WIP: The perception of effectiveness of Supplemental Instructors (SI) on course learning and engineering identity

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Abstract

Supplemental Instruction (SI) is an educational practice that has been utilized for decades to engage undergraduate students taking high risk courses with peer-to-peer support. With historic success, there has been a proliferation of SI programs at institutions of higher learning with over 3,500 programs across the United States [1], [2], [3]. To further continue the historic successes of the SI programs and student achievement, the motivations and perceptions of a student and their impacts on their performance in the classroom and aspects of university life are assessed. Further, engineering identity and perception of the profession are important factors that influence student success in undergraduate engineering programs. Despite these crucial factors, evaluations of student perceptions of SIs and how they might enhance engineering identity in students has been limited [4]. Confronted with this disparity, the authors seek to determine the student's perception of the effectiveness to the educational benefits of the SI program at the University of South Alabama. A survey was created and distributed to students and alumni who have attended the University of South Alabama's College of Engineering. Additionally, interviews of new and seasoned instructors were conducted to determine the perception and utilization of SI's in the classroom. These surveys investigate the students' perceived recognition, interest, and performance/competence in relation to the SI programs and their own performance in the classroom. Preliminary results provide a positive perception of the benefits of education by the utilization of the SI program as presented in the work-in-progress paper.

Introduction

Improving the rates at which students enter and remain in STEM programs has been a concern for any academic institution. In North America, half of engineering students who begin with engineering do not reach graduation and in Europe that estimation is 30 - 40% [5]. Researchers and university administrators have long recognized the attrition rates within STEM-rated programs and have steadily been providing resources to aid in the challenges individuals may face during a given 4-year degree period. Among the methods of improving these rates have been by implementing supplemental instruction (SI). In 1973, the University of Missouri-Kansas City (UMKC) introduced the first SI model to support the retention of students in its medical school program. This deployment was deemed successful and expanded to other courses [6], [7]. As of 2008, the SI model is widely used in approximately 29 countries and over 1500 universities [8]. *Supplemental Instruction* (SI) is defined as a cooperative learning model used to enhance student learning for the retention of students [6]. These learning models are implemented to assist students to develop a deeper understanding of material taught in *high-risk* courses. A *high-risk* course is defined as a course with one and/or more of the following

characteristics: (1) a 30% or higher failure rate, (2) taken within the first two years of a traditional student study program, (3) infrequent exams, (4) large amounts of reading, (5) large class sizes (i.e. high-enrollment), and (6) voluntary/unrecorded class attendance [9].

Many initiatives and policies have been implemented within the University in an effort to improve persistence from first to second year, as well as 4 and 6 year graduation rates. Within the College of Engineering, SI programs have been deployed to these *high-risk* courses (also known as "gatekeeper" or "weed out" classes) to aid in academic achievement of students for over 20 years. In this case, the courses are the following 200 & 300-level courses: Statics, Dynamics, Mechanics of Materials, Economics and Ethics, Engineering Thermodynamics, Electrical Circuits, Fluid Mechanics, and Material and Energy Balances. Students are made aware of SI sessions by the class instructor. SIs often attend classes and make an effort to be visible. The SI program has contributed to the increased 4-year graduation rate of 22% and increased 6-year graduation rates of 17% over the past 10 years. The persistence from first year to second year in the College has increased 11% over the past 12 years. Upon further studies, there were increased concerns in correlating students' academic performance to SI session attendance. Research links students' success to their science identity and self-efficacy [10]. Science identity pertains to a dynamic perspective of oneself relative to the surrounding culture [11]. An individual's science identity plays a considerable role in their resilience, student involvement, and career interests [10]. Self-Efficacy pertains to the brief to accomplish goals, and research links this to the students' science achievement [10]. Science identity and self-efficacy can have a direct impact on student retention and success within STEM, and there is little literature that studies the impact of SI on students' science identity and self-efficacy.

Impact of SIs on struggling vs top students

Previous research has related SI's effectiveness by the increasing of Grade Point Average (GPA) of students in STEM programs [12]. Other research correlates an increased final course grade to attendance at SI sessions [13], [14]. However, McCarthy et al. argues that assessing effectiveness of university SI programs has been inadequate and suggests more qualitative methods of assessing SI programs [15]. In a more recent study, Peter at al [16] states that assessments of SI effectiveness are often conflated with students' efficacy and science identity but are limited by available resources. Key findings from their study were that full attendees were 10% more likely to pass their subject and 9% more likely to continue their study in the following year. This paper focuses on students' experiences with SI in a variety of courses that span all of the *high-risk* engineering courses at this university and evaluate their perceived academic impact.

