

The Community College Pathway: A Study of Women in STEM

Roberta Rincon

Dr. Roberta Rincon is the Associate Director of Research with the Society of Women Engineers, where she oversees the organization's research activities around issues impacting girls and women from elementary through college and into the engineering workforce. Before joining SWE, Roberta was a Senior Research and Policy Analyst at The University of Texas System, where she focused on student success and faculty awards programs across nine academic institutions. Roberta received her B.S. in Civil Engineering from The University of Texas at Austin, an MBA and an M.S. in Information Management from Arizona State University, and a Ph.D. in Educational Policy and Planning from UT Austin.

Erin Carll

Erin Carll is a research scientist at the University of Washington Center for Evaluation & Research for STEM Equity (CERSE). She is a sociologist by training. She is experienced in qualitative, quantitative, and mixed methods. She has instructed a variety of undergraduate courses, including statistics, research practicums, sociology of education, and sociology of housing.

Emily Knaphus-soran

Emily Knaphus-Soran is a Senior Research Scientist at the University of Washington Center for Evaluation & Research for STEM Equity (UW CERSE). Emily has served as the evaluator for several NSF-funded programs aimed at improving diversity, equity, and inclusion in STEM education. Emily earned a PhD and MA in Sociology from the University of Washington, and a BA in Sociology from Smith College. Emily approaches her work with the intention to use her positions of privilege to challenge white supremacy and contribute to building a more just world. In doing so, she acknowledges the risk that her own blind spots and persistent biases could surface in her research, and invites continued discussion of research findings and implications with this in mind.

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Purpose of the Study

Many women begin their postsecondary education at a community college (CC), so encouraging and supporting them on the transfer pathway is critical for addressing the lack of gender diversity in STEM – particularly in engineering and technology. The National Academy of Engineering (NAE) has highlighted the importance of community colleges in broadening participation in engineering because of the diversity they represent [1] [2]. In fall 2019, approximately 41% of Hispanic undergraduates, 38% of American Indian/Alaskan Native undergraduates, and 31% of Black undergraduates were enrolled in two-year colleges in the U.S. [3] Approximately 34% of women undergraduate students attend two-year colleges [3].

Over 80% of first-time CC students intend to complete their bachelor's degree or higher [4]. However, relatively few CC students go on to four-year programs: only 33% transfer, regardless of major [5]. In engineering, over 65% of students who transfer eventually earn an engineering baccalaureate degree [6]. Unfortunately, only about 15% of CC students declare a major in engineering or computer science [7].

Women CC students face particular barriers in pursuing careers in engineering and computer science. Research has found that women students who begin their studies at a two-year institution have higher rates of switching out of engineering and computer science than men [8]. Further, research has found that women learn less about the engineering profession during their time in CC than men [9]. Women in CC also have less confidence in math and science than men [9].

To counteract these factors that contribute to women CC students' lower persistence in engineering and technology programs, the Society of Women Engineers (SWE) developed a pilot program to introduce CC women to engineers and scientists in four-year universities and the workforce. These events were part of the third phase of a research project to investigate persistence in engineering and computer science for women in CCs. Phase III built on the findings from previous work that found that women in CC with an interest in engineering or computer science could benefit from having more information about career pathways in these fields, stronger relationships with engineering professionals, and greater self-confidence in math and science.

The Phase III pilot program included six virtual networking events, three in spring 2021 and three in fall 2021. The aim of the networking program was to (1) provide more information about career pathways, (2) strengthen interpersonal relationships, networking, and mentorship, and (3)

boost confidence through connections with same-gender STEM experts to counteract stereotypes.

Research Questions

The questions guiding the evaluation of the intervention were:

1. Does the STEM networking intervention increase community college women's motivation, self-efficacy, and confidence in engineering and computer science?
2. Does the STEM networking intervention result in greater retention of community college women in engineering and computer science programs?

Conceptual Framework

Archer et al. proposed the concept of “science capital” as a theoretical lens to help explain why some students have intentions to pursue science careers, have different levels of science self-efficacy, and see themselves as a “science person” [10] [11]. This theory builds on Bourdieu's theory of cultural capital – that the relevant attitudes, knowledge, information, skills, and resources that an individual possesses can contribute to one's power and progress [12]. An individual's social network can serve to provide access and information that help a student navigate and persist on the CC pathway in engineering and computer science. This network can include parents and family members, friends, teachers, mentors, and advisors.

For this study, the project team sought to explore the impact of exposing women in CC to women in four-year university engineering degree programs and women in the STEM workforce on their motivation, self-efficacy, and confidence to complete a degree in engineering or computer science (or STEM broadly). The expectation was that introducing women students to other women in STEM in a non-intimidating way would lead to greater information-sharing and access to resources that would encourage students to stay on the STEM education pathway.

Methodology

Surveys were sent to registered participants before each virtual event took place. Immediately after each event, a post-event survey was sent to those who attended. In addition to the pre- and post-event surveys, a six-month follow-up survey was sent to those who attended the spring 2021 events.

