2018 CoNECD - The Collaborative Network for Engineering and Computing
Diversity Conference: Crystal City, Virginia Apr 29

Non-technical Conferences: Impact on Female Engineering Students

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Non-technical Conferences: Impact on Female Engineering Students

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***Abstract*—In academia, it is widely held that attendance at technical conferences is expected of faculty and graduate students. In the past several years, many professional societies have also created space to encourage undergraduate participation. The benefits of attendance includes sharing and learning new research, and networking with individuals in the field. In fact, many institutions provide support for their faculty and students to attend technical conferences. More recently, national conferences focused on professional development have emerged. Rather than focusing on novel research, these venues provide professional development in areas such as mentoring, leadership, empowerment, networking, gender equality, and diversity.**

The study collected data from 38 female engineering students, of all academic levels, before and after attending non-technical conferences. This research presents the correlation between the conference focus and the participants professional and personal development, commitment with current degree, and usefulness of the conference.

Quantitative and qualitative results show attendance at non-technical conferences may have a positive impact in the persistence aspects examined in this study: confidence, role model inspiration, personal and professional impact, and commitment.

I. Introduction and Related Work

ACADEMICS and educators are constantly searching for new strategies to excite, inform, and retain students in science, technology, engineering, and mathematics (STEM) fields [1], [2]. Unfortunately, many students are intimidated by the seemingly unapproachable worlds of STEM academia and industry. However, common methods of introducing undergraduate and graduate students to professional careers are through research endeavors and professional conferences. These opportunities have frequently been credited with improving students' confidence, sense of belonging in their chosen field, and professional skills. However, most of the current research on this topic focuses on technical/research conferences and general student participation. While this information is invaluable, there is an opportunity to narrow the focus of this discussion to specifically investigate the impact of non-technical conferences on women in STEM fields.

The benefits of conference attendance include valuable strategies to better retain women and other minorities in STEM careers. The findings presented in this paper have shown that undergraduate and graduate student attendance at non-technical conferences provide a non-threatening environment for participants that increases both their commitment to STEM careers and confidence in their skills. This research project is the result of a multi-year study where 18 undergraduate and 20 graduate female engineering students were awarded funding to attend non-technical conferences. The conferences focused on a range of topics including leadership, minority identities, and mentoring.

There are a wide range of benefits for undergraduate and graduate student participation in conferences and research such as increasing morale, educational opportunities, professional development, and retention in STEM fields. Seymour, Hunter, Laursen, and DeAntoni [3] focused on liberal arts undergraduate students who presented their research findings at a conference; it was found that these students reported a significant increase in confidence, identity, and skills. Similarly, a study by Russell, Hancock and McCullough [4] examined a pool of students majoring in STEM fields who undertook roles in undergraduate research opportunities and they concluded that participants gain an increased confidence, awareness, and understanding. While both studies indicate a trend of increased personal characteristics and confidence, the findings are limited to undergraduate students who are directly involved in research projects.

In addition to an improvement in intrapersonal skills, relevant studies also exhibit professional development opportunities for students who attend conferences. Multiple studies noted that students benefited from the career fairs, networking events, and structured social events that most professional technical and non-technical conferences offer [3], [5]. Furthermore, a study that focused on potential strategies for increasing the number of students of color in graduate school found that conferences provided opportunities for attendees to gain "real world" and practical experiences [6]. Many of these studies, including those conducted by Seymour et al. [3]; Alonso [5]; and Hamilton, Rogers, and Burton [6] reached these conclusions from qualitative and interview-based research. One area for future studies is to clearly define characteristics that are considered "professional skills" to better track potential improvement due to conference attendance.

It has also been found that conference attendance and research involvement provide supplementary education that can not be replicated in the classroom, and that students' experiences increased their personal interest in STEM careers post-graduation. Multiple studies found that when students attended conferences, they experienced both an increase and an affirmation of STEM career aspirations [3], [4]. More specifically, one study found that conference participation bolstered students understanding of STEM fields and helped

them to visualize the available opportunities [7]. Another study that focused on retaining female undergraduate students in STEM majors found that conference attendance was a "persistence factor," or a factor that motivated the students to remain in their major [8]. The most recent studies on the educational benefits of conference attendance were very broad, focusing on college students in general, and the studies that focus on minority retainment are almost 20 years old. There is an opportunity for new, targeted research that investigates the professional and educational advantages of non-technical conference attendance, particularly for female graduate and undergraduate students in STEM fields.

