The Future of Engineering Education

2024 Annual Conference & Exposition

Oregon Convention Center
Portland, OR . June 23 - 26, 2024

ASEE

Paper ID #43110

Board 291: Future STEM Leaders: An Innovative Career-Readiness Program for Female Graduate Students

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Future STEM Leaders:
An Innovative Career Readiness Program for STEM Graduate Students

Abstract

Future STEM Leaders: An Innovative Career Readiness Program for STEM Graduate Students prepares future leaders of the STEM workforce through a cross-departmental initiative to develop student transferable skills, activate mentor networks, and instill confidence in their ability to attain their career goals. The program encourages traditionally underrepresented students in STEM (including but not limited to women, minorities, and persons with disabilities) to participate and draws from a unique and broad set of partners at the university, including faculty in the College of Engineering & Applied Sciences, the central Career Center's career development and employer engagement teams, as well as the Office of Alumni Relations, each with distinct contributions to the student experience.

This two-semester experience employs a design thinking framework, adapted from Burnett and Evans, to prompt deep career exploration beyond the boundaries of traditional academe. Graduate students design three different futures, called Odyssey Plans, and prototype these potential careers by connecting with industry professionals who can introduce them to new ways of applying their graduate level knowledge and skills. In addition to the exploration of career alternatives, students receive additional resources from the Career Center's educational programs including salary negotiation and interview skills. The team uses materials specifically designed to address differences in salary knowledge and negotiation practices. Students learn to benchmark salaries based on job location, industry, and required skills. Narrative feedback from participants reveals a level of uneasiness about verbally expressing the utility of their skills, academic knowledge, and even project work. Formative assessment results are driving changes to the program to incorporate more practice in articulating self-value to different audiences, and an infusion of low-stakes industry project simulations to develop transferable skills and confidence.

Despite progress, women and underrepresented minorities remain statistically on the margins in advanced degree programs in STEM and in the STEM workforce [1,2], and earn less than majority male counterparts across all occupations and industry sectors [3]. Moreover, PhD students are less likely to understand the range of career options available outside of traditional tenure track professor roles [4]. These two problems, limited knowledge of career options, and entering professions at lower salaries, can undermine student confidence in their ability to be successful and their perceptions of the value of a graduate education.

Educating Future STEM Leaders: An Innovative Career Readiness Program for STEM Graduate Students, aims to create a blueprint for a public research institution to provide a rigorous program for graduate students in STEM disciplines, with focus on traditionally underrepresented students in STEM, to support their career exploration and advancement into both academic and professional careers. The purpose of this paper is to present preliminary findings from three cohort groups and examine the effectiveness of the programmatic interventions.

Increased awareness and effort have yet to generate a diverse workforce in US science and engineering. Women and minorities are underrepresented in degree attainment [5], professional roles [6,7], and leadership positions [8,9].

Research has also demonstrated the critical need to improve career readiness of female and minority graduate students in engineering [10,11,12] in tandem with hiring organizations making efforts to recruit these students more heavily. Doctoral granting institutions must promote and structure support for the attainment of transferrable skills demanded by engineering employers [13].

Recent scholarship further suggests that graduate students benefit from exposure to STEM professional mentors who share similar graduate education but differ in age, occupation, and years of experience. Drawing upon alumni and industry connections, research universities can assist in transitioning students from college to career [14,15], offering emotional support [16], and fostering self-confidence to overcome obstacles [17].

Universities have an obligation to structure support in and out of the classroom to promote student career readiness and prepare them for the workforce. The traditional intervention is coursework, yet graduate education historically has not offered career development outside the academic program, nor given much consideration to careers outside of academia. This is changing. Recent research on academic career courses for graduate students has demonstrated that the courses positively contributed to student career readiness, increasing awareness of career options, transferable skills, and career mentors [18].

Acknowledging that graduate education tends toward siloing [19] and that organizational silos often hinder communication, collaboration, and innovation [20] universities must dismantle departmental and divisional barriers and create programs of shared responsibility for student success [21]. Therefore, we have created a program that crosses organizational boundaries to support student outcomes.

The outcomes we expect students to achieve include improved sense of self, increased knowledge of industry and engineering workforce expectations, a stronger sense of engineering identity, and confidence in their ability to achieve their goals.

