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WIP: Examining the Multifaceted Significance of Scholarship Programs in STEM

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Introduction

In this Work-in-Progress paper, we share our ongoing work with an NSF Scholarships in STEM (S-STEM) program related to an iteration of analysis that looked across specific aspects in a more summative manner than our typical analyses during the five years of the project that are more formative. As the project will soon enter an extension into a sixth year to use existing scholarship funds, we took this opportunity to begin to reflect on overarching goals toward the development and submission of a new S-STEM proposal to continue this work. The Student Pathways in Engineering and Computing for Transfers (SPECTRA) program in the Clemson University College of Computing, Engineering, and Applied Sciences launched in the Fall of 2019, with the first students to receive financial support and SPECTRA-based programming in the Spring of 2020. Since then, the SPECTRA program has provided financial support to nearly one hundred undergraduate Scholars who are transfer students in the college.

While the Scholars have consistently reported the SPECTRA program's main selling point is its monetary value, other evidence indicates that transfer scholars in STEM often have myriad unmet needs beyond financial assistance [1]. Our research has shown this to be accurate; Scholars have demonstrated that their primary appreciation of the SPECTRA program came from a need for additional funding, but other aspects also contribute. Similar to the work by Duis et al. [2], our study underscores connections between program participation and enhanced academic performance arising from exposure to professional development, career fairs, and tailored major-based programs. Scholars have expressed their desire for many such programs and activities, with simple social events being among the most sought-after. As SPECTRA continues to improve its program using design-based research by adding more events for the Scholars to attend, Scholars have shown that their readiness and sense of belonging as transfer students have enormously improved. This evidence emphasizes such programs' crucial role in bolstering scholars' professional readiness, subsequently driving academic success.

Our overarching objective for this research is to understand the experiences of our SPECTRA Scholars better to identify transfer students' expectations and goals about their needs while participating in a scholarship program, other than the monetary value. To better understand Scholar's experiences, we guide our research implementation using design-based methods that provide opportunities to collect formative and summative data while improving the intervention through data-driven revisions to the implementation.

With this Work-in-Progress paper, we offer insight into the multifaceted significance of the SPECTRA program, spotlighting its initial four and half years. By better understanding the diverse needs of transfer students as they transition to the target institution, we aim to refine the SPECTRA program continually, ensuring it remains a source of holistic support for STEM transfer students and provides helpful knowledge for similar contexts.

Literature

Low-income, first-generation, and racially diverse students represent most of the STEM student population in community colleges, providing the pathway for diversity. The interest in integrating these students into four-year universities emerges from the increasing need to represent who prepared STEM individuals are, which is why academic and social transition is vital [3, 4]. Previous research states that there is a need for occupations in STEM, and recruiting STEM transfer students through community college is a path to obtaining more degrees with these qualifications [2]. Community colleges serve as a crucial pathway for underrepresented talent to enter STEM disciplines and thrive in their desired career. Offering the comprehensive educational opportunities that come with a four-year university breaks down barriers that may hinder individuals from pursuing a career in STEM. Even with financial aid scholarships to afford tuition, books, rent, etc., these students need more knowledge of resources that could enhance their professional career and social experience in school.

Many students who transfer from small institutions to large universities verbalize greater difficulty developing social groups and finding their niche. Previous research indicates that after interviewing transfer students on their ability to form camaraderie, numerous responses included answers regarding difficulty meeting new friends due to most students already having started friend groups [5]. Regarding students striving to work with familiar faces, multiple transfer students wished to form study groups as they did in community college but needed help finding non-transfers willing to participate. Previous research indicates that this feeling of belongingness is crucial to a transfer student's success in finding the cohort that gives them this relief [1]. Even though receiving a monetary benefit would help students in the financial aspect of transition, transfer students often feel less welcome than their peers who did not transfer.

Financial support is crucial in aiding low-income, marginalized students in transitioning to costly universities; however, the culture shock in academia for community college transfers compared to universities can be astounding. Previous research indicates that even though high school graduates at an institution in Georgia had tuition charges paid along with a textbook allowance through a program known as Helping Outstanding Pupils Educationally (HOPE), the lack of academic support drove these scholars into situations that they found difficult or impossible to navigate successfully [6]. Monitoring the progress of transfer students within the first year of transition and using previous transcripts from community colleges have been suggested for advising these students. A previous scholarship program funded by NSF S-STEM, the Quantitative Excellence in Science and Technology project, was designed to aid in forming cohorts for transfer students and promote academic, social, and professional development [7]. The most effective aid in promoting success with these students in this program was specialized mentoring, advising during the first semester of transition, and intervening in difficult situations the students could not overcome independently.