How are SIs related to undergraduate peer learning

Supplemental Instructors are peer-facilitated learning sessions hosted by a student who has met the criteria of 1) previously taken the course and received an "A" (i.e. exceptional markings,

highest achievable grade category), 2) has been identified or recommended by a professor at the university to has “soft-skills” such communication, empathy, and patience. These SI sessions are typically interactive, group discussions that encourage student participation in a low-stakes environment. It is important to note that SIs do not teach content but reinforce content discussed in the course by working on additional problems. It is also important to note that instructors are not teaching assistants due to the perception by students that they are authority figures [9]. Supplemental Instructors complete a mandatory workshop providing training related to peer interaction, tips on organizing a session, and methods to engage with the instructors on concept reinforcement. Previous research has shown that student attendance of SI sessions on average has improved the grade point of all students. The increased frequency of SI sessions has a further positive effect of grade point average on all students. Additionally, the attendance of SI sessions by traditionally disadvantaged students has closed the performance gap between non-disadvantaged students. Traditionally disadvantaged students are students that may have one or all the following statuses: minority, first-generation, eligible for the Federal Pell grant, and have taken English/mathematics remedial courses [17].

Supporting New Faculty

As new faculty begin their career at their prospective universities, they will take on a large amount of work and responsibilities in pursuit of advancement or tenure. They can struggle to keep up with their responsibilities from publishing their own research, mentoring their students, and teaching classes. It is vital at this time that new faculty can utilize programs that supplement their work and that are effective in helping students. One such program with historic success of retention is SI. These SIs support new faculty by informing new faculty of historic information of the class: how the class was taught before, student perception of the previous professors, and struggles of past students with content. The new faculty have the choice to continue the culture of the class or start anew. Additionally, increased student interactions with a SI leader or model student help create a community and example of learning. That model student can share his or her past experiences in the course, making students more comfortable. Students are then more likely to share their opinions of the course as well as troubles within the class. That feedback can be used to improve the new faculty’s teaching style or provide additional explanation to the class. Faculty can teach and help tailor SI leaders’ approaches to solving problems and guiding students. These faculty interactions with their SI leader will transition to their SI leaders’ guidance and help the faculty’s and SI leader’s students to achieve the faculty’s desired learning outcomes in a joint approach. A joint approach gives the opportunity for students to develop higher-level thinking skills by exposure to collaborative teaching and differing learning strategies in group settings [18]. With additional support, new faculty are better equipped to provide a learning environment conducive to achieving the goals of the course.

Research Questions:

The following research questions about Supplemental Instruction (SI) in STEM education classes were used to guide this study:

1. Do engineering students at the University of South Alabama have a positive perception of the effectiveness of SIs?

2. Do these perceptions of SI effectiveness differ by gender? Do they differ by ethnicity?

3. How are the SI's effectiveness perceived by higher performing students versus lower performing students?

4. Do SIs offer capabilities that improve the classroom environment for new faculty?

Methodology

A 36-question survey was formed with the goal of understanding the students' perceived effectiveness of supplemental instruction and recognition, interest, and performance of engineering students at the University of South Alabama, as shown in Appendix A. It should be noted that the questions in the survey were worded to reflect a positive response, so that the respondent agreeing with the statement reflects a positive perception of the effectiveness of the utilization of SIs. The survey was submitted and approved by the university IRB and then distributed to the student body and to some alumni of the College of Engineering. The pool of potential respondents includes 800 undergraduate students within the college as well as a small portion of alumni reached through the social media contacts of the authors. Students received weekly emails inviting them to complete the survey while it was active, and a flyer was visible around campus. Incentive meals were provided to a small percentage of respondents to the survey who entered a random drawing. The survey was open for 3 weeks in the Fall 2024 semester.

Data for each question was assessed across gender, ethnicity groups, and by self-identified academic performance. Using this method, overall trends could be assessed for the questions related to SIs. The survey also provided an opportunity for additional comments allowing open-ended responses. This quantitative data was also collected and analyzed. In addition to the survey, seven current faculty members who teach courses that utilize Supplemental Instructors were interviewed to provide some quantitative data on the effectiveness of SIs in student success. Two of these faculty were new to the University and have not experienced SIs in the past, either as a student or instructor. These interview responses provide insight into the instructor's perspective and provide insight into the perceived benefit for the new instructors to the College.

Results and Discussion

The respondent pool of the survey consisted of 217, with the classification of the students and alumni, gender, and ethnicity presented in Figure 1:

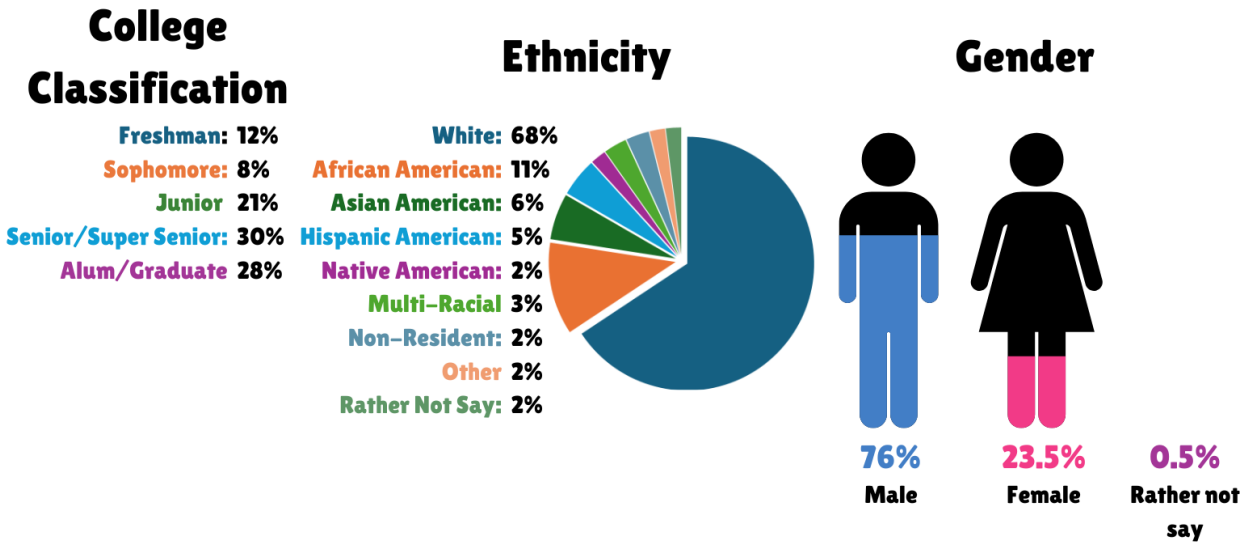

Figure 1: Student classification and alumni percentage of Survey Participants.

The gender of the respondents was very similar to the gender of the College of Engineering student body. The results were assessed across all students, then across ethnicity, gender, and academic performance. To verify that a reliable sample was received, the results of the demographics of the survey respondents were compared to the demographics of the student body of the College of Engineering at the University of South Alabama. The comparison revealed that the ethnicity was leaning 6% more towards "White" students in the survey and 6% less "African American" students than the college population. The population percentage of all other ethnic groups was within 1% of the college student body. A very small percentage of respondents self-proclaimed to have an institutional GPA of lower than 2.5, compared to the percentage of students in the College in that same GPA range. A potential reason could be that higher achieving students are more likely to participate in extracurricular activities such as surveys.

The results of the survey questions related to the student perception of the effectiveness of SIs was analyzed. Initially, the results from questions 8 through 14 were combined to provide an overall student perception of the effectiveness of the utilization of SIs in these higher risk courses. Overall, the respondents appeared to possess a positive perception of the effectiveness of SIs with 68.8% either somewhat or strongly agreeing with the positive effectiveness of SIs, as shown in Figure 2.

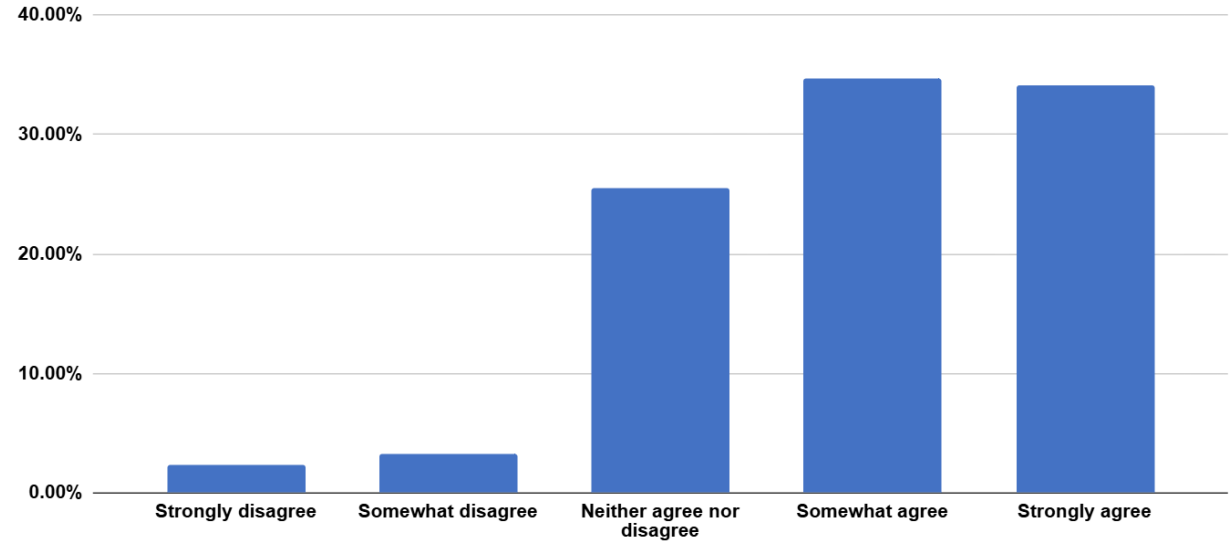

Figure 2: Combined Perception of SI Effectiveness (Q 8-14)

In order to understand the results shown in Figure 3, the data was assessed across ethnic groups. As can be seen, the African-American, Hispanic-American and Multiracial groups tended to skew towards "somewhat agree", while White students tended to "strongly agree". However, if the positive "somewhat agree" and "strongly agree" responses are grouped together, the African-American, Hispanic-American, Asian-American and Multiracial groups have a higher percentage of positive responses. This contrasting difference in perception of SI effectiveness across different ethnic groups raises questions about how SIs are utilized at the University of South Alabama. For example, it is possible that there could be a need to select SIs of more diverse ethnic backgrounds to improve the effectiveness for those ethnic cohorts. However, this will be for future study as no demographic data on SIs hired has been maintained.

