up primarily:		*	*	*
Inside US	2076	67	40	22
Outside US	211	53	52	29
Gender			*	**
Male	1436	67	39	19
Female	814	65	46	29
Rank				*
First year (FY)	272	69	44	28
Sophomore	540	63	42	27
Junior	560	63	40	22
Senior	566	70	42	<i>19</i>
Graduate	208	65	37	20
Institution (examples)		+	*	*
Large, public, R1	544	61	47	26
TechU, public, R2	348	72	35	18
Master's, large, public	219	70	38	<i>13</i>
Religious, R3	157	68	40	18
Private, medium, R1	151	72	42	17
Large, public, R2	138	60	45	28
Religious, Bachelor's	34	53	32	50
Discipline				**
Mechanical	835	69	40	20
Civil	402	66	37	29
Computer	295	66	42	<i>15</i>
Electrical	236	65	41	21
Environmental	225	<i>58</i>	40	37
Chemical	132	59	46	27
Biomedical	112	67	46	25

^a Chi-square tests p + <0.10, * <0.05, **<0.001

Discipline was only a significant factor in interest in living in a developing country. Environmental engineers had the most interest in living in a developing country, much higher than computing. The trends appear to reflect likely job opportunities. Developing countries have large needs for environmental engineers to help provide drinking water and sanitation. However, there are also large needs for biomedical engineering in developing countries, evidenced by the work of Engineering World Health (EWH) [22]. The observed differences among majors may be confounded by percentage of female students (who had a higher global work interest) among the respondents; environmental and biomedical engineering typically have a high percentage of female students [23].

Among institutions, large differences were found among the percentage of students who placed some importance on living in developing countries (13% to 50%) and smaller differences for living internationally in developed countries (32% to 47%). It is likely that the percentage of students participating in international programs at these institutions varies, and interacting with international students may inspire some students to work abroad. Some of the students who participated in the survey may also be international students

attending college in the U.S. and planning to return to their home country. For example, at the large, public R2 university that participated in the study, 17% of the engineering Bachelor's degrees were awarded to foreign students in 2016 [24], compared to 0% at the religious, Bachelor's institution. The impact of institutional factors on student's global work interests warrants further exploration.

When the point data were reclassified into the binary categories of whether or not the student felt that living outside the US in a developing country was important, a binomial logistic model predicted 76.9% of the cases (Cox & Snell R Square 0.074), and factors of significance included gender, rank, major, and institution:

$$\begin{aligned} \text{Work in developing country} = & -0.934 + 0.512 \text{ Female} - 0.195 \\ & \text{Rank} + 0.932 \text{ EnvMajor} + 0.650 \text{ CivilMajor} - 0.973 \\ & \text{ComputerMajor} + 1.29 \text{ ReligiousBachelorU} - 0.688 \\ & \text{PrivateResearchU} \end{aligned} \quad (1)$$

The model results imply that the high interest in working in a developing country among environmental engineering majors was largely due to the large representation of female students.

Binomial logistic modeling was less successful in predicting whether or not a student was interested in living abroad in a developed country (59.1% of cases predicted correctly; Cox & Snell R Square 0.012), and only three factors were significant (whether or not the student grew up primarily in the US or not, gender, and rank).

$$\begin{aligned} \text{Work in developed country} = & 0.321 \text{ Female} - 0.498 \text{ Grow up} \\ & \text{in US} - 0.078 \text{ Rank} \end{aligned} \quad (2)$$

The gender differences were not surprising, as higher participation of women in study abroad and global education experiences has been documented [25-26]. Large differences in the percentage of students participating in study abroad at various institutions has also been documented [25], which may correlate to different institutional cultures around global competency.

The findings related to rank could be due to three different factors: students decrease in their interest in living outside of the US for engineering work as they proceed through college; students have been increasingly coming into college with global work interests; or students with global work interests leave engineering and therefore do not persist to higher ranks. Future research should explore longitudinal trends, including tracking students who leave engineering. Further research should also be conducted to explore if there are particular institutions or engineering disciplines where these trends differ.

B. Interest in Working on Projects Outside U.S.

A high percentage of both first-year and senior students agreed with the statement "I am interested in working on projects outside the U.S. during my career", as summarized in Table II (70% to 94% responded 5, 6, or 7 on the Likert-type scale). Among the incoming FY students (pre), statistically significant differences among civil, environmental, and architectural engineering majors were not found in their Likert-type responses. In 2015, the end-of-semester interest of the civil and architectural engineering students had decreased

significantly (based on paired t-test $p < 0.05$). It does not appear that students decreased between first-year and senior year; for example, the 2014 civil engineering first-year students would become many of the 2017 civil engineering seniors. Note that students may have interpreted this question differently as compared to the national survey. Living internationally on the national survey likely implied a longer work assignment than “working on projects outside the US” which may include distance collaboration or shorter visits.