II. Methods

A. Research Question

This research is guided by the following research questions:

- Does the focus of non-technical conferences influence engineering students' attitudes towards their major?
- What are the perceived learning gains for participants attending non-technical conferences?

B. Data Collection and Assessment Instruments

This study presents data collected during a span of two years, with four collection periods: Spring 2016, Fall 2016, Spring 2017, and Fall 2017. For each collection period, participants completed an application form, conference pre-survey, and conference post-survey. Demographic information was obtained from the participants' application form.

The pre- and post-surveys were created based on programmatic reporting requirements to assess the impact of conference attendance on participants. The pre-survey contained multiple choice questions related to expected conference usefulness, self-efficacy, and self-confidence. The post-survey consisted of multiple choice and open-ended questions that covered self-efficacy, self-confidence, and perceived usefulness of attending the conference. The assessment instruments were built using a combination of questions obtained from the Purdue University Women in Engineering Program archive and Taylor-Powell and Renner's compilation of end-of-session questions [9]. All survey questions were categorized by their emphasis. The pre-survey was available on-line one week prior to the conference, while the post-survey was available for one week after the last day of the conference. In this study we examined post-survey questions related to usefulness and perceived benefits of the conference (refer to Table I).

Participants attended non-technical conferences that were approved by an award committee. Based on their characteristics, the conferences were categorized into four groups; Professional Community, Leadership, Minority, and Professional Development. For classification purposes, Professional Community conferences are characterized by their focus on a specific major or professional community. Conferences designated as part of the Leadership group emphasize mentoring, leadership, and/or coaching topics. Conferences in the Minority group focus on issues related to a specific minority group such as gender identity or ethnicity. Finally, the Professional Development category clusters conferences that offer general professional development topics, such as but not restricted to: advice on career development, networking skills, and creation of equal opportunity.

The quantitative analysis of the responses included calculation of means, frequency, correlation between variables, and multivariate analysis.

C. Sample Selection

To begin each study period, the award competition announcement and application was emailed to all female graduate and undergraduate students majoring in engineering. Spring 2016 and Fall 2016, emails were only sent to those students with a GPA of 3.0 or greater. In Spring 2017, the GPA requirement was lifted and all female graduate and undergraduate engineering students were invited to apply. Note that the program started in Fall 2015 but data collection was not systematic and therefore those awardees are excluded from this study.

The application form consists of applicant personal information (i.e. name, email, phone, major, year, gender, race/ethnicity), conference information, and motivation for attending a non-technical conference. Selection of awardees was student level-blind (graduate or undergraduate), race/ethnicity-blind, and based on responses to three questions: (1) Please indicate why you would like to attend the conference(s), (2) Please indicate how you plan to fully utilize the conference(s) experience, and (3) Please indicate how you will be sharing what you learned at the conference with others. There was no limit on the number of awards that could be granted during each period.

D. Data Analysis

Data obtained from the post-surveys were used in this analysis. The quantitative analysis of multiple choice questions (Table I) included determination of mean and standard deviation for each variable. A GLM analysis was executed to determine the effect of conference focus (independent variable) in conference usefulness rate, conference rate, recommend, commitment, confidence, personal impact, professional impact, and inspiration (dependent variables).

The qualitative analysis was preformed using axial coding on the two open-ended questions (Table I); the initial coding was used to develop categories and themes. Two members of the research team read the transcripts as a whole, and then coded the transcripts individually. The researchers, as a team, created the categories and themes.

III. Results

A. Demographics

The assessments of 38 participants were used for this study. Undergraduate students represented 47.37% (18) of the sample, and 52.63% (20) were graduate students. Note that in the four collection periods, 42 awards were accepted. However, of the 42 accepted awards, three participants failed to complete the pre-survey and at the time of this publication, one had yet to travel.