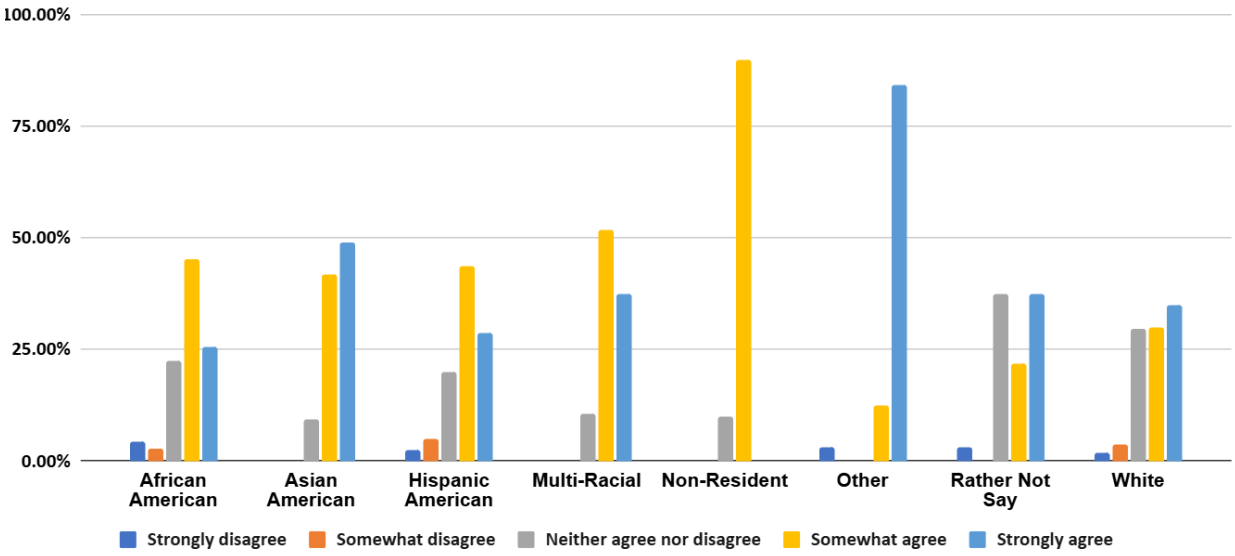

Figure 3: Combined Perception of SI Effectiveness by Ethnic Group

As can be seen in Figure 4, the female students gave a higher preference to “somewhat agree” while male students tended to respond “strongly agree” to questions related to the overall perception of SI effectiveness. However, when the positive “strongly agree” and “somewhat agree” responses are grouped together, it can be seen that overall both groups answered similarly. In this case, there is not a significant difference in response across demographic groups. However, the slight shift towards “somewhat agree” from “strongly agree” may point to a possible lack of appropriately diverse SIs to reach different audiences. It may also be that due to the overwhelmingly male population in the College of Engineering.