Surveys collected demographic information, including gender, race/ethnicity, undergraduate major, occupation, etc., and attendees' perceptions of the events. Pre-event surveys were sent to everyone who registered, and post-event and follow-up surveys went to all who attended, regardless of gender, major, or student status. For undergraduate students, there was a series of

survey questions that asked them to self-report about their abilities and their expectations for the future.

Due to a shift between the spring and fall events in the Institutional Review Board requirements for the project, there were two methodological changes. First, demographic information was collected only on the registration form for the three spring events, and not on the subsequent surveys. For the fall events, demographic information was collected on the surveys and not on the registration form. Therefore, demographic information for those who attended the spring events but did not complete surveys is available, but those who attended fall events and did not complete surveys is not. Second, data from the three spring events only include people that reported being 18 years of age or older, while fall surveys include minors.

A total of 132 people attended across the six virtual networking events. Of these, 84 provided demographic information, and 56 were undergraduate students. Of the 56 undergraduates, 18 reported attending a two-year college. In addition, five attendees were graduate students, and the remainder were working professionals in various fields. Table 1 presents a summary of demographic statistics.

The small number of respondents resulted in insufficient statistical power to draw inferential conclusions. This paper presents descriptive statistics for responses received from CC students, undergraduate students, and all respondents, as appropriate.

Average age:	26 years old (median age = 23 years old)
Gender	96% women 3% men 1% agender
Race/ethnicity	35% non-Hispanic White 15% non-Latino Asian 15% non-Latino Middle Eastern, North African, or Arab 12.5% non-Hispanic Black, African, or African American 12.5% Hispanic, Latino/a/x, or Chicano/a/x 5% multiple races/ethnicities 1% American Indian or Alaska Native

Table 1: Survey respondent demographics

In addition to the quantitative survey responses collected, the surveys also included several open-ended questions, allowing researchers to gain insight into the perceived value of the events. A handful of interviews with students who registered to attend the spring 2021 events, only some of whom ultimately attended an event, were conducted in the summer to gain a greater understanding of their experiences on the CC pathway and ways in which professional

engineering associations (PEAs) can better support them on their journey towards a career in engineering or computer science.

Networking Program Overview

Given the results from prior research that found that women in CC STEM programs were less likely than men to know anyone who worked in engineering or technology or know what an engineer does, SWE sought to provide opportunities for students to engage with women in engineering and computer science four-year programs (with the goal of encouraging transfer to complete a bachelor's degree) and with women in the science, engineering, and technology workforce. Initially, the networking events were planned to be held in person. Due to COVID-19 precautions, the events were offered virtually instead.

In the spring, the three virtual events included a moderated panel discussion for the first hour of the program, followed by small group discussions focused on specific topics of interest, including “Different Types of STEM Careers,” “Promoting Your Identity,” and “Mentoring.” The virtual platform selected to host the spring events was Remo, which allowed participants to move around virtual discussion tables and interact with facilitators and other attendees.

In the fall, the three virtual events included only one presenter/speaker using the Zoom platform, followed by a more interactive group session using Google Jamboards that allowed attendees to respond to pre-determined questions in a variety of ways, including with images, text, or voice. The purpose of this exercise was to encourage interaction in a less intimidating way for those who might be hesitant to respond verbally.

Events were promoted through SWE's newsletters and social media, as well as shared through SWE's professional network – including other PEAs, the 50k Coalition, and the NSF INCLUDES National Network.

Results

Research question #1

To help understand the impact of the networking intervention on CC women's motivation, self-efficacy, and confidence in engineering and computer science (RQ #1), researchers asked undergraduate students whether the event they attended helped them grow in a variety of ways:

- Over 80% agreed or strongly agreed that the event expanded their understanding of the potential career/educational pathways available as a STEM student.
- Over 90% agreed or strongly agreed that the event helped them see themselves as a part of a broader STEM community.

- Over 80% agreed or strongly agreed that they felt more confident in their ability to succeed in their desired career/education pathway.
- Approximately 80% agreed or strongly agreed that they met people in the STEM industry who could be valuable resources for them.

A second survey question asked undergraduate students to rate themselves on specific traits as compared to their classmates, including self-confidence, science ability, and communication ability. This question was asked on both the pre-event survey and the post-event survey, and responses were compared:

- 37% rated themselves higher on the post-event survey in terms of confidence.
- 26% rated themselves higher on the post-event survey in science ability.
- 42% rated themselves lower on the post-event survey in terms of communication ability.

Another survey question asked undergraduate students to indicate how much they agreed or disagreed that they can succeed in a variety of ways in engineering/computer science:

- The majority of students responded on both the pre-event and post-event surveys that they slightly agreed, agreed, or strongly agreed that they could succeed in all areas of their engineering/computer science curriculum, including math courses, physics courses, and engineering/computer science courses. After the events, between 21% to 36% of students agreed more strongly that they could succeed in these courses than they had prior to the event, while between 7% to 15% agreed less strongly.
- Expectations of success in the curriculum without having to sacrifice other interests saw an increase in the number of students who agreed more after the event than before it.
- 20% more students reported on the post-event survey that they felt that someone like them could succeed in an engineering/computer science career than did on the pre-event survey.

