The Impact of Gender and Extracurricular Activities on Retention Undergraduate Engineering Programs

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Abstract

The goal of this work in progress is to use quantitative surveys, interviews, and focus groups to elucidate how the gender composition of participants in experiential extracurricular activities affects the development of self-efficacy in males and females and to inform how team practices and attributes improve self-efficacy and retention of female and male students in undergraduate engineering programs. The Kate Gleason College of Engineering at the Rochester Institute of Technology (RIT) hosts two automotive-based competition teams. The RIT Hot Wheelz team is predominantly female while the RIT Formula SAE team is predominantly male. Both teams have similar performance goals, but the gender composition, attributes, and practices of the teams are very distinct. Qualitative data from the predominantly female team suggests that among the key benefits of the team is that it provides an environment with psychological safety where female members can be themselves and take risks to learn new skills or take on leadership roles. Participants have also cited the team as having contributed to their confidence and identity as an engineer and as one of the reasons they remained in engineering. Survey data is currently being collected from at least 30 existing and 30 former Hot Wheelz and Formula SAE members to quantify demographic characteristics (including gender and race), year level, and current levels of self-efficacy. Pre-existing validated scales for measuring self-efficacy and psychological safety are being used to assess engineering and career self-efficacy. The survey data will be used to develop interview and focus group questions that further quantify differences in self-efficacy for males and females and to inform how team practices and attributes improve self-efficacy and retention of female and male students in undergraduate engineering programs.

1. Introduction

Initiatives designed to diversify engineering have generated many positive impacts, however, women, racial and ethnic minorities, and persons with disabilities are still severely underrepresented in undergraduate engineering majors and in the engineering labor force [1]. The participation of women, in particular, remains relatively low. Of the engineering bachelor's degrees awarded in 2017, 18% were awarded to women and only 6% of the degrees were awarded to women of color [2]. Within the science and engineering workforce, the disparities are even greater. Only 28% of the college-educated workforce in science and engineering are women and only 15% are concentrated specifically in engineering [3]. A diverse, inclusive engineering labor force has the potential to address a wide range of societal needs and to

generate more innovative technological products and solutions for the 21st century [4-8]. However, to make the engineering workforce more inclusive, it is necessary to first understand barriers to persistence in engineering disciplines as well as practices and activities that could be leveraged to promote the retention of women or other underrepresented populations.

The relationships between self-efficacy and gender are well-documented in the literature and self-efficacy has been suggested as a factor that impacts the persistence and perseverance of women in undergraduate engineering programs [9-12]. Other studies have similarly suggested that extracurricular activities may contribute to the development of self-efficacy [13, 14]. These findings collectively suggest that the intersectionality between gender, self-efficacy, and experiential extracurricular activities may offer an intervention point for enhancing the professional formation of engineers for women or other underrepresented populations. However, what is not known is: (1) how the gender composition of extracurricular activities impacts the development of self-efficacy differently for males and females; (2) if there are underlying psychosocial factors, such as engineering identity or psychological safety, that contribute to development of self-efficacy; or (3) if there are practices or attributes of organizations that could be leveraged to maximize the development of self-efficacy.

The Kate Gleason College of Engineering (KGCOE) at the Rochester Institute of Technology (RIT) offers a unique opportunity to study the intersectionality between engineering-based extracurricular activities, gender, and the development of engineering self-efficacy. KGCOE hosts two undergraduate automotive racing teams, RIT Hot Wheelz and RIT Formula SAE Racing, that both design and build performance racing vehicles to compete in national collegiate racing challenges.

1.1 RIT Hot Wheelz

Hot Wheelz is an undergraduate, predominantly-female racing team at RIT dedicated to professionalism, mentorship, experiential learning, and preparing women for leadership roles through a real world design and build experience. The team was founded in 2012 and includes over 50 women. Each year the team designs, builds, and races a Formula style racecar to compete in a collegiate engineering design series competition. Although the primary objective of the team is to design and build a Formula-style racecar, the team is heavily focused on empowering young women to be confident and to develop leadership qualities. The team seeks to achieve this goal through targeted interventions that occur from the time new members are recruited through graduation and beyond. As part of new member training, all new members participate in hands-on, multidisciplinary training activities and older members are also encouraged to serve as mentors to their peers (*Flat* organizational structure). Each year the team participates in leadership retreats and activities with advisors, corporate partners, and alumnae and members are encouraged to take on leadership roles, even as early as their second year on the team. Opportunities for improving technical and communication skills are also provided through lunch and learn activities or activities with industry-employed alumnae.