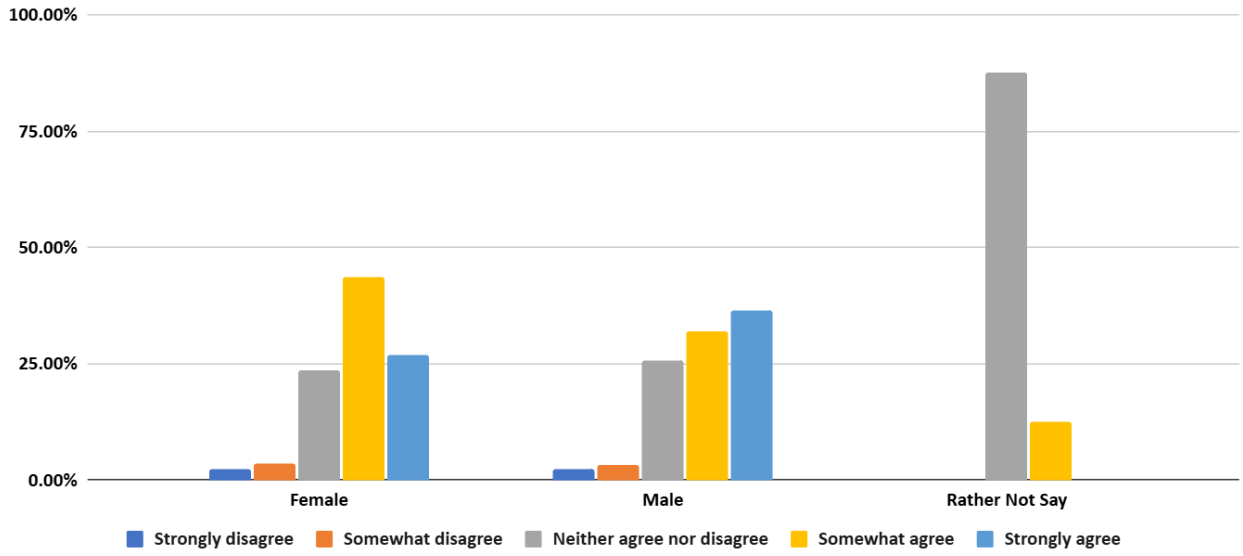

Figure 4. Combined Perception of SI Effectiveness by Gender

Analyzing Question 8: “My Supplemental Instructor (SI) made me want to learn more about Engineering.” individually (see Figure 5), there appears to be a different distribution than the overall responses with male respondents choosing “somewhat agree” more often and female students choosing predominantly selecting “neither agree nor disagree”. However, if positive responses “strongly agree” and “somewhat agree” are combined, it can be seen that the same proportion of male and female students have positive responses. The shift in responses could suggest that SIs are not necessarily encouraging male or female students to learn more about engineering, rather they are just focused on the details of the specific course content without relating it to practical applications. This might be difficult for SIs to implement considering they are also students with limited real-world engineering experience.

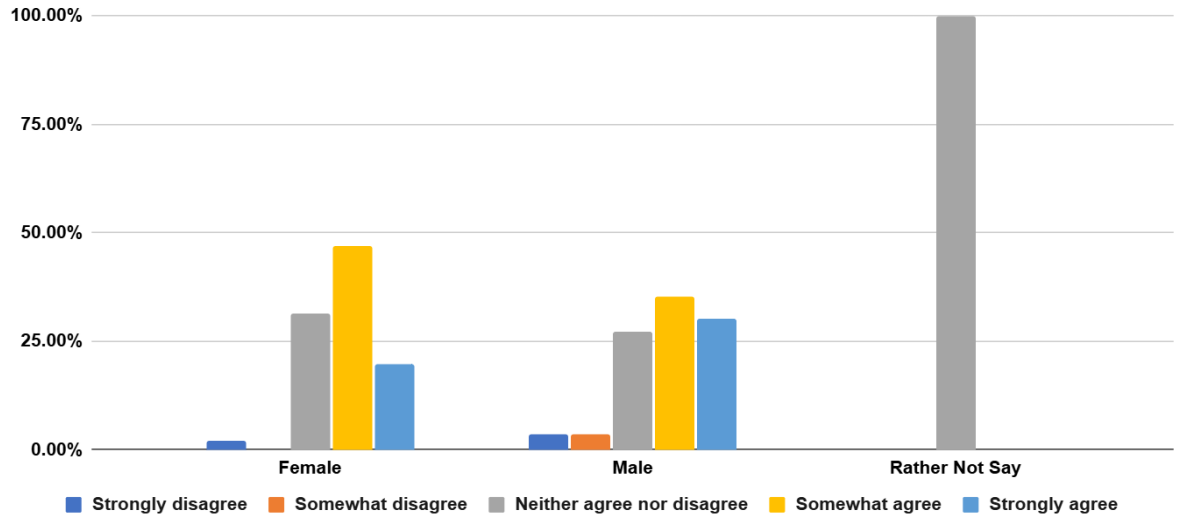

Figure 5: Results for Q8: "My Supplemental Instructor (SI) made me want to learn more about Engineering" across Gender

A similar distribution change can be seen in Question 10, shown in Figure 6. In this figure, the responses to Question 10 "Having a Supplemental Instructor (SI) in the class helps me feel like I belong at the College of Engineering" is broken out across genders. In Figure 6, "strongly agree" and "neither agree or disagree" are the most popular responses for men, deviating from the results in Figure 5. Overall, if "somewhat agree" and "strongly agree" responses are combined, it can be seen that having an SI in the class is perceived to have a more positive perception of their sense of belonging for female students than male students. This may suggest that for male students the sense of belonging to the College of Engineering and the engineering community may take more than attendance and participation in SI sessions.