Research question #2

Unfortunately, the response rate for the six-month follow-up survey was too small to allow for adequate analysis to determine if the STEM networking intervention resulted in greater retention of CC women in engineering and computer science programs (RQ #2). However, the survey responses did provide insight into students' expectations for the future.

To assess whether undergraduate students intended to pursue careers in engineering or computer science, researchers asked about their plans to pursue a career in engineering/computer science or another STEM field.

- On the post-event survey (compared to the pre-event survey), students reported more confidence in pursuing a career in engineering/computer science, and slightly less confidence that they would pursue a career in another STEM field.
- Of those students who responded to both the pre-event survey and the post-event survey, 20% reported being more likely to pursue a career in engineering/computer science.

Researchers asked undergraduate students how confident they were that their engineering/computer science career would be fulfilling:

- After the event, all students who indicated an intention to pursue an engineering/computer science career slightly agreed, agreed, or strongly agreed that their degree would enable them to find a job that is well paying, and almost all agreed that their degree would allow them to get a job where they could use their talents and creativity.
- Some students were less confident on the post-event survey than on the pre-event survey that they would be treated fairly on the job (20% agreed less), that they would feel “part of the group” on the job (over 10% agreed less), and that their degree would help them get a lifestyle they desire (almost 30% agreed less).
- However, some students expressed increased confidence on the post-event survey in some of these same areas. Substantial improvements were seen on whether students felt that they would be treated fairly on the job (over 40% agreed more) and whether their degree would facilitate the kind of lifestyle they want (over 40% agreed more).

Event satisfaction

Four open-ended questions were asked regarding attendees’ satisfaction with the event. Overall, the feedback regarding the virtual networking events was positive. When asked about the main highlight of the event attended, responses included:

“I loved being able to hear many women from diverse backgrounds and professions share their passion for their jobs.”

“I loved [that] you captured 4 different women in various stages of life.”

“[Dr. Montgomery] is a Powerhouse and really modeled being unafraid to claim your authentic self and take it to the public.”

“Actually getting to talk to the people. And interacting with the other people in the chat. It isn’t normally something I enjoy, but it was fun at this event.”

“Getting to hear from someone in my major about hardships and how to keep going.”

“I loved that [Dr. Grayson] shared honestly about how unconventional her journey was. It was encouraging and I was able to see myself in her. I also liked that she answered all our questions even after her talk.”

Lessons Learned and Next Steps

This research was conducted to examine our expectation that encouraging women in CC with intentions to pursue a STEM career, particularly those interested in engineering and computer science, to meet and engage with diverse women engineers and scientists would increase the likelihood that they would stay on the pathway to a bachelor’s degree in engineering or computer science. COVID-19’s impact on our plans to host in-person networking events in convenient locations and times in specific regions of the U.S. resulted in a need to pivot to virtual events. While this move allowed us to offer these events to anyone interested in attending, regardless of location, it presented some recruitment challenges that negatively impacted event attendance by the specific population we were most interested in studying,

This study was also undertaken to help inform SWE’s program development to better support CC students in STEM programs. SWE has limited relationships with students attending CCs, and these events were offered as a way to introduce students to SWE and its offerings.

One takeaway from this research is a greater understanding of the competing priorities among women in CCs, and the need to improve the messaging about the value in participating in PEA events. Of the students we interviewed in the summer, the majority had registered to attend an event, but did not actually attend. This was an issue we encountered with each of the six events hosted: Only about one-third of those who registered for an event attended the event. When asked why, the students interviewed noted that they had other commitments, including academic and family responsibilities:

“I do think for some students, especially the ones that are older, there are a lot of people who have children and a lot of people do have a part-time or if not full-time position, a job. So, I do think that there are those external factors that are pulling away their attention from some of the events....”

One student commented that they had had little understanding about what the event entailed, and they were intimidated by the use of the term “networking.” However, most students indicated that they just didn’t attend because they made the decision to focus on academic work instead.

We consistently heard from those we interviewed and who left comments that they found the events valuable, but that we needed to improve our marketing efforts. One student noted that

SWE should use other platforms to reach students, including Slack and Discord. Others suggested that SWE reach out to other PEAs to increase attendance.

This research study provides preliminary evidence supporting the expectation that exposure to diverse women in STEM is beneficial to undergraduate students' intentions to continue on their path towards a career in engineering or computer science. The next step in this effort to increase our support of women on the CC pathway towards a degree in engineering or computer science is to conduct a listening session with our new Community College Affinity Group. The focus of the listening session will be to find out from our members who work and study at two-year colleges what they believe would be effective ways to reach CC students, and what messaging would be the most successful in communicating the benefits or value of participating in these types of activities. In particular, we are considering ways in which we can involve our local sections in these efforts.

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