# Examining the Motivations and Experiences of Transfer Students Participating in an Undergraduate Research Course

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## Abstract

In this paper, we use both quantitative and qualitative methods to examine transfer student's in a scholarship program to better understand their university experiences and what drives them to succeed. The Student Pathways in Engineering and Computing for Transfers (SPECTRA) program is an NSF S-STEM (Award#1834081) that aims to aid students in their transfer from two-year college programs into Clemson University's College of Engineering and Computing and Applied Science (CECAS). In this study, we implemented a modified version of the Motivation and Attitudes in Engineering (MAE) to a cohort of students in the SPECTRA program (*n=16*). The MAE was developed and validated by Clemson researchers in 2017 and has been distributed to engineering students enrolled in selected required courses every year since Spring 2021. The purpose of the survey is to better understand what motivates students to pursue engineering, assess their identities as engineers, gauge their sense of belonging within their communities, as well as several other functions which will not be explored in this paper. Participating SPECTRA scholars who were midway through a one credit course in which they were expected to work in teams on various undergraduate research projects completed the MAE and were invited to participate in interviews about their experience in the course. The course is mandatory for first year SPECTRA students and the intent of the course is to support the construction of student cohorts, expose scholars to research, and to develop their skills as engineers. Survey results show that the students feel a high sense of belonging in their SPECTRA course and are motivated by several career outcome expectations, the highest of which was having job security and opportunity. Interview data suggests the SPECTRA students find value in several aspects of the course including working with graduate students and learning to develop professional skills. As the MAE was also conducted with students throughout all of CECAS (*n=1174*), we are able to compare the results of SPECTRA students with data from across the entire college. Preliminary results show some statistically significant differences between SPECTRA students and all of CECAS in subcategories within student sense of belonging and future-oriented motivation. The qualitative data from interviews was used to further explore these findings.


## SPECTRA Background

The Student Pathways in Engineering and Computing for Transfers (SPECTRA) program is a NSF funded (Award#1834081) project which aims to accomplish three goals:

(1) to provide scholarship opportunities to low-income students who wish to pursue engineering or computing at Clemson
(2) to build cohorts of transfer students to support their transition into Clemson while also allowing for the Advisors for Cohorted Engineers (ACE) Fellows

program to aid in the training and practice of PhD candidates who wish to pursue careers in academia
(3) to assess its progress both internally and externally to assist the transfer students best and improve the program

The program is based out of the Clemson College of Engineering and Computing and Applied Science (CECAS) and has been in effect for approximately four years. The program has graduated 9 students, with several more scheduled to graduate in the coming semesters.

This paper aims to analyze SPECTRA's efforts to build cohorts of students in an effort to support the students' transition. The data discussed may also be useful for internal assessment of how the process of cohort building has been successful or unsuccessful from the student's perspectives. Previous work done through qualitative analysis of student interviews has shown that the students in the program believe they receive both value and benefit from participating in undergraduate research projects with their fellow SPECTRA scholars [1]. This paper aims to further explore the students' experiences and attitudes within their undergraduate research course and compare the results against their attitudes and experiences at the university level and the engineering community by implementing the Motivation and Attitudes in Engineering (MAE).

**MAE Background**

The MAE was designed to assess undergraduate students' sense of belonging in their courses, departments, and universities and provide insight into what motivates them to pursue engineering and how they view themselves as engineers. The survey has been distributed in the Civil Engineering Department at Clemson since 2017 and was expanded to include students in all engineering programs in 2021.

Surveys are sent to targeted classes that aim to represent each level of student (first year through senior) in all engineering majors, and a report is generated for the departments at the end of each year summarizing the results. Through this project, instructors, staff, and administrators can observe data directly from the students, allowing them to make more informed decisions about the programs, courses, and curricula they offer within their departments.

**Methods**

This paper describes the results of a mixed methods explanatory design-based research and development project involving the implementation of project interventions in authentic contexts for iterative, real-world data collection and analysis.

The initial survey was a modified version of the original MAE [2]. Modifications included changing verbiage to reflect the course in which the SPECTRA students were involved. The original survey was meant to be taken in core curriculum classes for each participant's degree program. The new wording reflected that the survey will be taken in the context of their

SPECTRA undergraduate research course. Questions focusing on transfer status were removed, as all students in the course are transfer students. Additionally, survey questions relating to personality and the value of science were removed to keep the survey short and focus on the scholars' motivations and identity. While the original MAE underwent several rounds of iterative testing to ensure validity and reliability, due to the limited number of SPECTRA participants, the modifications made for this study were not subjected to reliability testing. The previous semester, the MAE was also implemented under a different project across all engineering majors, providing the opportunity to compare results.