1.2 RIT Formula SAE Racing

The RIT Formula SAE racing team is a predominantly male extracurricular experiential team also housed in KGCOE. The team similarly builds a Formula style racecar to compete in the SAE collegiate engineering design series. The Formula SAE Racing team was established in 1991 and has been highly successful in competitions to date, winning numerous national and international competitions. RIT Formula has well-established tiered-based structures in which members are promoted to progressively higher leadership positions based on prior experience and accomplishments (*Tall* organizational structure). In 2019-2020, the Formula SAE Racing team consisted of approximately 36 members, including 12 women, which is similar to the breakdown for RIT.

Table 1: *Structural Differences between Hot Wheelz and Formula SAE Racing Teams*

	Members (# of students)	**Female:Male (# of students)**	**AALANA (# of students)**	**Organizational Structure**
Hot Wheelz	51	50:1	6	Flat
Formula SAE	36	12:24	4	Tall

2. Methods

2.1 Research Questions to be Answered

Extracurricular experiential activities are critical in the professional formation of engineers during both the development of engineering students and the preparation of early career engineering professionals. These informal experiential activities play a significant role in shaping an engineering student's self-efficacy, or perceived level of competence. The goal of this work in progress is to elucidate how gender composition of activity participants affects the development of self-efficacy in males and females and to identify the activity attributes that reduce inequalities and improve career outcomes for underrepresented populations. The specific research questions being investigated include:

Self-Efficacy Development: *How do extracurricular activities shape students' self-efficacy in pursuit of an engineering career; are there differences based on gender and age? What elements, such as contextual supports, are considered critical (positive or negative) for development of undergraduate students' efficacy?*

Professional Development: *What are the practices and attributes of each team environment that promotes engineering and career self-efficacy among team members? How do extracurricular team activities and self-efficacy influence students' assimilation into the engineering workplace; are they, and how are they, the same or different based on gender make-up of the team?*

2.2 Data Collection

Quantitative data for the study will obtained from current team members and alumni from the RIT Hot Wheelz and RIT Formula SAE competition teams using quantitative surveys, interviews, and focus groups. Survey data will be collected from at least 30 existing and 30 former Hot Wheelz and Formula SAE members to quantify demographic characteristics (including gender and race), year level, and current levels of self-efficacy. Pre-existing validated scales for measuring self-efficacy will be used to assess engineering and career self-efficacy. A sampling of survey questions is provided in Table 2. The Psychological Safety scale, developed by Edmondson [15] will also be used to assess team psychological safety. All quantitative data will be analyzed using descriptive statistical methods to reveal underlying patterns and relationships between variable of interest and to connect those trends to the qualitative data. The data will also be used to inform the focus groups and interviews.

Qualitative data for the study will be obtained in part through interviews with current and former project managers for the Hot Wheelz and Formula teams. These individuals will be interviewed to obtain contextual information about team structures, practices for onboarding of new members, training of new and existing members, opportunities for leadership development, team social activities, or other pertinent information about team attributes and practices. The qualitative information obtained through the interviews will be used to provide context about the interventions and practices that each team offers to members during each year of their membership on the team. Focus groups with current and former team members will also be used to obtain qualitative data.

The focus groups and in-depth interviews will be conducted with at least 30 members of each team and at least 30 alumni to capture their lived experiences as member of Hot Wheelz or Formula SAE. The qualitative data collection efforts will include systematic data analysis of interviews where the attributes and practices of the group will also be explored. Current members will also be asked about how the group functions, the benefits or challenges associated with being on the team, their perception of the role of gender on their experiences, and how they think the experiences are preparing them for the future. Alumni will be asked to reflect on their experiences on the team as well as how well the team prepared them for their current role. Data obtained through this process will likely provide information about why team members join a particular team, how members perceive that their experiences on the team are impacted by gender and the gender composition of the team, and about individuals' perceived levels of self-efficacy. The information will be used to identify psychosocial or other factors that may contribute to self-efficacy.