As this novel program is a collaboration between the Career Center in Student Affairs and the College of Engineering & Applied Sciences in Academic Affairs, the recruitment plan reflected each partners' strengths. The Career Center publicized the program widely through its extensive mass marketing tools and social media platforms, distribution lists of student organizations, and the Graduate Student Organization, the formal university-wide governance body of and for graduate students. The College of Engineering & Applied Sciences contributed personal invitations from department chairs, graduate program coordinators, and individual faculty. Moreover, the Center for Inclusive Education located in The Graduate School, which supports graduate students from underrepresented groups, also shared the program invitation.

A credit-bearing course, Career and Life Design for Graduate Students (CAR 551) is the main hub of an ecosystem supporting students. CAR 551 is a one-credit online course combining design theory and career education. Over fifty students in the three cohorts joined the program and enrolled in the course from Spring 2022 to Fall 2023. These students represented a range of doctoral programs from applied math to pharmacology. The group also included master's level students from the university's engineering and computer science programs.

Regardless of academic field or degree program, all students cited a fervent desire to think critically about different career paths in a writing prompt issued on the first day of class.

The instructional methods for CAR 551 combined practices of empowerment associated with student development [22] as well as recent scholarship related to teaching online [23]. Furthermore, the course relied on insights from resources based on virtual feminist pedagogy [24]. The instructional goal was to promote an online culture that encouraged students to investigate social variables that can influence professional choices while learning collectively from peers and mentors about a variety of STEM occupations.

Through 12 weeks of synchronous and asynchronous assignments, CAR 551 students identify personal and professional values, define, or refine their expectations of graduate school, and interact with STEM professionals. The capstone event of CAR 551 is the creation and presentation of insights gained through informational interviews, called Odyssey Plans [25]. The informational interview is a standard tool for undergraduate career exploration; the Odyssey Plan for graduate students is more discipline-specific and requires students to consciously link skills learned in graduate school with a diverse set of occupations.

Mentoring is another feature of the program. Two assignments required student-mentor connections: self-directed informational interviews and facilitator-lead virtual meetings. In self-directed interviews, students engaged with at least three STEM professionals to learn about career paths, skills, and pivots within individual careers. Self-directed mentoring required students to determine the types of professions and professionals they wanted to investigate.

Facilitator-lead mentoring sessions exposed students to seasoned STEM professionals whose experiences included pharmaceutical marketing, translational research, and science commercialization.

Mentors in facilitator-lead workshops had completed research PhDs but opted to pursue radically different careers requiring an advanced STEM degree. Furthermore, these mentors had firsthand experience learning recent technology and working through economic boom/bust cycles. Their unique perspective offered a counterpoint to information from age-peers or professionals new to their occupations. Stony Brook capitalized on its graduate alumni, sourced by both the Career Center and Office of Alumni Relations, to directly address student questions related to leadership, job-market shifts, and skill development during and after graduate school.

Engaging with mentors in both self-directed and facilitator-lead sessions altered students' perceptions about STEM-based occupations. When asked to summarize the benefits of engaging with a diverse group of STEM professionals, the students spoke of learning pathways to advancement and how commercial product development relies on knowledge from graduate degrees. The students also reported greater confidence and willingness to explore jobs not directly related to their academic field but consistently employing individuals with graduate level skills.