TABLE I
ASSESSMENT QUESTIONS

#	Question	Variable	Type of Question
1	How would you rate the conference overall?	Conference Rate	Multiple choice:1-Poor, 2-Okay, 3-Good, 4-Excellent
2	Overall, to what extent was this conference useful to you?	Usefulnesses Rate	Multiple choice: 1-Not useful, 2-A little useful, 3-Very useful, 4-Totally useful
3	Would you recommend this conference to other students?	Recommend	Multiple choice: 1-Yes, 2-No
4	The most important thing I learned at this conference was:	Usefulnesses	Open-ended
5	Do you plan to use the information from the conference?	Application	Open-ended: Yes (How), No
6	Increased my commitment to completing my current degree program.	Commitment	6 point Likert scale: 0-Not Applicable, 1-Strongly Disagree, 2-Disagree, 3-Neither Agree nor Disagree, 4-Agree, 5-Strongly Agree
7	Helped build/reinforce confidence in my abilities to be a successful engineering professional.	Confidence	
8	Positively impacted my personal development.	Personal Impact	
9	Positively impacted my professional development.	Professional Impact	
10	Inspired me to emulate the successful women I saw at the conference.	Inspiration	

B. Conferences

The 38 participants attended 14 different non-technical conferences, and those conferences have been grouped according to the classification characteristics previously defined (Table II). Of the attended conferences, 85.71% (12) took place out-of-state and 14.29% (2) in-state, and half of these conferences were specifically for female participants. These conferences offered participants diverse activities, such as but not restricted to career fairs 42.86% (6), networking events 100% (14), competitions 28.57% (4), mentoring or coaching experiences 42.86% (6), and academic components 42.86% (6).

TABLE II
CONFERENCE CLASSIFICATION

Classification	Conference
Professional Community	• Materials Research Society Spring Meeting and Exhibit • DMMM2: diversity in the minerals, metals, and materials profession • Robert H. Goddard Memorial Symposium
Leadership	• National Conference for College Women Student Leaders • IEEE Women in Engineering International Leadership Conference • Indiana Conference for Women • Women Leaders Conference • UNM Mentoring • USNA Leadership Conference
Minority	• Out to Innovate 2017 • Women of Color STEM
Professional Development	• Purdue Annual Conference for Pre-Tenure Women • Society of Women Engineers National Conference • Women in Engineering ProActive Network Annual Conference

C. Conference attendance

A total of 36.84% (14) participants attended non-technical conferences in 2016 and 63.16% (24) in 2017. Using the conference classification detailed in Table II, it is noted that 10.53% (4) students attended Professional Community conferences, 50% (19) attended Professional Development conferences, 34.21% (13) Leadership, and 5.26% (2) Minority conferences.

D. Attitudes towards non-technical conference and degree

1) Quantitative Analysis: General statistics and GLM procedure were obtained from the data collected for the questions detailed in Table I.

- General Statistics
  General statistics of the dependent variables were calculated for undergraduate student participants (Table III), graduate student participants (Table IV), and the total sample (Table V). The variables of conference rate and usefulness rate had a rating scale of 1 to 4 with 4 denoting excellent or totally useful. The variables of commitment, confidence, personal impact, professional impact, and inspiration has a rating scale of 0 to 5 with 5 denoting strongly agree.

TABLE III
UNDERGRADUATE MEAN, STANDARD DEVIATION, MINIMUM, AND MAXIMUM VALUES OBTAINED FOR EACH VARIABLE

Variable	Mean	StdDev	Min	Max
Conference Rate	3.89	0.32	3	4
Usefulness Rate	3.5	0.51	3	4
Recommend	1	0	1	1
Commitment	4.11	1.13	0	5
Confidence	4.67	0.48	4	5
Personal Impact	4.72	0.46	4	5
Professional Impact	4.67	0.48	4	5
Inspiration	4.83	0.38	4	5

TABLE IV
GRADUATE MEAN, STANDARD DEVIATION, MINIMUM, AND MAXIMUM VALUES OBTAINED FOR EACH VARIABLE

Variable	Mean	StdDev	Min	Max
Conference Rate	3.8	0.41	3	4
Usefulness Rate	3.45	0.51	3	4
Recommend	1	0	1	1
Commitment	4.31	0.66	3	5
Confidence, Personal Impact, Professional Impact, and Inspiration	4.75	0.44	4	5

All participants felt compelled to recommend the non-technical conference to other students. Also, it is important

TABLE V
TOTAL MEAN, STANDARD DEVIATION, MINIMUM, AND MAXIMUM VALUES OBTAINED FOR EACH VARIABLE

Variable	Mean	StdDev	Min	Max
Conference Rate	3.84	0.37	3	4
Usefulness Rate	3.47	0.50	3	4
Recommend	1	0	1	1
Commitment	4.21	0.9	0	5
Confidence	4.71	0.46	4	5
Personal Impact	4.74	0.45	4	5
Professional Impact	4.71	0.46	4	5
Inspiration	4.79	0.41	4	5

to highlight that all the participants positively scored their experience.

