THE EFFECT OF OUTREACH PROGRAMS ON INCREASING FEMALE ENROLLMENT IN ENGINEERING

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Abstract – *The percentage of female undergraduate applicants and first-year student in engineering is increasing in the Faculty of Applied Science and Engineering (FASE) at the University of Toronto (UofT). Outreach programs are used to encourage high school students by gaining exposure and knowledge regarding the field of engineering. The effectiveness of these outreach programs in mitigating academic and social barriers is a key point of interest examined in the paper, specifically those catered directly to female students.*

This research analyzes the growing number of community outreach programs offered at the University of Toronto. We examined the effect of three outreach initiatives: the DaVinci Engineering Enrichment Program (DEEP), the Girls Leadership in Engineering Experience (GLEE), and the Young Women in Engineering Symposium (YWIES). Using statistical data from the FASE outreach office and participation feedback from the events, we compared the enrollment statistics, the percentage of students who chose engineering, and what students found most useful in events. Observations prove that although the events encourage the same number of female students entering engineering, however, suggest that eliminating social barriers and stereotypes influence the increasing number of female-enrollment.

Keywords: women in engineering, diversity, engineering education, university enrollment, outreach programs

1. INTRODUCTION

1.1 Motivation

It is important to increase diversity and equity within society in order to provide everyone with equal opportunities to pursue their goals. In 2016, women comprised only 12.8% of professional engineers in Canada. This falls short of the 30% female engineers by 2030 goal set by Engineers Canada [1]. One of the key factors, in order to increase this percentage, is through

university enrolment in Engineering and motivating female students to choose this career path.

Literature review has not determined a trend between participation in outreach events targeting women in engineering, and more female students enrolling in engineering programs. Universities such as the University of Oklahoma and the Massachusetts Institute of Technology have analyzed their own outreach events, including tours, demonstrations, and activities for high school students to gain a better understanding of the engineering field [2][3]. These schools concluded that outreach does provide a positive outlook for high school students towards the field, however there is no indication whether female students are likely to pursue engineering as a direct consequence of these events [2][3].

This paper investigates whether the positive outlook upon women in engineering, as communicated by outreach events, correlates directly to increases in female enrollment in engineering programs. These women in engineering initiatives can address the barriers that female students perceive when studying engineering. Indeed, Nadelson and Callahan determined that prior to outreach events, female students had a more negative view of engineering and could not picture themselves in the field [4]. However, following two engineering outreach initiatives, Nadelson and Callahan determined that students' perceptions changed through exposure to women in engineering careers [4].

Nadelson and Callahan's study predates recent trends seen by the University of Toronto's (UofT) female-to-male student ratio. In the last decade, there has been strong growth in the percentage of first-year female engineering students in the Faculty of Applied Science and Engineering (FASE) at UofT, nearly doubling from 23% in 2009 to 40.2% in 2018 [5]. Concurrently, the Faculty increased the number of community outreach events aimed at inspiring and encouraging junior high

school and high school students to pursue careers in Engineering.

1.2 Problem Definition

Understanding motivating factors influencing female students to study engineering helps describe the recent enrollment trends. UofT hosts a variety of outreach programs for elementary and high school students. This paper will focus on the prominent high school outreach programs provided by UofT, including the DaVinci Engineering Enrichment Program (DEEP), the Girls Leadership in Engineering Experience (GLEE), and the Young Women in Engineering Symposium (YWIES). These programs all offer hands-on activities as well as alumni industry panels to provide participants with a perspective on engineering.

This paper considers the effect of outreach programs on female enrollment in engineering through the following guiding questions:

- How does participation in outreach programs affect the number of first-year female students?
- How do these events influence participants' views on engineering?

1.3 Selected Methodology

To address the research questions, the following were considered: 1) the annual UofT Performance Indicator Reports (PIR) from 2009-2018, and 2) The Coordinator and Participant Feedback Reports for GLEE and YWIES from 2016-2018.

The PIRs document enrollment rates for female undergraduate engineering students, registration in outreach events, and female participation in these events. An analysis shows quantitative trends in the number of students participating in outreach and qualitative responses regarding the events from the university.