The SPECTRA students were divided into two courses taught by two different ACE Fellows, and the ACE Fellows asked the students to complete the survey during their course. Following survey implementation, the results of the SPECTRA scholars (*n=16*) were statistically compared against the results from all engineering student participants (*n=1174*). Analysis was completed using Statistical Package for the Social Sciences (SPSS)(Version 29) software [3]. Using SPSS, unpaired *t*-tests were performed on the results for SPECTRA and all engineering students. As this is a pilot of a larger study, further statistical analysis is needed to account for the differences in sample size. Responses were separated by constructs including Sense of Belonging, Future-Oriented Motivation, Career Outcome Expectations, and Identity. Within these constructs, there are also several sub-constructs that were compared. See Table 1 for a complete list and explanation of constructs and sub-constructs.

During the same semester in which the surveys were implemented, the SPECTRA scholars were invited to participate in voluntary interviews. The interviews were semi-structured and covered a wide range of topics. Among these topics were their experience in their undergraduate research course through SPECTRA and their sense of belonging in their program and at the University. The interview questions were developed and changed by the research team throughout the extent of the SPECTRA program. After each round of student interviews and data analysis, researchers discussed the outcomes and areas of emerging interest that arose from the data and adjusted the interview questions to further probe these areas of interest during the next round of interviews. Some questions, such as questions about engineering identity have been consistently asked through the program's existence while others were added more recently, such as asking about career motivations. The questions developed for this round of interviews were designed prior to the administration of the MAE; however, several aspects of interviews strongly overlapped with the constructs the MAE aims to measure. Only responses from the students in the research course (*n=11*) were selected for analysis.

| Construct | Sub-Construct | Description |
|---|---|---|
| Sense of Belonging | Sense of Belonging - University Community | Students' sense of fit and belonging at the university |
| | Sense of Belonging - Engineering Community | Students' sense of fit and belonging in their engineering department |
| | Sense of Belonging - Course Community | Students' sense of fit and belonging in their engineering course |
| Future-Oriented Motivation | Perceptions of Future | Students' perceptions of their future in engineering |
| | Perceived Instrumentality | Students' perceptions of how useful their courses are for reaching their future goals in engineering |
| | Future on Present | Students' perceptions of how the future affects their actions and decisions in the present |
| | Value | Value students place on thinking about the future |
| | Connectedness | Tendency for students to make cognitive connections between the present and the future |
| | Clarity | Degree of clarity in students' definition of their future career goals |
| | Alignment | Alignment of students' ideal and realistic future possible careers |
| Career Outcome Expectations | Making money | Importance of [expectation] for students' future career satisfaction |
| | Becoming well known | |
| | Helping others | |
| | Supervising others | |
| | Having job security and opportunity | |
| | Working with people | |
| | Inventing/designing things | |
| | Developing new knowledge and skills | |
| Identity | Self-Awareness | Students' perceptions of themselves as engineers |
| | Recognition | Students' perceptions of being recognized by others as engineers |
| | Interest | Students' personal interest in engineering |
| | Performance and Competence | Students' beliefs about how well they can perform engineering tasks and understand engineering concepts |

Table 1: List of constructs measured by the MAE survey, as well as sub-constructs and descriptions for each.

Interviews were conducted on Zoom to accommodate the students' time and travel limitations. They lasted approximately 30 minutes and were conducted with either one interviewer or two co-interviewers in which one researcher took the lead and the second asked follow-up questions if they deemed them necessary. Transcriptions of the interviews generated in Zoom were cleaned and uploaded onto Taguette [4]. A pre-established code book was used to analyze the initial data. Codes relating to the student's participation in the research course and their experience at the University were further analyzed, as they were most relevant to the MAE results. The codes were then compared to the survey results, and the research team could observe and discuss similarities and differences in the responses.

## Results

### *Quantitative Results*

In comparing the MAE results of the SPECTRA students' responses to the responses of all engineering students in this study, few significant differences were found. No significant differences were found in the Career Outcome Expectations or Identity constructs (summary of the statistics for these two constructs can be found in Table 2). However, there were significant differences within some sub-constructs within the categories of Sense of Belonging and Future-Oriented Motivation.