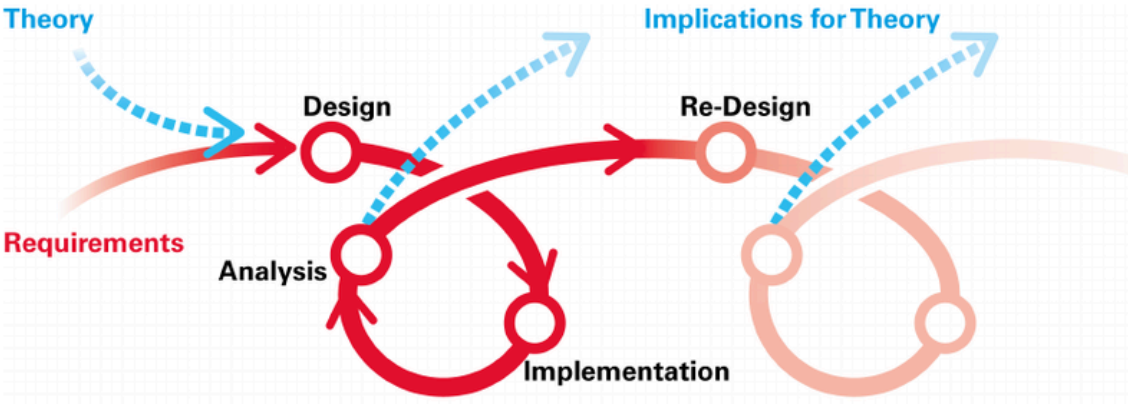

Figure 1: Design-Based Research

Methods

We use design-based research (DBR) methods in educational research and project evaluation of the SPECTRA project to structure iterations of design, implementation, and reflection on ongoing aspects of the project. DBR methods support authentic implementations of research and development that use formative iterations of review to increase the quality of real-life applications (see Figure 1 [8]). This research design allows us to identify gaps in previous work that would enable room for improvement, as has been used effectively in earlier parts of this study [9].

The study we share in this Work-in-Progress paper is a part of the overarching multi-year DBR project and focuses on a particular aspect of the educational research process that we have not been able to entertain until we have reached a level saturation from more extensive data sets, resulting from an accumulation of participant data across eight semesters of data. New and returning SPECTRA Scholars have participated in surveys at the start of each semester and interviews mid-semester since the spring of 2020. These engagements encompass a broad spectrum of student experiences and aspects of their professional preparation, ranging from financial challenges, professional identity development, coursework management, program involvement, and support systems to future perspectives. We recorded Zoom interviews with the participant's consent and transcribed the interviews. We then coded student interviews and analyzed the resulting data to provide evidence for assessing project fidelity and pinpoint improvement in future iterations of the SPECTRA program.

SPECTRA Scholars consent to the research aspects of the S-STEM, which is deliberately separate from the scholarship and coursework aspects of the SPECTRA program. As a research team, we invited all of the Scholars to participate in the human subjects research aspects of the NSF project. Still, we wanted them to feel free to participate or provide untrue responses for fear that their feedback was connected to their scholarships. We worked with our Institutional Review Board to create protocols for an exempt approval that would allow Scholars to avoid participating in the research aspects; however, to this date, no Scholar has denied consent to collect their survey and interview data.

Although there are demographic data for each Scholar in the SPECTRA program, for this study, we have separated individual identifiers, including demographic information, from the data set to maintain focus on the content of Scholar responses to the topics in this study. Our study participants are undergraduate students in the SPECTRA program who have transferred from another institution to Clemson. As part of SPECTRA, they must major in the College of Engineering, Computing, and Applied Sciences. Participants range in age from 18 to 38 years old. They are diverse in background, identity, and other factors—their common characteristic as study participants is being a member of the SPECTRA program. To avoid potential researcher bias from knowledge of individual Scholars beyond the data present for analysis, we use a multi-researcher, multi-pass thematic analysis process to maintain code integrity.

Scholars participate in a survey early each semester, followed mid-semester by an invitation to interview with research team members via Zoom. Scholars are asked various qualitative and quantitative questions to understand better where they are in their social, professional, and academic lives at Clemson University. We include various survey question types, including Likert scales, multiple-choice, and open-ended questions. The open-ended questions asked during the interviews and surveys were a crucial part of the qualitative data from Scholars for this study focusing on particular issues from a summative analysis of years of data, using the prompt "What types of support are you hoping to receive from your SPECTRA cohort this semester?" This survey and interview prompt was semi-structured, allowing follow-up questions and relating to other topics.

