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Work In Progress: Initiating a graduate teaching fellow program to support undergraduates transferring into engineering and computing programs

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Introduction

The Student Pathways in Engineering and Computing for Transfers (SPECTRA) program is a relatively recent NSF S-STEM site within South Carolina and expected to provide scholarships for students through 2026. The program was anticipated to provide a streamlined academic pathway for transfer students from 2-year programs within South Carolina into Clemson University, and provide programming to aid their academic success and social integration. To achieve this, the faculty intended to solidify cohorts of students at two community/technical colleges (Spartanburg Community College and Trident Technical College) and then support that cohort as they transitioned together into Clemson University. To provide the students in the cohorts with a shared experience, all scholarship recipients at Clemson University (4-yr programs) are required to participate in two semester research courses. Undergraduate research experiences were chosen since these experiences have been shown to enhance an undergraduate student's academic experience, deepen their understanding of their field, and lead to increased retention of these students within science, technology, engineering, and mathematics fields. This shared research experience occurred at a set time each week, which allowed the scholarship recipients to meet with the program administrators on a regular basis. This resulted in meaningful professional skill development (such as resume formatting, learning to give presentations) at a set time rather than trying to schedule special events during each term (Olsen 2016). While other S-STEM programs have looked at increasing research preparedness of students (Graham 2017) or offered some scholarship recipients an option of participating in research (Chatterjee, 2021), this is the first to require scholarship recipients to participate in a two-semester research experience after matriculating to the research university site.

These 1-credit research courses are designed by the graduate student fellows who have either completed their MS degrees or have finished their qualifying exams for an engineering or computing program. These graduate students work with the SPECTRA program faculty and their dissertation advisors to propose and implement these research courses. While there are no limitations on the type of research, the topics must allow a team of scholarship recipients from a diverse array of engineering and computing majors to authentically contribute.

This paper provides an overview of the larger SPECTRA program and a deeper dive into the role of the graduate teaching assistants ('fellows'). Specifically, we will provide an overview of: (1) changes between initial program vision and adjustments from this vision during initial implementation, (2) recruitment processes and application requirements for the graduate teaching fellowship, (3) the framework for development of undergraduate research courses taught by fellows, (4) mentorship web for fellows on the research university campus and technical/community college locations, (5) the lessons learned from semi structured programmatic exit interviews of matriculated fellows, and (6) design for additional professional programming for scholars at the community/technical college locations by the fellows.

Overview of the vision for SPECTRA and adjustments made during the first two years

This S-STEM program is a collaborative effort between a research university (Clemson University) and two technical/community colleges within South Carolina (Trident Technical College and Spartanburg Community College). All three sites provide scholarships, which are summarized within Table 1. Scholarships at Trident Technical College and Spartanburg Community College are provided to students who wish to transfer to a 4year engineering or computing degree program, complete an application and meet academic requirements (GPA and course enrollment). At Clemson University, scholarships are granted to students who transferred from any of the 16 community/technical colleges within SC, apply to the program and meet academic requirements (such as GPA). Scholarship recipients at Clemson University normally have either sophomore or junior level class standing within their respective engineering/computing major.

Table 1: Number of scholarships awarded by SPECTRA as of February 2022.

	Number of Scholarships Granted at Clemson University	**Number of Scholarships granted at Spartanburg Community College**	**Number of Scholarships granted at Trident Technical College**
Yr. 1 (Fall/Spring)	*8*	*0*	*2*
Yr. 2 (Fall/Spring)	*9*	*2*	*4*
Yr. 3 (Fall)	*14*	*5*	*7*
Total Given Since Inception	*31*	*7*	*13*
Est. Scholarships Remaining to Be Given	*203*	*75*	*38*
Remaining	*172*	*68*	*25*
	85%	*91%*	*66%*

While scholarships are awarded at all three sites, the 'power' of the program was envisioned to be the solidification of cohorts of students transferring together from Spartanburg Community College and Trident Technical College to the Clemson University together. Figure 1 shows that while there may be small pairs of students naturally transferring together, SPECTRA would provide programming to support this and increase the number of students until they reached a critical cohort size. Furthermore, SPECTRA aimed to help the students once they reached Clemson University to matriculate successfully through their engineering/computing majors. The decision to implement a cohort structure was made to (1) establish engagement through collaboration, (2) increase retention, (3) provide supportive model for academic success, and (4) aid in the transition to a research university. In addition to providing students with a peer-driven support system, the cohort also models positive collaboration to enhance students' ability to work as a team which is vital in preparing students for a successful career (Lei et al., 2011). Finally, peer relationships impact students' access to academic support and as a result, the collaborative learning structure of a cohort can positively affect student learning and increase retention (Doolen & Biddlecombe, 2014).