Within the construct of identity, SPECTRA students' responses were similar to other engineering students' in the sub-constructs of their University Community and Engineering Community. However, the SPECTRA students scored significantly higher than other engineering students as having a strong sense of belonging within their Course Community. Refer to Table 3 for a summary of results and Figure 1 for a graph of results.

| Sub-Construct | CECAS Data | SPECTRA Data | t-test Results |
|---|---|---|---|
| *Self-awareness* | n = 1144, M = 5.17, SD = 1.27 | n = 14, M = 5.38, SD = 1.04 | t(1156) = 0.61, p = 0.54 |
| *Recognition* | n = 1143, M = 5.11, SD = 1.29 | n = 14, M = 4.89, SD = 1.13 | t(1155) = 0.63, p = 0.52 |
| *Interest* | n = 1144, M = 5.84, SD = 1.12 | n = 14, M = 5.71, SD = 1.13 | t(1156) = 0.41, p = 0.68 |
| *Performance and Competence* | n = 1144, M = 5.53, SD = 1.06 | n = 14, M = 5.42, SD = 1.25 | t(1156) = 0.41, p = 0.28 |
| *Making Money* | n = 1144, M = 5.80, SD = 1.12 | n = 14, M = 6.14, SD = 0.77 | t(1156) = 1.14, p = 0.25 |
| *Becoming Well Known* | n = 1144, M = 3.56, SD = 1.71 | n = 14, M = 3.50, SD = 1.74 | t(1156) = 0.12, p = 0.90 |
| *Helping Others* | n = 1143, M = 5.90, SD = 1.11 | n = 14, M = 5.64, SD = 1.01 | t(1155) = 0.85, p = 0.40 |
| *Supervising Others* | n = 1144, M = 4.13, SD = 1.56 | n = 14, M = 4.14, SD = 1.23 | t(1156) = 0.02, p = 0.98 |
| *Having Job Security and Opportunity* | n = 1143, M = 6.20, SD = 0.95 | n = 14, M = 6.07, SD = 0.92 | t(1155) = 0.52, p = 0.60 |
| *Working with People* | n = 1145, M = 5.44, SD = 1.38 | n = 14, M = 4.93, SD = 1.38 | t(1157) = 1.38, p = 0.17 |
| *Inventing/Designing Things* | n = 1145, M = 5.49, SD = 1.36 | n = 14, M = 5.36, SD = 0.93 | t(1157) = 0.38, p = 0.71 |
| *Developing New Knowledge and Skills* | n = 1145, M = 6.07, SD = 1.04 | n = 14, M = 6.00, SD = 1.04 | t(1155) = 0.24, p = 0.81 |

Table 2: Summary statistics for the Identity and Career Outcome Expectations sub-constructs.

| Sub-Construct | CECAS Data | SPECTRA Data | t-test Results |
|---|---|---|---|
| *University Community* | n = 1173, M = 5.76, SD = 1.05 | n = 16, M = 5.90, SD = 1.10 | t(1187) = 0.51, p = 0.61 |
| *Engineering Community* | n = 1173, M = 5.64, SD = 1.10 | n = 16, M = 5.90, SD = 1.01 | t(1187) = 0.92, p = 0.36 |
| *Course Community* | n = 1173, M = 5.78, SD = 1.14 | n = 16, M = 6.53, SD = 0.88 | t(1187) = 2.64, p = 0.008 |

Table 3: Summary statistics for the Sense of Belonging sub-constructs.