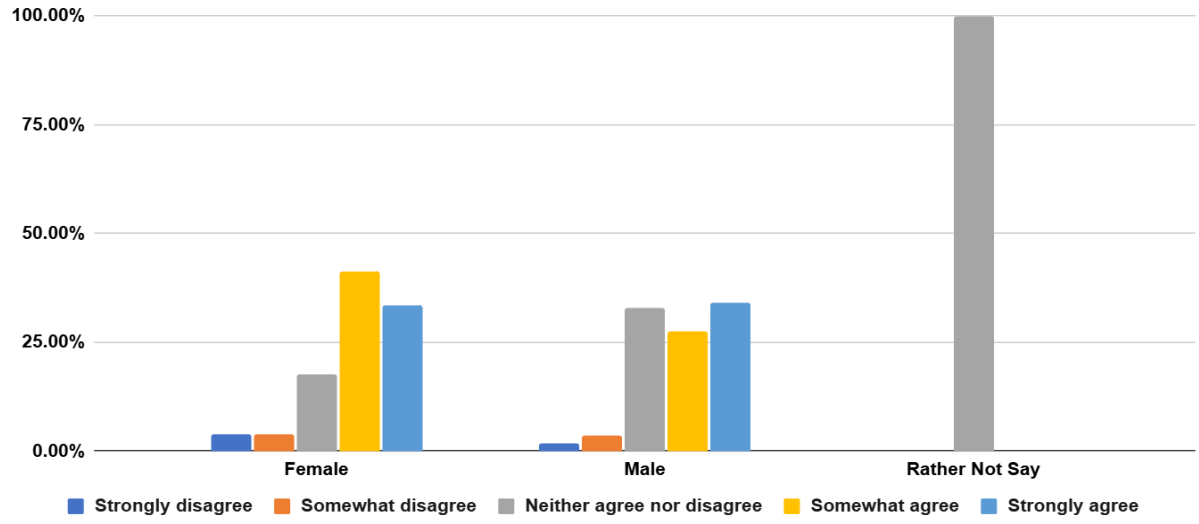

Figure 6: Results for Q10: "Having a Supplemental Instructor (SI) in the class helps me feel like I belong at the College of Engineering" across Gender

Responses were also compared across students grouped into GPA cohorts, as illustrated in Figure 7. This distribution of responses is different depending on the GPA group. Students with a 3.5-4.0 GPA tended to either strongly agree or neither agree or disagree with the SI Effectiveness questions. Conversely, students in the 3.00-3.49 and 2.50-2.99 groups tended to "somewhat agree" with positive perceptions of SI Effectiveness. Tellingly, the group with the least positive responses to SI Effectiveness questions were either Below 2.00 or 2.00-2.49 GPAs. These groups tended to answer "neither agree nor disagree" which may represent some difficulty in helping this lower performing in SI sessions. When positive responses are grouped, it can be seen that students with GPAs from 2.50-4.00 tended to respond more positively than students in the less than 2.50 cohorts. It should be noted that SI sessions are often voluntary to attend. Lower performing students often are not attending these SI sessions for various reasons. There are several possible reasons for the difference in responses when looking at GPA distribution. It is possible that higher-achieving students may find that SI sessions are not as effective or useful for them. Similarly, lower-achieving students may find that SI sessions do not help them overcome the significant learning difficulties or other issues that they have with the material. Both of these impacts may be affected by SIs "teaching to the middle" in an attempt to move sessions forward while still engaged with the majority of students. It may be, from a cursory analysis of this data, that it would be more effective to split the students by GPA and tailor the SI sessions to different levels. This is an important question that could use more data, especially as respondent rates were lower for lower-achieving students than the actual college demographic.

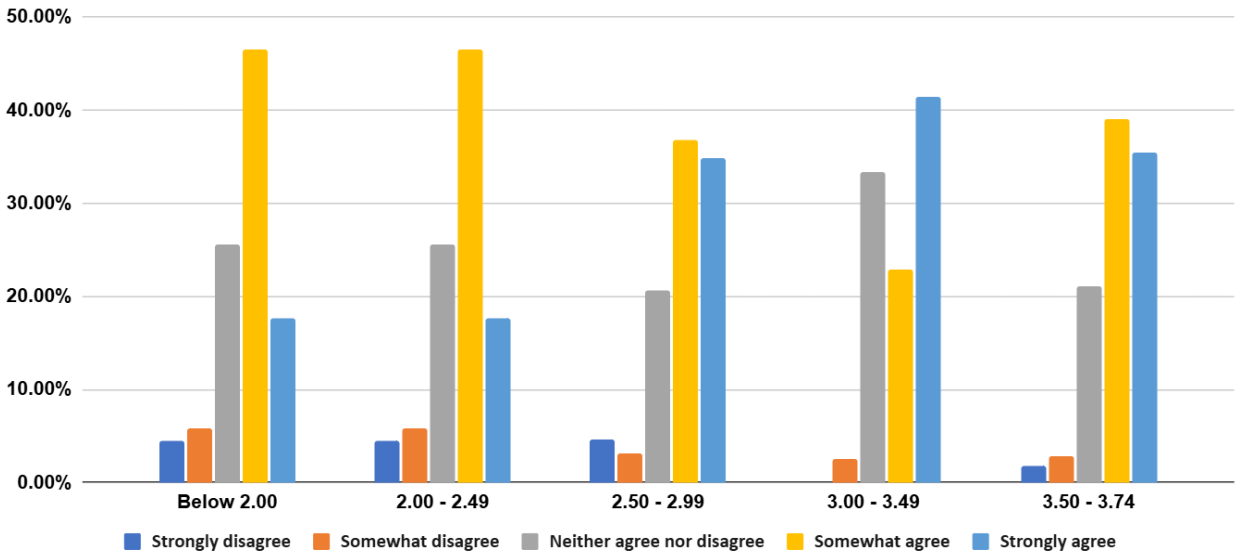

Figure 7: Combined Perception of SI Effectiveness by GPA

In Figure 8, it can be seen that with the exception of Below 2.00 and 2.00-2.49, the answer is predominantly "neither agree nor disagree" and mostly "somewhat agree" for the other GPA groups. This suggests that SI sessions do not encourage lower-achieving students to learn more about engineering. Further, as the responses are mostly "somewhat agree", mid and higher-