While all scholarship recipients should be pursuing an engineering or computing degrees, the requirements to attain and maintain the scholarships between the sites vary. At all three sites, the students must have filled out the FAFSA® application, have a documented financial need and

have completed the SPECTRA application to be considered for a SPECTRA scholarship. However, the GPA requirements, math placement, and expectations such as participation in activities and course enrollments once on scholarship varied significantly between Clemson University, Spartanburg Community College and Trident Technical College. For example, neither of the collaborating community colleges required scholarship recipients to participate in SPECTRA programming while those at Clemson University were required to participate in both social and professional programming while on scholarship.

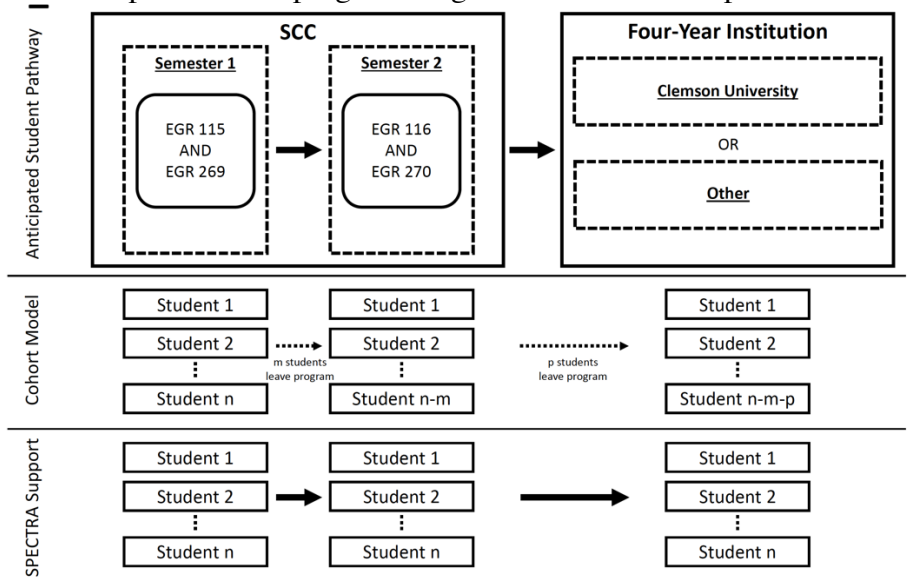

Figure 1: This figure displays the anticipated movement of students through required courses (EGR 115 'Creative Inquiry in Engineering I'; EGR 116 'Creative Inquiry in Engineering II'; EGR269 'Engineering Disciplines and Skills'; EGR 270 'Introduction to Engineering') while at a 2-year. institution (Spartanburg Community College, SCC) prior to matriculating to a 4-year institution. SPECTRA was anticipated to help students form a short and support their movement between institutions. This support was predicted to increase the success of students completing 4-year STEM degrees after transferring.

To facilitate the undergraduate programming and research programming at all sides, graduate students from Clemson University were recruited for 2-year teaching fellowships. The first year, the fellows were scheduled to teach at the partner community/technical college sites. The second year, the fellows would return to Clemson University with their cohort of transfer students and oversee their 1-credit research course.

Adjustments from vision for initial implementation

The following are the large adjustments made in the administration of graduate student fellow roles within SPECTRA during the first two years including the types of class delivery used by the fellows (in persons vs virtual), the number of fellows hired by the program each year, the order of locations at which the follows taught (4-year to 2-year), the students who would participate in the classes with the fellows.

Fellow Course Delivery Changed: The SPECTRA program was initiated (Fall 2019) just prior to the COVID-19 pandemic (beginning Spring 2020). As outlined by other groups (Washburn and Bragg 2022), the educational experience of students was impacted by stay-at-home orders. In South Carolina, this change started on March 16th when Governor McMaster announced the closing of all schools in South Carolina through the end of the month including all universities, colleges, and technical colleges. This meant that much of the programming and interaction with the fellows and scholars within this program became virtual that year. Scholars in the program reported difficulties transitioning to the online courses during administrative checking, similar to the findings of Washburn and Bragg (2022). In addition, the recruitment efforts (informational sessions about scholarships and graduate teaching fellowships) were transitioned to a virtual platform.

