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Internship Prevalence and Factors Related to Participation

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Internship Prevalence and Factors Related to Participation

The value of internship experiences for engineering students is widely discussed in the literature. With this analysis, we seek to contribute knowledge addressing 1) the prevalence of internship experiences amongst engineering students drawn from a large, multi-institutional, nationally representative sample, 2) if the likelihood of having an engineering internship experiences is equitable amongst various student identities, and 3) what additional factors influence the likelihood of a student having an internship experience, such as engineering field.

Data were drawn from a 2015 multi-institutional nationally representative survey of engineering juniors and seniors, excluding one institution with a mandatory co-op program (n = 5530 from 26 institutions). A z-test was used to analyze differences in internship participation rates related to academic cohort (e.g., junior, senior), gender, underrepresented minority (URM) status, first-generation, and low-income status, as well as a subset of identities at the intersection of these groups (gender + URM; first-generation + low-income). A logistic regression model further examined factors such as GPA, engineering task self-efficacy, field of engineering, and institution type.

We found that amongst the students in our dataset, 64.8% of the seniors had "worked in a professional engineering environment as an intern/co-op" (41.1% of juniors, 64.7% of 5th years). Significantly less likely ($p<0.05$) to have internship experiences were men compared to women (52.9% vs 58.3%), URM students compared to their majority counterparts (41.5% vs 56.8%), first-generation students compared to continuing (47.6% vs 57.2%), and low-income students compared to higher income peers (46.2% vs 57.4%). Examined intersectional identities significantly less likely to have an internship were URM men (37.5%) and first-generation low-income students (42.0%), while non-URM women (60.5%) and continuing high-income students (58.2%) were most likely to report having an internship.

Results from the logistic regression model indicate that significant factors are cohort (junior vs senior), GPA, engineering task self-efficacy, and engineering field. When controlling for the other variables in the model, gender, URM, first-generation, and low-income status remain significant; however, the interaction effect between these identities is not significant in the full model. Institution type did not have much impact. Having a research experience was not a significant factor in predicting the likelihood of having an internship experience, although studying abroad significantly increased the odds. Amongst engineering fields, industrial and civil engineering students were the most likely to have an internship, while aerospace and materials engineering students were the least likely.

This analysis provides valuable information for a variety of stakeholders. For engineering programs, it is useful to benchmark students' rates of internship participation against a multi-institutional, nationally representative dataset. For academic advisors and career services professionals, it is useful to understand in which fields an internship is common to be competitive on the job market and which fields have fewer opportunities or may prioritize research experiences. Ultimately, for those in higher education and workforce development it is vital to understand which identities, and intersectional identities, are accessing internship experiences as a pathway into the engineering workforce.

Introduction

An engineering internship experience (or co-op) is widely regarded to be a valuable, and potentially formative, part of an engineering student's education. However, there is a gap in the literature critically examining access to engineering internships for various identities including first generation, low income, and underrepresented minority status students, particularly through an intersectional lens.

This work is one part of a larger NSF REIF grant titled: *The Role of Internships in Developing Engineering Professional Identity for First Generation Low-Income Students*. Grounded in the frameworks of engineering identity and social capital, the larger research questions are:

RQ1. What role do internships play in developing engineering professional identity as students approach entering into the workforce?

RQ2. How do engineering professional identity and the role of internships in forming engineering professional identity differ for FGLI students as they approach entering into the workforce?

RQ3. What are the barriers and supports to internship access for FGLI students?

The experiences of FGLI students have been thoughtfully examined in recent literature, particularly with respect to how these students select and persist in an engineering major [1-12]. However, much of this work focuses on engineering *student* identity and examines early-year college students. This research study with its sequential mixed-methods approach is generating new knowledge pertaining to later-year undergraduate students, how they form identity as a professional engineer as they prepare to enter the workforce, and how that is mediated by FGLI status.