achieving students are possibly not being encouraged to do more in engineering by SI sessions. Again, when positive responses are combined, it can be seen that students in the 3.00-4.00 cohorts tended to have the same proportion of positive perception of SIs encouraging them to learn more about engineering.

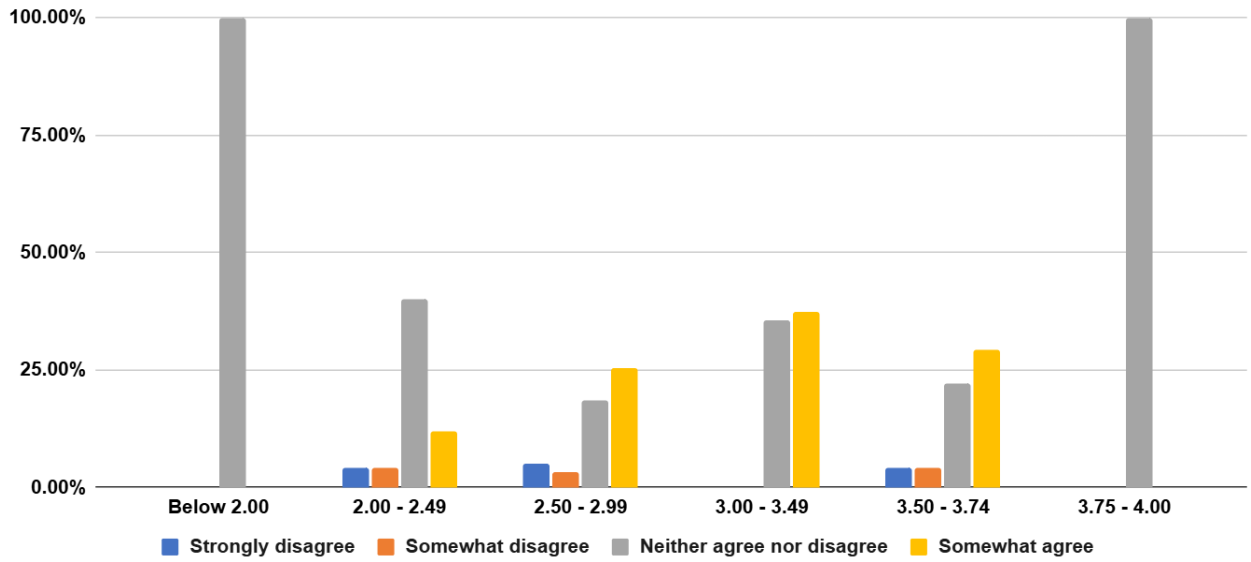

Figure 8: Q8 “My Supplemental Instructor (SI) made me want to learn more about Engineering”

While these presented data appear to provide trends, this is a preliminary analysis and more statistical analysis is necessary to further illuminate the student perception of the effectiveness of SIs in the learning of engineering content.

Student Comments

Figure 9 illustrates the comments left by students. Student comments with respect to SIs were overwhelmingly positive. The positive comments left by students can be broken down into the categories: student recognition of SI leader as a model student, student interest into a subject/class because of and SI, and student acknowledgement of SI leader’s performance/competence. Students commented that they found the SIs helpful and thought that they contributed to their overall success in their respective program. All of the comments pointed towards short course-based gains, or an increase in understanding of core concepts. It is notable that there were no student comments related to engineering identity or belonging in the profession. However, this follows closely the analysis given above, where SIs may not necessarily have encouraged learning or provided a feeling of connection to the profession.