- GLM procedure
  Using conference classification as the independent variable (Table II), the following p-values were calculated for each dependent variable: conference rate 0.36, usefulnesses rate 0.27, commitment 0.35, confidence 0.69, personal impact 0.58, professional impact 0.47, and inspiration 0.75. The variable recommend was not processed given that all participants answered Yes to that question. The alpha value used in this test was 0.05, thus, there is not enough evidence to support the difference between the outcomes and the conference classifications.

2) Qualitative Analysis: The authors analyzed two open-ended questions for emerging patterns around the perceived impact of participation in non-technical conferences. Analysis of the question "The most important thing I learned at this conference was:" revealed 24 codes, six (6) categories, and two (2) themes. For the second open-ended question "Do you plan to use the information from the conference?", 28 codes, seven (7) categories, and two (2) themes were identified. A summary of the codes, categories, and themes derived from the analysis are found in Table VI and Table VII.

TABLE VI
CODING FOR "THE MOST IMPORTANT THING I LEARNED AT THIS CONFERENCE WAS:"

Theme	Category	Code
Professional development	Workplace	Retention of woman
		Empathy with other women
		Work-life balance
		Tools
		Navigating the environment
		Women issues
	Academic application	Applications in real world
		Innovative ideas
	Networking	Techniques
		Communication strategies
		Build a supportive network
		Keep contact
Personal development	Empowerment	Role model inspiration
		Impact of women
		Self-esteem and self-confidence
		Leadership
		Inspiration
		Guidance
		Mentoring
		Accept imperfections
	Issues	Persistence
		Women recruitment to STEM
	Gender	Diversity
		Equality

IV. DISCUSSION

The aim of this study was to explore the impact of participation at non-technical conferences by determining usefulness of the conference and perceived benefits gained by participation. Student-focused non-technical conferences were specifically selected for this program because they are focused on holistic living rather than just academic pursuits. Such conferences typically allow participants to grow in both personal (e.g. work-life balance, health and wellness, empowerment) and professional (e.g. networking and negotiating) arenas.

Female graduate and undergraduate students in engineering were afforded the opportunity (through a competitive application process) to attend non-technical conferences focused on leadership and/or professional development. It is important to note that the majority of conferences the participants attended are not associated with a national society and they are not typically attended multiple times. This is of particular importance because attendance at a professional conference focused either in a discipline or on a particular group (or membership in such a professional society) enables participants to, over time, build a network and a level of comfort interacting with peers and role models. Outlined below are the demographics of the participants followed by a discussion of the perceived benefits gained by attending a single non-technical conference.

Table VIII shows a breakdown of the number of applications, awards, and accepted awards from Spring 2016 through Fall 2017. Over the course of these 4 periods, 98 total applications were submitted and 56 awards were granted (an award rate of 57%). Of the 56 awarded grants, 42 were accepted giving an acceptance rate of 75%. Of the 42 applicants who did not receive awards, 31% (or 13 individuals) had previously received an award. Figure 1 shows the applicant pool (female undergraduate and graduate engineering students) and the applicants by self-reported race/ethnicity. Fewer applicants of White, 2 or more races, and Unknown race/ethnicity applied than the eligible pool and a larger percentage of applicants who indicated their race/ethnicity as International, Asian, and Underrepresented (URM which includes American Indian or Alaska Native, Black or African American, Hispanic/Latino, and Native Hawaiian or Other Pacific Islander) applied than the overall eligible pool.

Over the course of the study, 56 awards were granted with 27% going to International students and 73% to domestic students (or subdividing the domestic category into self-reported race/ethnicity, there were 9% Asian, 5% URM, and 59% White students). The division of the awardees' self-reported

TABLE VII
CODING FOR: "DO YOU PLAN TO USE THE INFORMATION FROM THE CONFERENCE? YES(HOW:), NO"