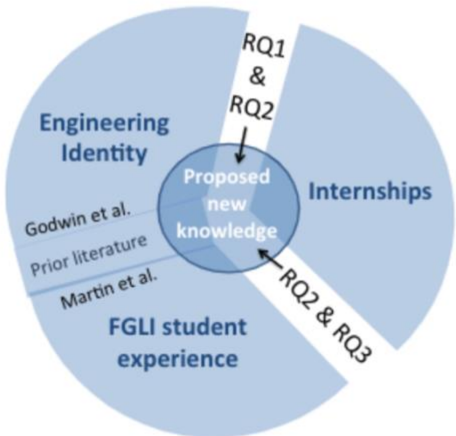

Figure 1: Conceptual map of the larger research study

At this point in the grant, we have done an extensive deep dive into the dataset critically examining 1) the various definitions used in research for "first generation" and "low income" labels, and 2) the impact of using an intersectional lens when considering "first-generation, low-income" students [13]. This paper presents our second deep dive into the dataset exploring the research component of "internship." We are currently operationalizing variables used in the dataset related to the three aspects of engineering professional identity using the Godwin framework to analyze. We have also finalized a protocol for interviews to be conducted in Spring 2021 to probe aspects of the quantitative results further, particularly around access to internship opportunities for first-generation, low-income students, and experiences at the internship that are related to recognition of being an engineer.

Research Questions

For this particular component of the larger work, the research questions are:

RQ1: What is a baseline rate of internship participation amongst engineering students?

RQ2: How does internship participation vary with student identity?

RQ3: What factors impact the odds of a student having an internship experience?

- Does being FG and LI change the odds of having an internship?
  - Is there an interaction effect?
- Does being female and URM change the odds of having an internship?
  - Is there an interaction effect?

Methods

Data were drawn from the Engineering Majors Survey, a 2015 NSF-funded, multi-institutional, nationally representative survey of engineering juniors and seniors, excluding one institution with a mandatory co-op program (n = 5530 from 26 institutions). Details of that survey are found elsewhere [14]. All procedures were approved by the IRB at the authors' institutions.

The variables used in the analysis are shown in Table 1. Details of these variables and how we developed the definitions for 'first-generation' and 'low-income' are provided in our previous work [13].

Specifically, "internship" was defined as having "worked in a professional engineering environment as an intern/co-op." This measure did not distinguish between experiences that took place during the summer as opposed to during the semester, although the question did specify "for one full academic of summer term." We elected to exclude the one institution in the dataset with a mandatory co-op, where over 90% of survey respondents answered 'yes' to this question. We were more interested in internship experiences that are not mandated to graduate, particularly with the larger study exploring potential issues of access to internship opportunities.

A z-test was used to analyze differences in internship participation rates related to academic cohort (e.g., junior, senior), gender, underrepresented minority (URM) status, first-generation, and low-income status, as well as a subset of identities at the intersection of these groups (gender + URM; first-generation + low-income).

A logistic regression model further examined factors such as GPA, engineering task self-efficacy, field of engineering, and institution type. The outcome variable was Internship ("worked in a professional engineering environment as an intern/co-op"). A block stepwise approach included blocks of related variables as shown in Table 1, and then the interaction terms. Interaction terms were created for an interaction between first-generation college and low-income, as well as between female and underrepresented minority. These intersectional identities have been considered in our prior work [13, 15] and allowed us to validate the results as consistent with prior analysis.

Table 1. Variables considered in the analysis *(modified from [13])*

Demographic Characteristics	
FGC	First generation college status defined as neither reported parent 1 or 2 had more a bachelors degree or higher
LI	Low-income status based on self-identification as low or lower-middle family income growing up
URM	Underrepresented racial/ethnic minority status in response to 'racial or ethnic identification' including Latinx, African American, Native American or Pacific Islander*
Female	Question about sex
College Experiences *While an undergraduate, have you done (or are you currently doing) for at least one full academic or summer term: (binary measures where 1 = yes, 0 = no)*	
Internship	Worked in a professional engineering environment as an intern/co-op
Research	Conducted research with a faculty member
Job	Work-study or other type of job to help pay for college education
Study Abroad	Participate in study abroad
Environmental Factors	
Field	Field of engineering, includes 8 fields
Institution	4 classifications based on research/non-research and large/small engineering program
Engineering Task Self-Efficacy	
ETSE	Average of 5 items on a 5-point scale asking 'how confident are you in your abilities to do the following at this time?' (5 being the highest confidence). Sample items include "Design a new product or project to meet specified requirements" and "Conduct experiments, build prototypes, or construct mathematical models to develop or evaluate a design"