Rotation of Site Locations for Fellow Teaching Assignments: In the initial vision, we anticipated having the fellows teach their first year on a community/technical college and then transition with the scholars to the research university campus during their second year. However, we implemented the inverse of this to ensure close mentoring of the graduate students during their initial year of teaching and earlier stage of their dissertation research. This alteration was further supported since our analysis showed that cohorts of scholars at technical/community colleges did not matriculate to research campus together. We initially theorized that the scholars would matriculate as a cohort from the community/technical colleges to the research campus. However, the order of courses, rate of preparatory course work completion and other factors, meant that scholars moved individually from a technical college campus to four-year programs (not just those offered by the research university campus) at a wide range of time frames. Table 2 summarizes the overlap between students on scholarship at the technical/community colleges and the research university in the first two years of the program. The movement of students, shown in Figure 2, is done as individuals and not as cohorts.

Table 2: Overlap between students at research university and technical/community programs.

		Technical/ Community College in State of Research University								**SPECTRA Overlap Between Sites**			
Academic Year	**Number of Scholars at Research University Campus**	**Partner (Site 1)**		**Partner (Site 2)**		**CC/TC in State Partner (Site 3)**		**CC/TC in State Partner (Site 4)**		**Number Scholars who moved from Partner 1 to Research University**		**Number Scholars who moved from Partner 2 to Research University**	
Yr. 1 (Fall/Spring)	**8**	**1**	*13%*	**4**	*50%*	**3**	*38%*	**0**	0%	**1**	*13%*	**0**	*0%*
Yr. 2 (Fall/Spring)	**9**	**4**	*44%*	**1**	*11%*	**4**	*44%*	**0**	0%	**3**	*33%*	**0**	*0%*

Yr. 3 (Fall)	**14**	**2**	*14%*	**5**	*36%*	**6**	*43%*	**1**	7%	**1**	*7%*	**0**	*0%*

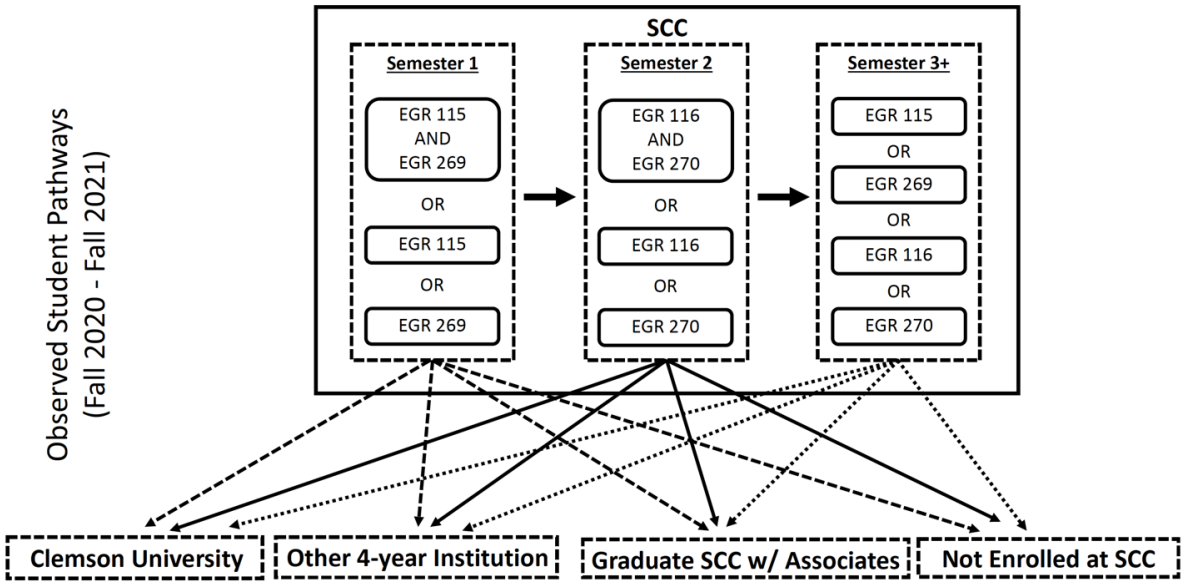

Figure 2: Matriculation of students from 2-year. to 4-year. institutions were not completed as cohorts as expected. Instead, students matriculated in a large array of pathways. Here we show how students at one of the partner community colleges progressed through required courses (prior to either matriculating to Clemson University, matriculating to another 4-year institution, completing their associates degree or simply not re-enrolling within the community college.