For this work-in-progress paper, we use a subset of the overall project data to focus on qualitative evidence and open-ended survey questions provided by scholars each fall and spring semester since the spring of 2020. We previously analyzed the data used in this study during formative reviews after the semester in which we collected data. Although we have maintained a running guide to the results of that work over time, we take another review of the data for this study. In addition, two research team members were not part of data collection and analysis before May 2023, giving them a fresh look at much of the data. We use thematic analysis in collaborative Taguette documents to illuminate trends from the qualitative data.

This analysis offers focused, evidence-based insight into scholars' evolving needs and aspirations regarding the SPECTRA program. Given the project timeline and usable data amounts, we intend to integrate other qualitative evidence from additional questions and quantitative data through similar summative processes. While each cohort of Scholars typically does not provide enough responses to allow for interpretive statistical analysis, we intend to aggregate and standardize all quantitative human subjects data at the project's end. The findings from our study of the survey and interview data regarding SPECTRA support provide a procedural guide for our ongoing analysis of other qualitative data and produce emergent results for a better understanding of the experiences of SPECTRA Scholars.

Results

Our comprehensive analysis of surveys and interviews with Scholars since the first students joined the program shows that Scholars' experience with the SPECTRA program goes beyond financial gain. Scholars have appreciated the social and academic value that SPECTRA offers as a multifaceted program, and it's clear that they have gained and still seek more than just

monetary value. When openly asked, "*What types of support are you hoping to receive from your cohort and the* SPECTRA *program this semester?*" Scholars' answers fit into the following categories.

First, social-centric responses:

"Just people to share this experience with. I always feel more comfortable and less stressed if other people are beside me..."
"General social support is always a helpful counterweight to coursework pressure. I have several friends from my cohort in classes specific to my major this semester."
"I'm no longer in the CI, but I've met some good friends from SPECTRA and hope to hang out with them this semester."
"Just the usual friendliness of saying hey and talking for a little when seeing each other in public/school"
"Maybe a tag up in terms of socializing with other members of the team and share a snack."
"I'm hoping to see my cohort around campus and having meaningful conversations. I know most of them are more than willing to answer questions about life/coursework if I ask."
"Sense of community"
"Opportunities to hangout or events that are fun / informational"

Second, academic-centric responses:

"I like that they give us the opportunity to reach out and help us work through problems from other resources other than my course teacher"

"Academic support"

"just assistance with questions and such pertaining to classes. I already got a scholarship that has helped me out dramatically so I can't really ask for more."

"Class work"

"A place and people I can go to if I have problems or need to find assistance either from them or as a guide to proper assistance"

"I hope to receive tutoring help from my cohort."

"Academic support so that I can succeed in my coursework."

"Advice to improve academic performance"

Third, professional-centric responses:

"I[']m] hoping to receive [a] new research opportunity."

"Industry contacts and general social networking"

"Exploring more about my career"

"Networking Opportunties"

Finally, a large number of responses fit into more than one category:

“Connections to possible social and profession[al] experiences”
“People to study with and meeting new people!”
“Help with questions in classes and connections.”
“I'm hoping to see my cohort around campus and having meaningful conversations. I know most of them are more than willing to answer questions about life/coursework if I ask.”
“Group projects with other engineers”
“Connections and advice on my current courses from members who have already taken the courses”
“Help with advise and guidance in finding the right courses, help in studying, and connections to coops and internships.”
“Assistance with homework and the material. Also, social support as I would consider many from my cohort as friends.”

From these results, we can see Scholars emphasizing the desire for shared experiences, networking and professional opportunities, and study partnerships – all of which point back to the general desire and importance of social support within the SPECTRA program.

Discussion

These aggregate findings from our ongoing study reveal a particular aspect contributing to a nuanced understanding of scholarship programs' role in higher education, particularly within the STEM disciplines. Beyond the monetary assistance they offer, programs like SPECTRA are crucial in addressing the multifaceted needs of transfer students, who often navigate unique challenges upon entering a new academic environment. This study underscores the importance of creating supportive networks that are not prescriptively defined but organically cultivated to address students' dynamic and diverse needs from cohort to cohort and year to year.