***** Respondents were asked to 'mark all that apply'; any respondent that indicated one or more items in a group considered to be an underrepresented ethnicity or race in engineering in the U.S. was coded as URM [20]

Results

RQ1: What is a baseline rate of internship participation amongst engineering students?

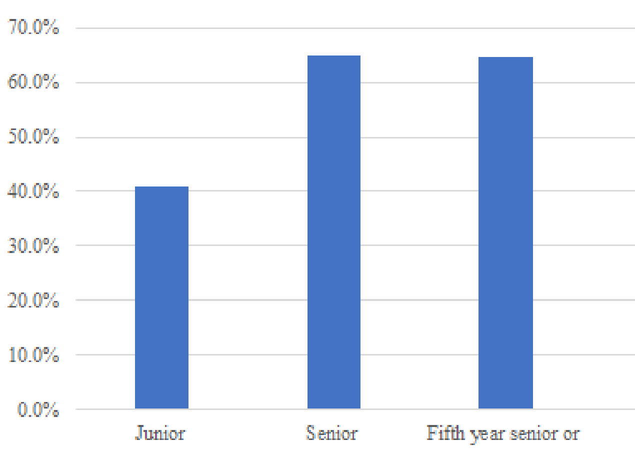

Figure 2. Students having an internship experience broken down by academic standing (ie, class year)

We found that amongst the students in our dataset (excluding mandatory co-ops) **by the time they are seniors, 64.8% of students had an engineering internship experience** (41.1% of juniors, 64.7% of 5th years). Overall, 54.0% of the dataset (n=5530) had "worked in a professional engineering environment as an intern/co-op."

RQ2: How does internship participation vary with student identity?

Significantly less likely ($p<0.05$) to have internship experiences were men compared to women (52.9% vs 58.3%), URM students compared to their majority counterparts (41.5% vs 56.8%), first-generation students compared to continuing (47.6% vs 57.2%), and low-income students compared to higher income peers (46.2% vs 57.4%). Examined intersectional identities significantly less likely to have an internship were URM men (37.5%) and first-generation low-income students (42.0%), while non-URM women (60.5%) and continuing high-income students (58.2%) were most likely to report having an internship.

	URM	**Not URM**	
Female	**47.9%**	**60.5%***	58.3%*
Male	**37.5%***	**55.4%**	52.9%
	41.5%*	56.8%*	**54.0%**

Figure 3. Representation of the percentage internship participation broken out by gender and URM status, including the intersection of these identities. Note: smallest n=112 in this analysis for female URM with internship. * indicates a significant difference from the overall mean at the $p<0.05$ level. Effect sizes calculated with Cohen's h, show that most of the effect sizes are small (below h=0.20) with the exception of URM vs total (0.025) and male URM vs total (0.33).

	FGC	**Continuing**	
Low Income	**42.0%***	**52.2%**	46.2%*
Higher Income	**53.6%**	**58.2%***	57.4%*
	47.6%*	57.2%*	**54.0%**

Figure 4. Representation of the percentage internship participation broken out by first generation college and low income status, including the intersection of these identities. Note: smallest n=256 in this analysis for low income + continuing generation, without internship. * indicates a significant difference from the overall mean at the $p<0.05$ level. Effect sizes (Cohen's h) were all small ($h<0.20$) except the FG+LI vs total (0.24).

RQ3: What factors impact the odds of a student having an internship experience?