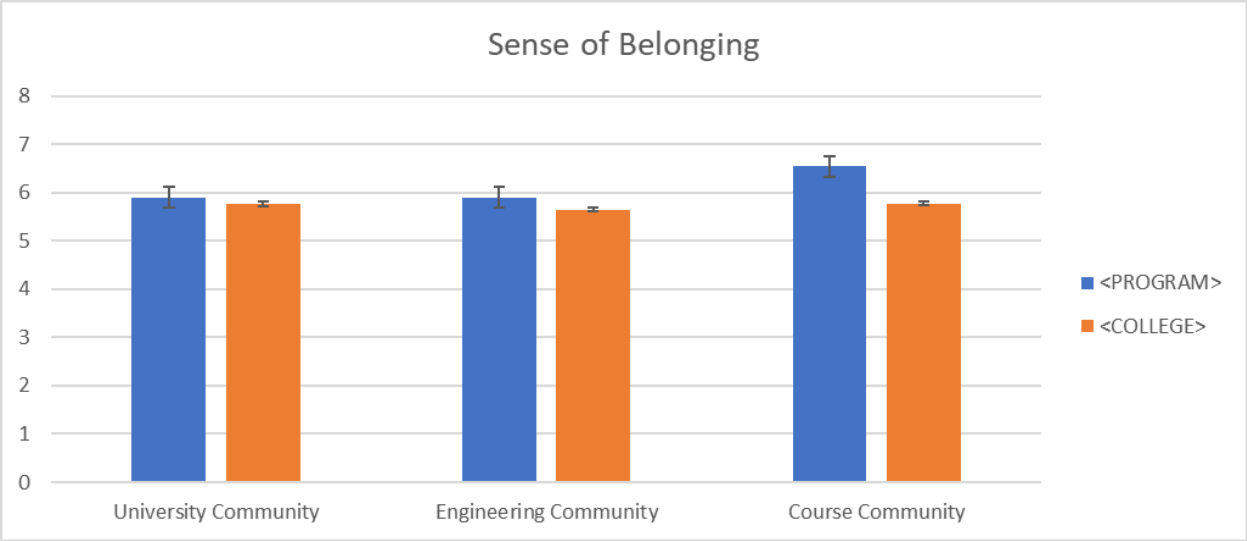


Figure 1: MAE results for the sub-constructs within the Sense of Belonging construct comparing SPECTRA student responses to those of all engineering students ("CECAS").

A significant difference between SPECTRA and engineering students was also found within a sub-construct of Future-Oriented Motivation. The data from Table 4 as well as the graph in Figure 2 shows the only significant difference within this construct is in Clarity, or the degree to which students can define their future career goals. SPECTRA students show higher levels of Clarity in comparison to the results for all engineering students in this study.

| Sub-Construct | CECAS Data | SPECTRA Data | t-test Results |
|---|---|---|---|
| *Perceptions of Future* | n = 1154, M = 5.74, SD = 1.16 | n = 14, M = 6.06, SD = 0.82 | t(1166) = 1.02, p = 0.31 |
| *Perceived Instrumentality* | n = 1153, M = 5.44, SD = 1.10 | n = 14, M = 5.52, SD = 0.83 | t(1165) = 0.24, p = 0.81 |
| *Value* | n = 1152, M = 5.11, SD = 1.10 | n = 14, M = 5.22, SD = 1.10 | t(1164) = 0.30, p = 0.69 |
| *Connectedness* | n = 1153, M = 5.51, SD = 1.06 | n = 14, M = 5.74, SD = 1.51 | t(1165) = 0.81, p = 0.42 |
| *Clarity* | n = 1149, M = 4.22, SD = 1.36 | n = 14, M = 4.97, SD = 1.01 | t(1161) = 2.04, p = 0.04 |
| *Alignment* | n = 1148, M = 4.92, SD = 1.17 | n = 14, M = 5.37, SD = 1.30 | t(1160) = 1.42, p = 0.15 |
| *Future on Present* | n = 1148, M = 4.26, SD = 1.51 | n = 14, M = 3.79, SD = 1.80 | t(1160) = 1.19, p = 0.23 |

Table 4: Summary statistics for the Future-Oriented Motivation sub-constructs.