Theme	Category	Code
Community	Sharing	With peers
		With students
		With student organizations
	Support	Generate diversity and inclusion
		Involvement in women organizations
		Support women
		Generating change
Individual	Academic	New technical knowledge
		New academic interest
		Academic applications
	Personal	Every-day life
		Self-confidence
	Networks	Networking strategies
		Build Network
		Mentoring relationships
		Maintaining relationships
		Seek mentor's advice
	Workplace	Teamwork
		Work-life balance
		Relaxation techniques
		Focusing techniques
		Leadership tools for workplace
	Job	Offers and negotiations
		Opportunities
		Improving soft skills
		Resume tips
		Financial strategies
		Negotiating salary

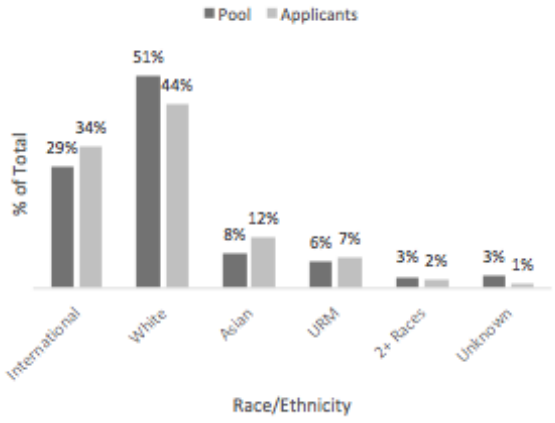

Fig. 1. Applicant pool and Applicants by self-reported race/ethnicity. Included in URM are American Indian or Alaska Native, Black or African American, Hispanic/Latino, and Native Hawaiian or Other Pacific Islander

race/ethnicity aligned well with that of the eligible pool even though the applicant pool saw variation from the eligible pool (as shown in Figure 1). A total of 47 graduate students and 51 undergraduate students applied for the award from a pool that was 27% graduate students and 73% undergraduate students. It is apparent that graduate students, rather than undergraduates, were motivated to apply for the awards. Of the 56 awards granted, 54% went to graduate students and 46% to undergraduate students. Graduate students may have received a greater percentage of awards because some of the conferences either were for graduate students only or focused on graduate students. Another factor could be that graduate students are more skilled at completing competitive applications.

The 98 applicants came from 14 of the 15 engineering departments established at the institution. Not surprisingly, almost 50% of the applicants were from departments with the largest number of women: Agricultural & Biological Engineering, Electrical & Computer Engineering, Industrial Engineering, and Mechanical Engineering. Those departments, along with Engineering Education, saw the largest number of awardees. Overall, the research team is satisfied with the diverse composition of the awardees pool given the applicant pool.

Qualitative and quantitative analysis was performed on the awardee pool. The analysis suggests that attending non-technical conferences has a positive impact on participants. The GLM results for each dependent variable suggest conference focus (Leadership, Professional Development, Professional Community, Minority) does not affect the variables of conference rate, usefulnesses rate, recommend, commitment, confidence, personal impact, professional impact, and inspiration. Additionally, the qualitative analysis suggests that participants found non-technical conferences useful at both a personal and professional level.

Participants provided details regarding the most important thing that they learned at the conference. The results of the analysis shown in Table VI indicate that the codes and themes are equally divided between professional development and personal development. Professional development focuses on the workplace, networking, and academic applications. Personal development focuses around empowerment, issues, and gender. However, one-third of all the codes are grouped into the category, "Empowerment". Participants felt empowered by hearing keynote speakers, acquiring communication skills and strategies, accepting self-perceived imperfections, finding role models, and learning about their potential role as leaders. One participant wrote that she gained "motivation and inspiration to make a change". Another wrote, "I was inspired by the accomplishment of female engineers, both collegiate and professional, in the conference. I realized that I can still improve myself in aspects such as academia and leadership, and felt more confident in continuing studying engineering". Latu, Mast, Lammers, and Bombari [10], suggest that exposure to successful role models can increase performance and self-evaluation of female students in stressful tasks. Non-technical conferences seem to represent a non-threatening environment in which participants feel comfortable to approach role models. In addition to the technical accomplishments of role models, participants get to know the history behind their success, and can relate their own struggles to that of the role model. Also, role models are perceived as approachable and even familiar, when leaving technical knowledge out of the interaction.