Results from the logistic regression model (Table 2) indicate that significant factors are cohort (junior vs senior), GPA, engineering task self-efficacy, and engineering field. When controlling for the other variables in the model, gender, URM, first-generation, and low-income status remain significant; however, the interaction effect between these identities is not significant in the full model. Institution type did not have much impact. Having a research experience was not a significant factor in predicting the likelihood of having an internship experience, although studying abroad significantly increased the odds. Amongst engineering fields, industrial and civil engineering students were the most likely to have an internship, while aerospace and materials engineering students were the least likely.

Table 2. Results of the regression model using Internship as the outcome variable

	B	S.E.	Wald	df	Sig.	Exp(B)
First generation college	-.250	.078	10.183	1	.001	.779
Low income	-.267	.080	11.257	1	.001	.765
Female	.323	.073	19.795	1	.000	1.381
URM status	-.499	.095	27.383	1	.000	.607
Current academic standing	.688	.048	207.645	1	.000	1.989
Overall college GPA	.206	.026	62.689	1	.000	1.228
Research	.017	.072	.056	1	.813	1.017
Job	.321	.064	25.028	1	.000	1.378
Study abroad	.234	.090	6.662	1	.010	1.263
ETSE	.391	.040	95.911	1	.000	1.479
Aerospace Engineering	-.577	.184	9.824	1	.002	.562
Chemical Engineering	-.304	.130	5.495	1	.019	.738
Civil Engineering	.229	.112	4.225	1	.040	1.258
Electrical Engineering	-.166	.097	2.949	1	.086	.847
Industrial Engineering	.434	.167	6.777	1	.009	1.544
Materials Engineering	-.476	.193	6.106	1	.013	.621
Other Engineering	-.479	.091	27.664	1	.000	.619
Research U Small EGR	-.345	.087	15.667	1	.000	.709
Non-Research Large EGR	-.283	.234	1.456	1	.228	.754
Non-Research Small EGR	.038	.085	.195	1	.659	1.038
Constant	-2.057	.171	144.485	1	.000	.128

Note: Comparison group for discipline is mechanical engineering, and for institution type is research university with large engineering program.

Holding constant other factors including year in college, GPA, engineering task self-efficacy, and having a job to help pay for college (all significant predictors)

- a student who is first-generation, or low-income, or both, has lower odds of having an internship compared to their peers benefitting from systemic socioeconomic advantage (OR ~ 0.80),
- a student who is female has higher odds of having an internship, compared to male peers (OR~1.3), and
- a student who belongs to an underrepresented minority race/ethnicity is about half as likely to have an internship, compared to majority peers (OR~0.59).

Finally, an analysis of between-group variance suggested that we should include both discipline and institutional type in our model. Inclusion of these factors changes the odds of the demographic factors in our model slightly but not substantially. There are some interesting and statistically significant disciplinary differences in the odds of having an internship, while the only institution type difference is with research universities with small engineering programs, students are the least likely.

Conclusions and Future Work

This analysis provides valuable information for a variety of stakeholders. For engineering programs, it is useful to benchmark historic students' rates of internship participation against a multi-institutional, nationally representative dataset. For academic advisors and career services professionals, it is useful to understand in which fields an internship is common to be competitive on the job market, and which fields have fewer opportunities or prioritize research experiences. Ultimately, for those in higher education and workforce development it is vital to understand which identities, and intersectional identities, are accessing internship experiences as a pathway into the engineering workforce.

As part of the larger NSF-funded study, we are operationalizing engineering professional identity measures related to questions in this multi-institutional dataset based on Godwin's framework comprising competence, interest, and recognition. These measures will be analyzed to determine the relationship between internship experiences, engineering professional identity, and first-generation and low-income status as mediated by the other variables in the dataset. In addition, semi-structured interviews with first-generation and low-income students with at least one internship experience have recently been conducted, with qualitative analysis of those interviews to begin soon. These interviews seek to elucidate the reasons driving some of the trends seen in this work by probing obstacles to first-generation and low-income students obtaining internship experiences as well as specific internship experiences, tasks, interactions, and incidents that either supported or suppressed engineering professional identity formation for these students.

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