Understanding the impact or results of this project as well as its future direction future required insights gained from student demographics including citizenship status.
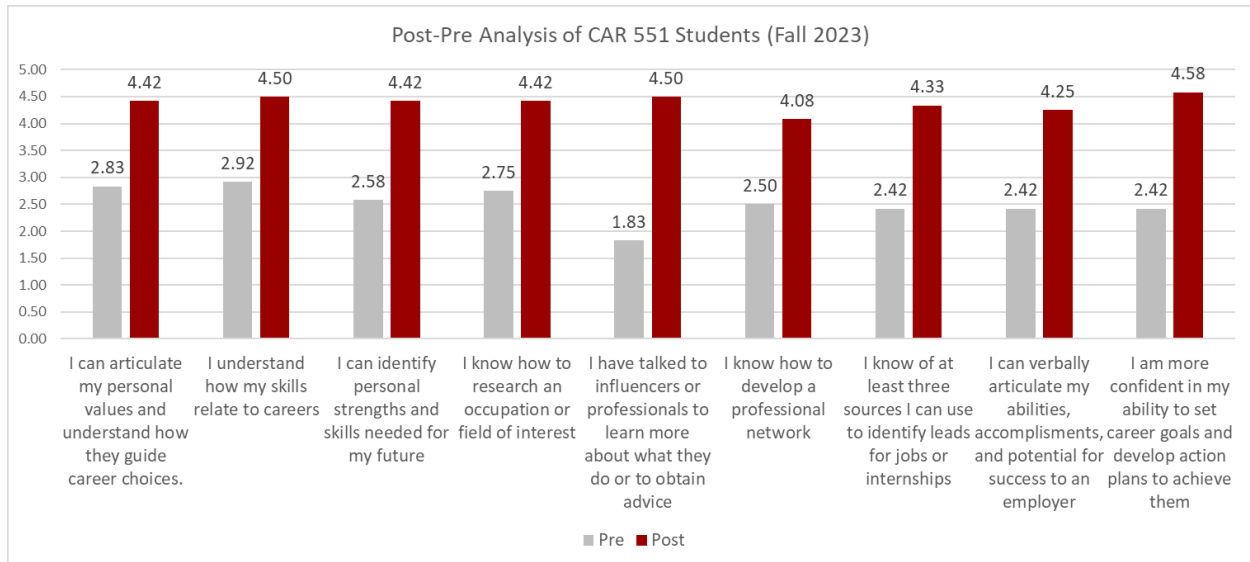
Demographics of the student participants over three cohorts include:
- Academic level: G1 (first year): 14% and G3-5 (continuing): 86%
- Ethnicity: Asian: 38%, Unknown: 33%, White: 11%, Latinx: 3%
- Citizenship Status: US Citizen: 38%, Permanent Resident: 5%, International: 61%
- Academic Program: Engineering: 72%, Life Sciences: 25%, Medicine: 3%

We utilized a post-pre survey, also known as a retrospective pre-post [26,27,28], to assess students' perspective on their achievement of the course objectives.

The Fall 2022 cohort (n=9) reported an average of 1.70-point increase across all outcomes, with an average increase of 55.7% in each individual outcome. The Spring 2023 cohort (n=16) reported an average of 1.40-point increase across all outcomes with an average increase of 45.6%, and the Fall 2023 cohort (n=18), reported a 1.87-point increase across all categories with an average increase of 77.25%.

Below is a graph of the Fall 2023 cohort responses.

Post-Pre Analysis of CAR 551 Students (Fall 2023)

Question	Pre	Post
I can articulate my personal values and understand how they guide career choices.	2.83	4.42
I understand how my skills relate to careers	2.92	4.50
I can identify personal strengths and skills needed for my future	2.58	4.42
I know how to research an occupation or field of interest	2.75	4.42
I have talked to influencers or professionals to learn more about what they do or to obtain advice	1.83	4.50
I know how to develop a professional network	2.50	4.08
I know of at least three sources I can use to identify leads for jobs or internships	2.42	4.33
I can verbally articulate my abilities, accomplisments, and potential for success to an employer	2.42	4.25
I am more confident in my ability to set career goals and develop action plans to achieve them	2.42	4.58

Self-reported growth is a signal that without a specific and structured intervention like CAR 551, students may remain isolated from expectations of any would-be employer across all sectors, including academic employers. While graduate students entered the program with STEM research experience, they acknowledge low levels of career knowledge and career readiness.

Building a team of supporters is a feature of career design and embedded throughout this project. CAR 551 promotes a design thinking mindset while supporting participants in exploration of options, forming networks according to interests and skills, and constant revision. Yet, career design principles have the potential to disrupt well- established comfort zones in students about the use of STEM skills.

Project organizers created an end-of-semester celebration/reflection to normalize career design and encourage participants to continue to apply practices of exploration and revision. This in-person event includes a cross-section of SBU students from previous CAR 551 sections. These invited guests are close to graduation, usually on the job market, and highly skilled at describing how their perception of STEM skills evolved after taking CAR 551. The celebration/reflection has become a communal event with the development of a network between cohorts.

CAR 551 has evolved and adapted through comments and data collected from each cohort of students. The instructor gathers feedback from participants after virtual meetings with mentors and issues an anonymous survey at the end of the term to measure students' progress on learning objectives.