The GLEE and YWIES Coordinator and Participant Feedback Reports explain the decision-making process students undertake when choosing engineering at UofT. These reports were selected from time intervals relevant to periods of increased female enrollment. From the GLEE Reports, the following questions were used:

- “Did you make your final decision about which university/college to attend before or after attending GLEE?”
- “Did GLEE have any effect on your final choice of university and/or program?”
- “Which part of the event did you feel was most useful?”

2. METHODOLOGY

2.1. Performance Indicator Reports

The PIRs from 2009 to 2018 include information published by the University and is publicly available data. The PIRs also discussed the enrollment trends of females in undergraduate students, female participation in outreach programs such as DEEP, and statistics regarding enrollment in other outreach programs at UofT. These reports allow for analytical data analysis used in finding trends in enrollment.

2.2. Feedback Reports

The Coordinator Feedback Reports for GLEE and YWIES from 2016-2018 contains event descriptions, participant enrollment rates, and event feedback from both student participants and the event coordinators. Data collected from these Coordinator Feedback Reports are used alongside the PIRs to develop statistical trends.

The Participation Feedback Reports for GLEE and YWIES are forms completed by the student participants after each year's YWIES and GLEE events. Every year, around 30-35 participants provided feedback regarding their experience in the events, giving a relatively large and stable sample size. Furthermore, these reports offer data in order to analyze the effectiveness of these two programs on the participants' views on engineering and if they were influenced in choosing engineering as a career path.

3. RESULTS AND DISCUSSIONS

3.1. Participation of Outreach Programs

Fig. 1 shows an increase in the percentage of female first-year undergraduate students at UofT. 2015 is where the enrollment percentage started to increase the most, however, it has been concluded that there are no outreach-related factors from that time period which resulted in this increase.

Figure 1. Percentage of Female First-Year Undergraduate Engineering Students

Figure 3: Percentage of Accepted Offers from GLEE Participants

Figure 2. Percentage of Female Enrollment in DEEP Programs

Analysis of the female enrollment in DEEP programs, summer programs catered towards all high school students, shows a relatively steady relationship every year as seen in Fig. 2. Conclusions are made that DEEP participation does not correlate directly to applications into UofT engineering. Other outreach events targeting female students offer similar steady trends.

From the YWIES events, which started in 2014 and are catered to grade 11 female students, data from 2016 and 2018 suggest that 48% and 38% of participants later applied to UofT, respectively. This data suggests that fewer YWIES participants continue to enroll at UofT.

From data analysis of the GLEE reports, Figure 3 suggests a relatively steady, but slightly declining, trend of the number of students who chose UofT Engineering after attending GLEE events. For GLEE, students must be accepted into UofT in order to participate, however, the PIRs show a mean average of 40% of students that were influenced to go into engineering, with slight variance every year analyzed from 2014 to 2018.

Regarding participant feedback, twice as many students had determined prior to GLEE that they were going to enroll at UofT for the upcoming school year, as seen in Fig. 4. However, as shown in Fig. 5, many students still responded that GLEE played a role in their decision to study engineering at UofT.

Figure 4. Responses to “Did you make your final decision about which university/college to attend before or after attending GLEE?”

Figure 5. Responses to “Did GLEE have any effect on your final choice of university and/or program?”

Despite there not being a distinct trend of more female students accepting their offers at UofT for engineering that has increased over the years, more students are being influenced by these programs overall. This result correlates with understanding the effectiveness of these outreach programs.

3.2. Effectiveness of the Programs

Fig. 6 and Fig. 7 were generated from the 2017 Incoming Student Entrance Survey sent out to all first-year engineering students, with around 600 respondents. Although many incoming students know what sector they wanted to work in after their high school graduation (Fig. 6), more than half of these students (Fig. 7) are not familiar with the routines of people who work in those areas, suggesting a need for outreach events to focus on engineering careers post-graduation.

Figure 6. Responses to “I know what I want to do for work after I graduate”

Figure 7. Responses to “I am familiar with the daily routine of people working in my desired career”

Incoming students would benefit from engineers in industry sharing their experiences in applying the knowledge they learned in school to the workforce. Indeed, participant feedback from the GLEE and YWIES outreach initiatives show that industry-related events are of most use to participants, as shown in Fig. 8 and Fig. 9. “Mythbusters” panels provide a question and answer period where common misconceptions regarding studying engineering and working as a female engineer were answered by current female undergraduate students. Keynote events allow a female professor to share her experiences and opportunities within the engineering field, and also provides a greater understanding of the engineering workforce. It is important to note that participants could also give feedback on other events they attended, but less than 10% of respondents chose to share their experiences and they were excluded from the analysis.