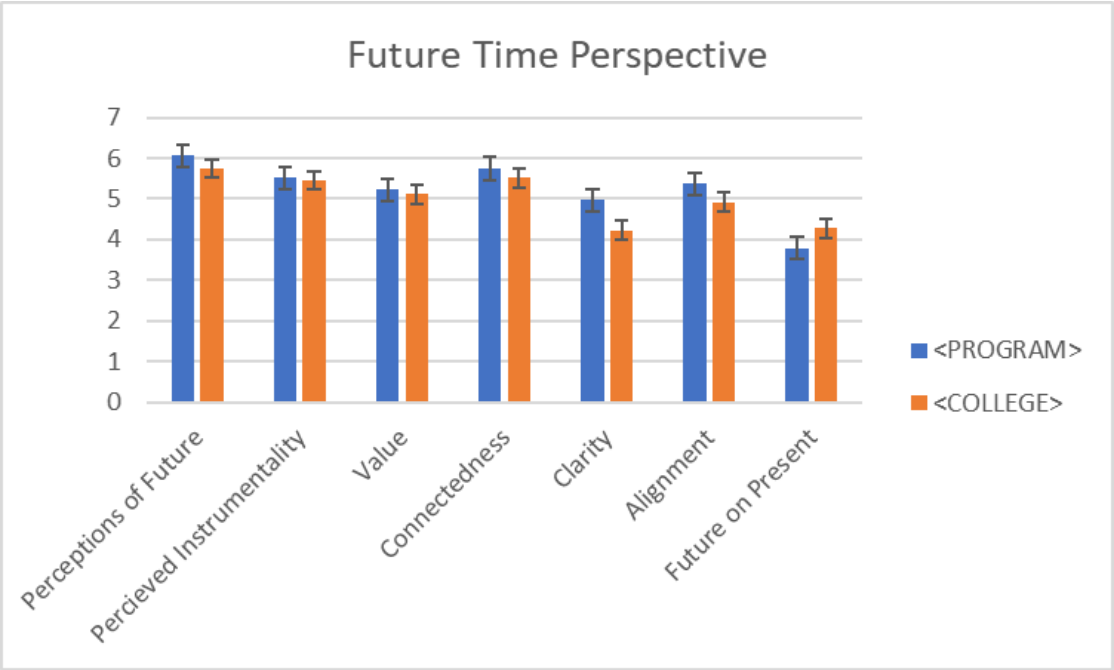


Figure 2: MAE results for the sub-constructs within the Future-Oriented Motivation construct comparing SPECTRA student responses to those of all engineering students ("CECAS"). Only results for Clarity were significantly different.

High Clarity is an interesting result and would need to be further explored to determine the driving factor behind the students' higher sense of Clarity and whether it relates to their status as transfer students, their participation in the SPECTRA program, courses and careers held before their transfer process, or other underlying factors. Some of these are explored further in the qualitative analysis.

*Limitations*

A few factors must be taken into consideration when observing these results. For one, the courses in which the MAE was implemented in engineering majors were not focused on undergraduate research, and all of the engineering courses were part of the students' degree requirements. In comparison, the SPECTRA course was not required for students' degrees, but it was a requirement to remain within the SPECTRA program. Another difference between these courses was the class size, which was much smaller for SPECTRA than for the engineering courses required for each major. While not a perfect comparison, the results of this survey provide evidence that the students feel a high sense of belonging within their SPECTRA courses. Given the limitations of quantitative comparisons, we sought more insight into the SPECTRA students' experiences through interviews.

*Qualitative Results*

The quantitative portion of this work indicated that the students in the SPECTRA course felt a stronger sense of Course Community than the engineering students who completed the MAE in Spring 2023. The qualitative analysis of interview data can give us further insight into the SPECTRA students' feeling a sense of community in their courses. The primary outcomes of this analysis are that the students see the SPECTRA course as a chance to connect with other transfer students, and many of them have indicated that they utilize both their ACE Fellow and fellow students as contacts or sources to get help with academics as well as campus support (such as finding buildings). See table 5 for a compilation of example quotes highlighting student feelings of course community.

| **Example quotes showing *Course Community*** |
| --- |
| When I had questions about, like, co-ops and internships, stuff like that, I would reach out- I'll reach out to [ACE Fellow]. He's- he's the instructor. I'll reach out to him about it, or I'd ask people in the class- or especially since I was new on campus, I would ask them questions about maybe “where's XY and Z on campus?” |
| It’s been beneficial in the- on the camaraderie side. For sure I've been able to meet some people. One guy specifically- awesome dude- he taught me a lot about what's to come for- Help me prepare, even mentally, for the challenge, you know. |
| I really, like, everybody has, like, a common mindset, they’re transfers, you know, just trying to figure it out. And it's just good like that. |

Table 5: Quotes from SPECTRA participants highlighting course community.

While students appear to feel somewhat connected with their peers, several students indicate that they feel the strongest connection to students that they see in other courses besides their SPECTRA course and that they do not know the SPECTRA students outside of their individual courses well. Some students indicated they did not feel as socially connected in the class as others. Perhaps the strong sense of belonging comes partially from some students having a chance to encounter students from their other courses in a setting that allows them to identify each other as transfer students within the same program. Having similar identities may lead to deeper connections and, consequently, a stronger feeling that they belong in the space. If this is the case, the SPECTRA research course may be highly beneficial for students who share a major but less beneficial for those who are the only students in a major in the SPECTRA course.