Common themes from the interviews and focus groups will be synthesized with contextual data from the quantitative surveys using a mixed methods approach for synthesizing qualitative and quantitative data. The synthesized data will be used to establish intersectional relationships between self-efficacy, the attributes and practices of each team, and gender-based differences for current team members and alumni.

Table 2: *Sample Questions to Assess Workplace and Career Self-Efficacy*

Question – How confident are you in your ability to…	Assessment of…
Help build a team as a working unit.	Work Self-Efficacy
Be clear when presenting my ideas.	Work Self-Efficacy
Work under pressure.	Work Self-Efficacy
Manage conflict among group members.	Work Self-Efficacy
Solve new and difficult problems.	Work Self-Efficacy
Invent new ways of doing things.	Work Self-Efficacy
When first becoming aware of a problem, try to find out exactly what the problem is.	Work Self-Efficacy
Listen effectively to gain information.	Work Self-Efficacy
Know an organization's long-held traditions.	Work Self-Efficacy
Learn from my mistakes.	Work Self-Efficacy
Coordinate tasks within my work group.	Work Self-Efficacy
Learn to improve on my past performance.	Work Self-Efficacy
Be sensitive to others' feelings and attitudes.	Work Self-Efficacy
Function well at work even when faced with personal difficulties.	Work Self-Efficacy
Listen effectively to understand opposing points of view.	Work Self-Efficacy
Make a plan of your goals for the next five years.	Career Self-Efficacy
Accurately assess your abilities.	Career Self-Efficacy
Determine the steps needed to successfully attain your career goals.	Career Self-Efficacy
Persistently work toward your career goal even when you get frustrated.	Career Self-Efficacy
Determine what your ideal job would be.	Career Self-Efficacy
Choose a career that will fit your preferred lifestyle.	Career Self-Efficacy
Prepare a good resume.	Career Self-Efficacy
Decide what you value most in an occupation.	Career Self-Efficacy
Find out about the average yearly earnings of people in an occupation.	Career Self-Efficacy
Change occupations if you are not satisfied with the one you enter.	Career Self-Efficacy
Figure out what you are and are not ready to sacrifice to achieve your career goals.	Career Self-Efficacy
Talk with a person already employed in the field you are interested.	Career Self-Efficacy
Choose a career that will fit your interests.	Career Self-Efficacy
Identify employers, firms, and institutions relevant to your career possibilities.	Career Self-Efficacy
Define the type of lifestyle you would like to like.	Career Self-Efficacy
Successfully manage the job interview process.	Career Self-Efficacy

3. Discussion and Conclusions

This work in progress study is one of the first to look at the intersectionalities between experiential activities, gender, and self-efficacy with a study design that uniquely enables direct comparisons to be made between equivalent gender-biased organizations. Hot Wheelz team is

one of few predominantly-female teams in the world and is uniquely situated in the KGCOE with Formula SAE, an equivalent, predominantly-male team with a similar focus. The study also seeks to understand how non-traditional experiential activities, such as informal experiences, could be leveraged to impact the development of engineers. The outcomes from the study will provide attributes and practices of experiential extracurricular activities that could be integrated into interventions aimed at improving the self-efficacy of underrepresented populations in engineering.

The work in progress study also seeks to look at psychosocial factors, such as psychological safety, that contribute to self-efficacy and could be leveraged to enhance persistence and perseverance in engineering disciplines. The study of psychosocial safety as a contributing factor in engineering education is unique and environments that offer this safety could provide innovative strategies for engaging underrepresented populations. Thus, the findings from the study have the potential to identify critical practices and traits associated with experiential extracurricular activities that contribute to psychological safety for women and how these ultimately impact the transition from an academic environment to a professional engineering workplace.

Understanding how women and other underrepresented populations develop as engineers is essential for building an innovative and inclusive engineering workforce for the 21st century. Self-efficacy is an established component in the professional formation of engineers, thus results from the proposed study could help refine gender specific theories about how engineers develop. Findings from this work in progress study will be the first to analyze, by gender and age, how self-efficacy develops differently for males and females in informal settings, such as experiential extracurricular activities. The study will also generate information about how the practices and attributes of groups in informal settings contribute to improved self-efficacy. The findings could be used to make recommendations about best practices that could be leveraged to retain a more diverse population in the field of engineering. The long-term goal is to develop strategies that reduce inequalities associated with factors, such as gender, race, or socio-economic status, and broaden inclusivity in the professional formation of engineers.

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