Figure 8. GLEE answers to: “Which part of the event did you feel was most useful?”

Figure 9. YWIES answers to: “What part of the Symposium did you find the most useful?”

Data suggests that student enrollment after participating in women in engineering initiatives remained relatively steady after 2014. The larger understanding of engineering education and opportunities after graduation influence more female students to apply for engineering. These outreach events most likely established a positive atmosphere surrounding women in engineering amongst event participants, and this foundation remained a great influence in choosing university programs in later years.

4. LIMITATIONS

The categorization of applicants by in-province, out-of-province domestic, and international students is a limitation of the participant scope. According to Fig. 10, 59.43% of enrolled students attend UofT from in-province high schools, compared to 13.52% of students from other Canadian provinces and 18.24% of students coming from schools abroad (American-based and International Baccalaureate high schools were excluded from these numbers since we cannot determine whether schools following these curricula were in-province or out-of-province). For in-province students, the deadline to accept their offer of admission is the beginning of June; for both out-of-province domestic and international students this deadline is in the beginning of May. Because GLEE is held at the end of May, out-of-province participants had already accepted their offer before the outreach event, and the event itself had no effect on their decision to attend UofT.

Figure 10. Responses to “I completed high school in (select all that are appropriate): ”

In addition, survey results can be biased because more engaged students are more likely to respond to the surveys issued by the Engineering Outreach Office. It is likely that students who are more engaged would be more likely to enroll in UofT. This affects the neutrality of the data gathered, and we cannot determine with complete impartiality that the qualitative feedback is free from participant bias.

The sample size of this study is very small: UofT has numerous outreach programs which were developed within the past five years. We selected only the largest and most influential programs to analyze in this paper because they have reliable data from many past iterations of the programs. For newer programs, there is fewer participant data or feedback gathered because they have operated for only a short duration. In addition, some outreach events serve audiences which fall outside the targeted age range of the outreach events analyzed in this paper. For example, the DEEP events can begin as early as Grade 3 in elementary school, but this event was not considered in this paper because more data would be required to develop a trend in enrollment tendencies of DEEP participants. Future investigations into this research question could track participants in the DEEP initiative from elementary-school participation through to university applications and determine whether continued involvement in women in engineering initiatives influenced them to study engineering.

Future investigations could benefit from analyzing results from only in-province applicants or out-of-province applicants. Furthermore, this paper did not consider whether the reputation of the universities in consideration played any role in applicants’ final acceptance decisions. Continuations into this research

question could investigate whether programs unique to a school – such as cooperative work terms, industry connections, or strength as a research institution – and a school’s academic or social prestige were addressed in outreach events, or if students were more attracted to a school because of these factors.

5. CONCLUSION

Female enrollment in engineering and diversity is an asset to the field, which is why conducting studies on this is important. This research proves to show that the quality of outreach events influences female student enrollment rate by helping prospective female students gain a better understanding of engineering and helping to eliminate perceived barriers facing female applicants and women in engineering.

Numerous outreach programs have been created in recent years to help students make decisions regarding their future. There is no direct correlation between a student’s participation in outreach events and their subsequent enrollment in an engineering degree. However, this paper determined that outreach events which included question-and-answer sessions with current engineers or engineering students addressed an uncertainty that many incoming first-year students faced about career paths upon graduating from an engineering program.

From the outreach programs analyzed, it can be concluded that although outreach programs are not the major determining factor in female enrollment in a quantitative sense, the atmosphere that is created through these events helps foster a sense of community that female students can feel comfortable in and share the common barriers they face, which helps increase enrollment.

This report provides a stepping stone to helping education researchers understand the barriers women in engineering face and how steps can be taken to further increase females pursuing engineering. As society continues to change and the engineering student culture continues to develop and embrace students of varying backgrounds, cultures, genders and experiences, the incoming future engineering classes will reflect this.

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