Another of the findings from the quantitative portion of this work was that the students in the SPECTRA course had high Clarity in their future careers and goals. Several factors appear to influence the students' views and thoughts on their futures. Many of the students interviewed had already worked several years in industry, either working directly with engineers or in related fields, such as in the military, or adjacent fields, such as welding. The students with these working experiences had clear goals and a good understanding of what would be required of them in the engineering careers they were pursuing due to seeing and speaking with others working engineering jobs around them. See table 6 for a compilation of example quotes highlighting student feelings of clarity from prior experience.

| **Example quotes showing *Clarity from Prior Experience*** |
| --- |
| Chemical engineering was definitely inspired from where I started as a welder. I did a welding program a while back and I took a few classes in there that were more theoretical though really interesting. |
| I used to rub shoulders with engineers and I used to fly the helicopter. So they- they'd run their test. And I'd be the, you know, the monkey pulling the wrenches. And so they- they had different systems and components and software updates and different implementations. They wanna put in the aircraft. And then, you know, we tested and see whether the Marine Corps wanted to buy for all ever- all the aircraft. So I got to do that and so that's what I was like, man, I want to do some of this stuff it's pretty cool, you know. And so that's- that's kind of where I got the- the want to be an engineer. |

Table 6: Quotes from SPECTRA participants highlighting prior experience.

Students who had not previously worked in industry also indicated strong directional goals and ideas on what they would like to get out of their future careers. For example, some desired to run a business or had a niche career they wanted, and they believed the engineering degree they were pursuing was the best way to achieve their ideal careers. See table 7 for a compilation of example quotes highlighting student feelings of clarity from career goals.

| **Example quotes showing *Clarity from Career Goals*** |
| --- |
| So I can go do off- do my own thing with what I learn. I have a bunch of ideas kind of with just, like, making things with- that align with my interest. But I don't- I know what I want, but I don't know how to get there. So with mechanical engineering. I feel like I will learn the processes of-oh, if I want to make this, I know I need to do this this and this. |
| I guess I've seen multiple people own pretty successful businesses doing it. And I think that's pretty common with civil compared to other engineers. A lot of times civil engineers own their own business. So, that- that's what I'm looking for too. |

Table 7: Quotes from SPECTRA participants highlighting career goals.

Others indicated that their time spent in school doing classes or speaking with instructors before their Clemson experience was a driver in pushing them toward an engineering or computer science degree. See table 8 for a compilation of example quotes highlighting student feelings of clarity from previous coursework.

| **Example quotes showing *Clarity from Previous Coursework*** |
| --- |
| I always like math. So it was really my advisor at [Tech-School]. She- she helped me a lot of- cause I didn't know what I wanted to do necessarily. When I got here freshman year to college, she said I should give engineering a shot with this 3-2 program now- also took some summer classes at community colleges. So ever since then, I always liked it. |
| So one of the main reasons I went to [Tech-School] first as well as I did electronics in highschool. I finished my degree in that at [Tech-School]. So in the middle of doing that I just realized I didn't want to be working in a plant much, like- that wasn't for me. So-But I kind of wanted to stay in, like, the technical field, I guess you would call it, and I love construction and stuff like that. So civil is right up my alley. I love construction, but don't want to work construction. |

Table 8: Quotes from SPECTRA participants highlighting clarity from previous coursework.

**Discussion and Conclusion**

SPECTRA scholars are required to take an undergraduate research course with their SPECTRA peers as the course was initially intended to provide the students a space to interact with fellow transfer students within the program and help facilitate the formation of cohorts or a relationship between the students. Additionally, the course intends to provide them with peer connections and students they can relate to about courses and struggles they may experience, specifically as a transfer student. In observing the results from the MAE, particularly in looking at the SPECTRA student's high sense of belonging in their research course community, it seems to suggest that, while the research class may not be the only way in which the students are forming connections with their peers, it is providing an environment in which they feel comfortable and can help them facilitate at least some of the relationship building that the SPECTRA students form with each other.

We can use the qualitative research results to develop our observations further from the results of the MAE. The student interviews suggested that the course design was more open to conversation and that the students could relate to the other transfer students through shared experiences. Most students interviewed found one or a small group of SPECTRA students that they connected with strongly, but others felt a limited connection with everyone. So, while the MAE results show that the SPECTRA course connects students more strongly in their course community than other CECAS courses, there is still some work to be done so that the course can benefit all students. Further observing both quantitative and qualitative results, the SPECTRA students indicate high clarity of their future goals. Most of the students interviewed had prior experiences that pushed them to their desired careers, whether working in industry or through additional experiences at their high schools or technical colleges.

In conclusion, the SPECTRA students feel a sense of belonging at the course level that is higher than their non-transfer peers, and SPECTRA seems to enhance some students' feelings of

belonging at the course level and provides peer connections with other transfer students. While further work is necessary to provide all students in SPECTRA these same benefits, particularly for students who are the only representative of their major, SPECTRA is in a good position to achieve its goals to aid students in their transfer experience and continually improve its programming.

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