The first iteration of CAR 551 (Spring 2022) had a weekly course schedule encompassing career education assignments on topics of self-awareness, gathering industry knowledge, personal debt, salary negotiation, and interviewing skills. Participants also had to develop a LinkedIn profile signaling their experiences, skills, and unique value. Students meet with the course instructor

online each week from late January to late April. Feedback from students was positive but there was a need to reduce the number of assignments and topics. Some individuals, including advanced doctoral students, were balancing graduate school with outside employment to support themselves. As project staff become aware of students' multiple commitments, organizers revised modalities for submitting assignments and activities to meet leaders in industry roles.

The second iteration of CAR 551 allowed students to complete assignments during synchronous meetings and offer group feedback on LinkedIn profiles. The term ended with an entire class session dedicated to verbal reflections about individual learnings. Active learning became an essential feature in future semesters.

Since each CAR 551 cohort influences the future experiences of the next group of students, project leaders made changes by offering more synchronous sessions to accommodate student academic responsibilities as well as adding more 1:1 coaching to advise students during Odyssey Plan development. Student comments also lead to the establishment of a well-defined period without online meetings.

The virtual environment of the project posed several challenges. Students logged in from jobs or other locations that limited participation in class discussion; a few individuals were outside the United States with inconsistent wi-fi. Since building relationships with other graduate students is a core feature of CAR 551, the instructor allowed active use of Zoom's chat box feature to keep everyone engaged.

The prevalence of F1 visa holders in CAR 551 required another slight modification to the project. Since international students comprise a majority, organizers had to adapt the ecosystem to address unique situations faced by international students in cross-cultural communication, managing relationships with SBU advisors, understanding expectations of US-based employers, and networking in professional settings. The project team approached alumni who had A) previously held an F1 visa, B) pivoted from traditional teaching/research focus to industry, and C) intentionally sought leadership roles before and after graduation. CAR 551 students then developed a series of questions to prepare for mentoring sessions with the alumni.

Through in-person and virtual meetings with these former F1 students, participants more openly discussed how to maintain their identities as a scientist or an engineer, balance personal goals, and skills needed for advancement. Having access to alumni with direct experience managing work visa timelines, academic obligations, and individual goals was a turning point for the students. As they discovered new options for visa holders and discussed professional advancement within the context of an international background, the CAR 551 students found new value in their graduate degree.

To manage variables related to academic commitments and students located outside New York the original model for mentoring relationships changed. CAR 551 participants are full-time students with obligations to research and projects. Organizers had to acknowledge that consistent one-to-one mentoring experiences were unrealistic under the circumstances. If organizers wanted CAR 551 participants to engage and learn from STEM professionals in diverse occupations, then we had to rethink how to do so. The first remake in mentoring occurred in Spring term 2023 with

a group in-person visit to PhD alumni employed as a project manager at a commercial incubator. This meeting exposed students to science commercialization from energy research at SBU. Most participants encountered an unfamiliar professional setting for STEM skills. But the in-person format did not serve the interests of distance learning students.

To arrange mentoring conversations for all students, the staff hosted two virtual meetups with a round table of role models for the participants. The result was connection to leaders in government and the private sector. Each mentor had a STEM graduate degree and had established careers in diverse areas of tech policy, drug development, engineering management, and health/nutrition products. The mentors offered insights about developing management skills, advancement opportunities, emerging technologies, and impact of machine learning.

Results demonstrate that graduate students are open to exploring career possibilities through the life design process. This project recognizes that career education is not organic to the experience of STEM graduate education and students need incentives to participate. Offering the program using a credit-bearing course provides structure and familiar semester deadlines. Another important inducement is offering a monetary stipend to participants once they report updates in technical skills and conference attendance.

All three cohorts of CAR 551 participants reported positive changes in their ability to develop a professional network and understand how skills relate to careers. In discussions with professionals during the creation of Odyssey Plans and through conversations with mentors, CAR 551 students expanded their definitions of career choices with a STEM degree.

Universities implementing a project like this should review recent scholarship on student expectations of graduate education and inclusive teaching practices. For example, CAR 551's career design curriculum requires collaboration and active participation in an online environment. Accountability between peers and facilitators is a core feature of career design and graduate students unaccustomed to interdisciplinary settings and/or have limited contact outside of an immediate academic area will need more support. Active learning is another key strategy for career and life design.

Moreover, universities interested in implementing career design initiatives may consider developing assessment tools to compare early career outcomes data from career design students with data collected from first destination surveys of the schools' overall STEM graduates.

Progress in implementing career design comes through communication between project facilitators and student participants. Project leaders also need to create a culture allowing reflections and participation from all students and not just the individuals who thrive online.

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