TABLE II. PERCENTAGE OF STUDENTS WITH INTEREST IN WORKING ON PROJECTS OUTSIDE U.S.

Rank Major	2017	2016	2015	2014	2012
	Pre Post	Pre Post	Pre Post	Pre Post	Pre
FY Arch	NA	94 ³³ 77 ¹³	84 ¹⁹ 73 ¹¹	76 ³⁷ 82 ²²	73 ³³
FY Environ	NA	NA	81 ³³ 80 ⁶¹	83 ⁷⁰ 82 ⁷²	NA
FY Civil	84 ⁶² 87 ⁵³	86 ⁴³ 71 ¹⁷	90 ⁵² 70 ²³	84 ⁵⁰ 80 ²⁵	83 ⁴⁰
Senior Civil	82 ⁵⁶ 74 ⁴²	85 ⁴⁶ NA	75 ¹² NA	NA	NA

Superscripts are number of responses; NA = data not available

Some incoming students evidenced their global work interests on the first homework assignment as they discussed their inspiration for engineering. For example, one student wrote: “Civil Engineering interested me because of the global approach to engineering. I’ve always wanted to go work overseas and help make a difference in the life of at least one person.” Another wrote, “I want to go overseas and help third world countries be able to have clean water to drink. Also, to repay the country that I grew up in, I would like to make an effort to fix the current water systems in America.” Thus, we see an individual who aspires to both global and domestic work in their future.

Limited demographic data were available for the survey takers. Gender differences were not statistically significant, although somewhat more female than male students were interested in working on projects outside the US (incoming FY students: 88%F vs. 85%M, 2012-2017, pre-survey, Fisher’s exact test $p = .58$; civil engineering seniors: 95%F vs. 80%M, 2015-2017, pre-survey, Fisher’s exact test $p = .19$). Among the seniors on the pre-survey in 2016 and 2017, 15 of the 18 who had participated in study abroad (83%) agreed they had some interest in working on projects outside the U.S. during their career; this was not higher than among seniors who had not participated in study abroad.

The post survey in the first-year introductory course gathered more detailed information on students’ international work interests in 2014, 2015, and 2016. Different extents of working abroad in three different types of countries were evaluated, with choice options shown in Table III. There were not statistically significant differences in the level of interest between 2014, 2015, and 2016 (chi-test), so the aggregates of these three years of data are shown. The only statistically significant difference was for living the bulk of one’s career in poorer community: 31% in 2014, 21% in 2015, and 3% in 2016 (chi-test $p < 0.05$). Chi-square tests found that there was a significant difference for all types of international work across the three different types of international settings (i.e. Western-type, rapidly developing, and poor), except in the ‘never’ category. Thus, the students were not equally interested in all

types of international locations, which mirrors the results from the 2013 national survey.

TABLE III. PERCENTAGE OF FIRST-YEAR CIVIL/ARCH. ENGINEERING STUDENTS INTERESTED IN INTERNATIONAL WORK SETTINGS (N=169)

Type of international work	first world countries such as Canada, Australia, or Europe	rapidly developing countries; e.g. India, China, in the Middle East	poorer developing communities, such as in Africa, South America, or Asia
Never	2	6	5
From US using distance collaboration	21	33	28
For a few short-term assignments in-country	53	49	50
Living in-country 1 or more years	54	37	40
Living there the bulk of my career	21	15	22*

* Significant change over time, 2016 different from 2014

V. SUMMARY AND FUTURE WORK

A significant percentage of engineering students had an interest in traveling or living abroad for work. Some students had interests in both developed and developing countries and others had more limited interests. There were differences among students based on rank, institution, and discipline. These generally strong global interests are likely to translate into strong motivation for learning global competencies.

The data from this preliminary study implies that additional research should explore longitudinal trends among students. Additional pre-college factors could be explored, including parental nationality and international travel during childhood. Qualitative methods could be used to determine what factors help to develop international work interests during college, including curricular, co-curricular, and institutional factors. The extent of these global interests should also be explored, distinguishing an interest in short-term assignments versus living abroad for an extended period of time. Researchers should use particular care in the wording of survey items and interview questions, as nuances of project location, work location, and living location are likely important. Further, the language used to categorize different locations in the world may have derogatory or judgmental connotations. Terms like “first world” and “developing” are falling out of favor. Therefore, care should be taken to avoid bias in the language used by the researchers.

Researchers interested in global competency education may wish to explore the full spectrum of EVT, examining students’ expectancy, intrinsic value, attainment value, and relative cost assessment, as well as an expanded consideration of utility value. Based on SCCT, global work interest assessment should be reframed more clearly into the language of career goals. The importance of work location goals could be contrasted against other career goals. Sources of students’ self efficacy around their global work abilities and expectations around these outcomes could also be evaluated in future research.

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