Each fellow now initial spends eight hours per week during their first academic year (Fall/Spring term) on the research university main leading a research team open to undergraduates receiving scholarships from the SPECTRA program. In their second year as fellows, they work remotely at one of the partner technical/community colleges where they facilitate a one credit research course for students expecting to transfer and then teach a fundamental engineering course required for students to transfer into engineering programs. It was also expected that the fellows balance their new teaching and administration responsibilities while continuing progress towards completion of their dissertations.

Fellows Impact Expanded to Students Not on Scholarship: While the fellows teach only transfer students on scholarship through this program ('scholars') at the research university, they teach any student who signed up for their research course on the technical/community college sites. While these courses were intended to be for all students on scholarship at those locations, the range of course requirements needed by each community college student to successfully transfer to a 4-year. program varied significantly and there was not always room for an optional course within the student's program.

Number of Fellows Changed in First Two Years: Another alteration was a need to ramp up the number of fellows hired instead of an immediate onboarding of four fellows. For the first two years of the program, only two fellows were hired instead of four as we negotiated the regulatory paperwork needed to place these graduate students into instructor of record positions at each site.

Decrease Requirement for Graduate Students Applying to be Fellows: The final major change for the program was to no longer require all fellows to be enrolled in a formal certificate program for engineering education. This requirement was waived for the initial two fellows. Evaluation of these fellows during their teaching programs have shown that this requirement is not required to have strong classroom performance. In addition, there was concern from applicants about the additional class times required to complete all the certificate requirements in addition to the PhD program requirements. There will not be a requirement for the ACE Fellowship recipients to show financial need.

Recruitment processes and application requirements for the graduate teaching fellowship
In the first two years of the program, the two fellows were targeted recruits. The program director reached out to the graduate students and their dissertation advisors directly and no formal interview process was implemented. This process was changed to recruit the subsequent fellows after the first two years. To recruit graduate students who had either completed a MS degree or became candidates within their PhD programs during this third year, emails were sent to faculty through the research university in engineering, computing, and applied science programs. In addition, emails were sent directly to all graduate students with the offer to informational sessions hosted by either the program directors or graduate students currently supported by the scholarship program. All applicants were asked to submit a form application packet including their resume, statement of interest in the program, a summary of how they perceived the program would benefit their careers and a letter from their research advisors confirmed their support of the application. Once the applications were reviewed, all applicants were offered a 20-minute interview during which they answered the following questions (Table 3).

Table 3: Prompts for applicant interviews for graduate teaching fellow positions.

Q1	Why do you want to become an ACE Fellow? That is, what are you seeking to gain?
Q2	How might this experience (being an ACE Fellow) influence your future career path?
Q3	What is the difference between a technical/community college (such as Trident or Spartanburg) and a traditional four-year institution (such as Research University)?
Q4	What are some challenges that transfer students to Research University from Trident or Spartanburg may face?
Q5	ACE Fellows are asked to teach ‘Creative Inquiry’ courses. Can you tell us what ‘Creative Inquiry’ is?
Q6	In this program, we will ask you to teach an undergraduate research (‘Creative Inquiry’) course on a specific topic. Have you identified any potential focus areas for this class? If so, what might outcomes be teaching the course after a semester or a year?
Q7	Have you previously mentored undergraduate researchers and if so, what were unique challenges or opportunities?
Q8	What is your teaching philosophy (statement of one's beliefs and thoughts about what's important in teaching and learning)?

Q9	What would you do if you do not have the expert knowledge to the questions asked by the students?
Q10	What challenges for your degree progress do you see by taking this opportunity?
Q11	How will you balance your obligations for your dissertation research and this graduate teaching fellow program?

Each year, the fellowship program director, additional program faculty and staff attended the interviews and selected two graduate students as fellows. In the first implementation of this interview cycle, the program received a total of eight applications for the two fellow positions. It should be noted that while these fellows are supported from the S-STEM program, they were not required to show financial need as their support came from the 40% curricular and cocurricular programs and services rather than the 60% going to student financial awards. Fellows have been primarily men (60%), from engineering PhD programs (100%) and have had a prior MS degree prior to enrolling in this PhD program (60%).