In addressing the diverse needs of STEM education, our research highlights the leverage point of transfer students' diversity. These students bring varied perspectives that enrich the learning environment and, when supported appropriately, can enhance the inclusivity and effectiveness of STEM education. By offering more than just financial aid—such as professional development opportunities and just-in-time learning resources like resume workshops and internships—programs like SPECTRA significantly level the playing field for underserved and traditionally underrepresented learners in STEM fields.

Our findings emphasize the critical role of retaining learner agency and building student resilience. The SPECTRA program's data collection and analysis approach—centering participants' experiences through respectful and supportive methodologies like surveys followed by interviews—underscores the importance of periodic opportunities for scholars to provide feedback. This process not only aids in continuously refining the program but also ensures that it remains responsive to the evolving needs of its participants. The design-based structure of this project makes that effective.

Challenges and Limitations

This paper shares our first formal aggregation of data from multiple iterations that we analyzed through a most summative lens on the information. Our numerous iterations of survey and interview data with smaller numbers of participants each semester are, in this fifth year of the program, providing a helpful cumulative perspective on the work, even as it continues into an unplanned sixth year due to unused funding. The following have been and continue to be some of the most challenging limitations of this five-year-plus project.

Impact of COVID-19 on Research

The COVID-19 pandemic significantly impacted the course of our research. The unprecedented global health crisis introduced unforeseen challenges, primarily restricting the ability to meet in person for SPECTRA program activities. Social distancing measures and lockdown protocols disrupted regular operation schedules, leading to delays in data collection. The rapid shift to virtual environments posed difficulties in maintaining the same level of collaboration and communication among team members, which is crucial for research progress.

Issues with Recruitment

Another critical challenge encountered was in the area of participant recruitment. The pandemic-induced restrictions made reaching out to and engaging with potential participants difficult, leading to a lower recruitment rate than anticipated. This issue was further compounded by general public apprehension towards participating in in-person activities, which limited the diversity and number of participants, potentially affecting the representativeness and generalizability of our findings. In addition, students at some technical colleges in South Carolina received free tuition for their studies, decreasing their motivation to seek scholarships.

Effects of Project Personnel Turnover

The research project also faced significant turnover in personnel, primarily with the faculty and administrators on the project. There is now only one member of the original proposal team, as everyone from the original team has left the institution. The loss of key team members at various project stages led to interruptions in the research workflow. This turnover slowed down the process and brought about a loss of expertise and continuity in the project. With student interns, we were prepared for their turnover, as they could only remain on the project for two years maximum, so the turnover process was workable. Still, team leadership changing almost entirely has been challenging to navigate.

Influence on Research Outcome

Emerging issues such as recruitment were essential methodological decisions during the project; however, other aspects of the original outcomes in our funding proposal need to change. Several factors collectively influenced the result of our research in several ways. The disruptions caused by COVID-19 led to extended timelines, affecting the project's overall efficiency and progress. The recruitment and personnel turnover issues resulted in a smaller and potentially less diverse

dataset, which might have impacted the robustness and applicability of our conclusions. These challenges necessitated a reevaluation of our initial objectives and methodologies, leading to alterations in our research approach to adapt to the evolving situation. Despite these setbacks, the team's resilience and adaptability allowed for the continuation and eventual completion of the research, albeit with modifications from the original plan.

Conclusion and Future Directions

The SPECTRA program addresses critical areas such as social integration, academic support, and professional development through its diverse offerings beyond monetary support. Scholars have highlighted these areas as essential to their success and well-being within the educational environment. The program's focus on creating a sense of community, offering academic mentorship, and facilitating professional networking opportunities aligns with transfer students' diverse and evolving needs, thereby contributing to a more inclusive and effective STEM education landscape.

The iterative design-based research approach, incorporating surveys and interviews, enabled an in-depth exploration of the scholars' experiences, revealing the importance of adaptive and responsive program structures to meet the dynamic needs of students. This research lays a foundation for future studies and program enhancements for similar projects. Identifying emergent needs among the scholars has suggested avenues for refining the SPECTRA program's offerings, such as expanding course-based opportunities and supporting professional network development. Additionally, the insights gained underscore the importance of maintaining flexibility in program design to accommodate the multifaceted needs of STEM transfer students, which may evolve across generations and diverge from existing literature.

The SPECTRA program's impact extends well beyond financial support, fostering an environment that contributes to the holistic development of STEM transfer students. By continuing to refine and adapt the program based on the insights gained from this research, there is a significant opportunity to enhance the effectiveness and inclusivity of STEM education for transfer students. This study helps to inform the next generation of scholarship programs for transfer students, building on our evidence-based understanding of transfer students' experiences.

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