Professional development conferences, by definition, are designed for self-improvement. When asked how they plan to use the information gathered at the conference, participants indicated both for individual improvement (as expected) and for community improvement (Table VII). The acknowledgment of the workplace challenges faced by women increased the

TABLE VIII
NON-TECHNICAL TRAVEL AWARD APPLICATIONS, AWARDS, AND ACCEPTED DATA

Academic Period	Applications	Awarded	Awarded Rate	Accepted	Accepted Rate	# of non-awarded applicants that were previous winners
Spring 2016	10	3 (2 previous winners)	30%	3	100%	4 / 7
Fall 2016	28	19 (1 previous winner)	68%	14	74%	4 / 9
Spring 2017	36	17	47%	12	71%	0 / 19
Fall 2017	24	17 (1 previous winner)	71%	13	76%	5 / 7
Total	98	56	57%	42	75%	13/42

participants' intentions of applying what they learned to help the greater female engineering community. One participant noted that they would be "more motivated to support my fellow female engineers - by supporting suggestions and pointing out sexism when it occurs". Another participant wrote that she would use the information to help others as "many of them are women in engineering who are going through some of the struggles of being a female in a male dominated field".

Rosenthal, London, Levy, and Lobel [11] suggest that same-sex environments could increase sense of belonging of the individuals, however, in this study same-sex conferences were not score higher than mixed gender conferences. This could be due to the conferences focus on non-technical skills, and that participants are not under the stress of presenting their work during their conference experience.

Several factors are associated with the gender disparity in STEM fields, including but not limited to: self-confidence, gender stereotyping, lack of female role models, and self-efficacy [12]. This study suggests that non-technical conferences may be a suitable way to offer professional development to female engineering students in an empowering, encouraging, and inspirational environment. Furthermore, the data indicate that participants who attend non-technical conferences could gain valuable academic information which may lead to new areas of academic interest.

High school grade point average and quantitative SAT scores are known to be good predictors for success in engineering majors [13]. While in college, research shows that engineering student persistence improves with student-centered learning as well as co-curricular activities that improve a students' sense of belongingness and their engineering professional identity [14]. Academic programs, such as "Women in Engineering", work to retain female students by increasing self-confidence and identity through dynamic and nurturing offerings that support, affirm, and strategically educate participants. This study shows that non-technical conferences also have a positive impact in participants' personal and professional development as female engineers.

For female engineering students, particularly underclassmen who are more likely to drop out of their engineering degree [15], attending a conference focused on promoting women and/or minorities in STEM can be pivotal for their professional and personal development. Attendance helps them to view themselves succeeding in engineering, offers networking experience, exposes them to inspirational role models in their various fields, and makes them feel welcome in a career path where they are the minority. Opportunities like the ones discussed in this paper also allow students (mainly undergraduate) to have a positive first conference experience, which can be pivotal for students who are interested in attending more conferences, technical or non-technical, in the future.

The principal limitation of this study was the lack of a control group to contrast the results. This travel award program was started from the motivation to provide more professional development opportunities for female engineering students. To that end, data was gathered only around the perceived impact of the participant's experience at a non-technical conference. These initial results could be used to design a more robust study that include other components such as a control group, longitudinal examination of impact, attendance at multiple non-technical conferences, or a comparison of perceived gains from attending a technical conference versus a non-technical conference.

V. CONCLUSIONS

It is well-known that student participation in conferences impact their professional and personal development. This study went further to examine the impact of attending non-technical conferences on female engineering student persistence factors. Participants gained positive benefits from attending non-technical conferences regardless of the conference focus. Additionally, the qualitative analysis suggests that attending non-technical conferences boosts participants personal development around empowerment, persistence, and gender as well as professional development areas of workplace issues, academic applications, and networking. Finally, participants intend to apply the knowledge gained at the conference at both the community and individual level. With the realization that non-technical conferences provide a wide range of professional and personal benefits for female students, institutions should realize that these types of events, if held locally, would be a relatively inexpensive avenue of student development.

VI. FUTURE WORK

This research has shown that students gain benefits from attending non-technical conferences focused on professional development and leadership. Moving forward, it may be interesting to gather data from the participants during the conference to determine when and how self-esteem and self-efficacy were impacted. Additionally, a control group of individuals who did not attend conferences could be incorporated into future studies. Another research path could include the examination of the benefits gained from conferences with a technical focus versus conferences with a non-technical focus. It would also be useful to determine

the long-term impact of the experience by implementing a longitudinal study with participants attending multiple non-technical conferences. Finally, it would be interesting to examine how participants implement the gained benefits into their academic work as well as their job search.

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