Framework for undergraduate research courses taught by fellows at the research university and community college partners

The course catalogs at the research university and partner community colleges already have approved research/inquiry courses that could be utilized for this program. To utilize the course, the fellows were required to 'pitch' their research ideas to the scholarship program directors and then worked with them to set up the courses. The research course scopes needed to allow for a multidisciplinary team at the sophomore/junior level and allow the undergraduate scholars to probe gaps in existing literature parallel to the fellow's dissertation focus. In addition, each fellow was asked to design a framework so that the scholars developed strong research mentoring skills and increased their sense of belonging in their engineering discipline (identity development) and their scholar cohort (comradery within the cohort).

Mentorship web for fellows on the research university campus and technical/community college locations

Since these graduate students could come from any computing or engineering program within the research university, they had a wide range of undergraduate degrees. The grant leadership team was therefore needed to incorporate training related to communities of practice, engineering identity and cohort building. During the first year, the fellows had routine meetings with the program director for individual training. This was done in the first year by enrolling all the fellows within an existing graduate course focused on mentoring undergraduate researchers. The fellows teaching at the research university site used this time to work with the program director on their class set up. Those students in the second year also participated in this class and were additionally mentored by the program director at their respective technical/community college. Even before the fellows arrived on the technical/community college sites, email communication between the graduate mentors and these faculty were encouraged to help the graduate students transition to a more independent role. Since the graduate students were teaching foundational engineering courses that directly transferred to the university, the fellows were also integrated into the teaching communities within the main campus centered on those

general engineering courses. These instructor communities shared topical outlines, assignments, best practices, and other materials that aided in the preparation of the fellows. By comparing the teaching materials, the fellows noted an evolution of course content from when the courses at the main campus and community colleges were initially approved for transfer.

Lessons learned from fellow formative assessments and exit interviews

At the close of their two-year position, the first graduate fellow was asked to reflect on the following questions (Table 4) and then meet with the program director to discuss their responses.

Table 4: Semi structured interview prompts for programmatic exit interview of fellows who finished their rotations.

Q1	What was the most challenging aspect of your ACE fellow experience? Why?
Q2	What was the most rewarding aspect of your ACE fellow experience? Why?
Q3	One of the goals of this program is to build a cohort of transfer students as then transition into Research University. Do you feel that occurred? Why?
Q4	What career goals and aspirations do you have now? Are they different from when you started the program?
Q5	Do you feel the program has prepared you for your future career?
Q6	What skills will be useful in your future career and what skills do you wish could have been further developed?
Q7	What advice would you give to graduate students just starting this program?
Q8	When recruiting graduate students into the program, what should we be sure to tell them?

Key suggestions and insights made by this first fellow included:

- They viewed the teaching experience to be significantly different role from being a teaching assistant. As they reflected on the experience of being a fellow, they noted that they had different interactions with students. They observed undergraduate students not responding to communications. They also needed to make the decision to fail a student and was responsible for choosing the instruction mode.
- They saw different connections forming between students in their research courses at the research university campus versus those on the technical/community college campuses. They perceived that the students in the technical/community college course were friendly but did not view themselves as a cohort and interact outside of the classroom. This was distinct from the research university, where the scholars formed a cohort that met outside of the classroom setting. The fellow attributed this to the additional activities required of the scholars on the research university setting such as attending social activities together. They perceived that while the students on all campuses received the same scholarship, those on the research campus saw themselves as a ‘special cohort’.
- Participating in the program built the graduate student’s communication skills. It helped them hone their skills in explaining and teaching their research to other people with different backgrounds and educational levels. They learned how to give other people

enough information for them to work without overloading them. They were also better able to explain the motivation for their dissertation work.

- The role of the dissertation advisor was important to the fellow. The dissertation advisor helped them scope the project for their undergraduate research course to be interesting to the undergraduate students from diverse backgrounds, publishable (novel) and was a sounding board for issues that came up during the four semesters she taught the undergraduate research courses. They appreciated their advice on when to 'give grace' vs. 'ask for more intention' from the student.

Future Work: Design for additional professional programming for scholars at the community/technical college locations by the fellows

To foster the sense of cohort at the technical/community colleges not observed by the initial fellow, the program leadership focused on outlining a professional development of activities for scholarship recipients on those sites. After assessing the cocurricular activities provided on the research university campus and reviewing literature on professional programming at other S-STEM sites, an outline of new programming opportunities was assembled to increase their identities as scholars within the program. During this programming design, the team also considered the needs to later transfer these activities to the other 14 technical/community colleges within the state, that the students at these sites had a relatively high percentage of first-generation and non-traditional enrollment, and that pandemic restrictions were not uniform across sites.

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