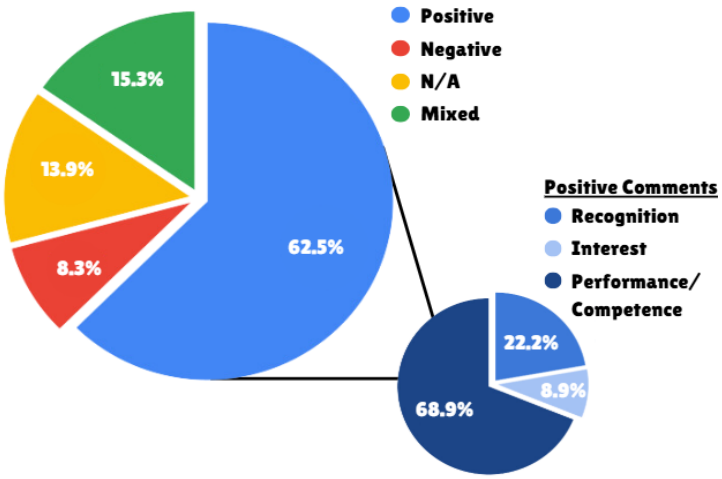

Figure 9: Breakdown of Survey Comments

Faculty Interviews

In addition to the student survey, faculty interviews were conducted with five experienced faculty that utilize SIs and with two new faculty that utilize SI. The faculty members had an overall consensus of positive responses concerning SIs and their use of SIs. All of the faculty claimed that they will continue to use SIs in their future courses with a few comments for improvement. The improvements mentioned were for more frequent communication between the SI and the faculty and for more detailed training of the SI, so they are more uniform in the SI sessions. The call for uniformity comes from some SIs being more useful than others and wanting all SIs to have similar outcomes. One faculty member with teaching experience of 10+ years commented “Not all use SIs, but those that do use the SI is the difference between surviving and not surviving.” The professor was referring to surviving as passing the course and wishes more students would utilize the SI sessions.

The new faculty members also had positive feedback on the use of SI in their classroom. One new faculty said “I really appreciate the existence of SIs” since they have not experienced teaching with one before. Another new faculty member expressed that “I think it [sic] helps new faculty [sic] a lot in engaging students and communicating between students and faculty, sharing experiences about previous instructors.” Both new faculty members are new to the SI program, and both expressed their appreciation towards the program. With the use of SI, the new faculty members have more time to focus on developing content delivery methods, service to the College and University, and conducting research.

Conclusion

Examining the results of the SI survey, it can be seen that students hold a positive perception of the effectiveness of SIs. However, there are variations across ethnicity, gender, and student performance. These variations suggest that there are opportunities to improve SI sessions across genders, ethnic groups, and performance levels. The disparity in responses across gender, from male to female, suggests that female students find SIs to be less effective in helping them learn new material, find an engineering identity, or belong in the College of Engineering. This variation suggests that female students can be better served by SIs than they currently are. The responses across ethnic groups suggest that the two largest demographic groups, White and African American students, have different perceptions of SIs. Specifically, White students "strongly agree" that SIs help them to feel like they belong in the College of Engineering, while African American students only "somewhat agree" across these questions. This may suggest that there should be a more diverse population of SIs that students are exposed to. Aside from the ethnic difference, there was also a significant difference across cohorts grouped according to GPA with lower-achieving students holding a less positive perception of SI effectiveness. This may suggest that these students require more focused tutorials that are aimed at the fundamental building blocks of a specific course or topic. There may be a need for required attendance to sessions when early courses assessment suggests intervention is needed.

The results from Question 8, which relates to whether SI sessions encourage students to learn more about engineering, show that SIs are not necessarily driving student engagement or interest in the material. This is somewhat expected as the main drivers of student engagement need to be faculty. This means that although new faculty can rely on SIs to provide reinforcement of material, it is up to faculty to encourage students to be engineers and to help students find their engineering identity. However, the overwhelmingly positive response of students to questions about SI effectiveness suggests that new faculty can potentially be confident that SIs can be effective in leading sessions to improve content understanding. This also helps new faculty members improve content delivery in the classroom, while providing increased opportunities to begin developing a research program.

The results of this survey provide many more opportunities to analyze the effectiveness of SIs through comparison of the student perception and cross-referencing the ethnic, gender, and student performance. Further, there are a number of senses of belonging and engineering identity questions in the survey that can be assessed and synthesized based on various demographics. Additionally, an analysis of how SI session attendance impacts the future academic performance of students. A key aspect of the assessment of the SI program is the ability to retain students and this understanding of how SI attendance impacts GPA would be important to investigate. Similarly, an understanding of the demographic groups of SIs would help to solidify whether diversity of SIs is a factor in the difference of responses across gender, ethnicity, and GPA. In

future, the authors propose to perform a more in-depth statistical analysis to determine the mean and standard deviation of the survey results. Further, the authors intend to run this survey over multiple years to improve the statistical significance of the results.

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Appendix A.

Student Survey Questions

1: Age

Under 18, 18-20, 20-24, 22-24, 24 -26, 26+

2: Gender

Male, Female, Rather Not Say, Other

3: Ethnicity

White, African American, Asian American, Hispanic American, Native American, Pacific Islander, Multi-Racial, Non-Resident, Rather Not Say, Other

4: Current GPA Range

3.75-4.00, 3.50-3.74, 3.00-3.49, 2.5-2.99, 2.00-2.49, Below 2.00

5: What is your major in engineering?

Chemical Engineering, Civil Engineering, Computer Engineering, Electrical Engineering, Mechanical Engineering, General Engineering

6: College Categorization

Freshman, Sophomore, Junior, Senior/Super Senior, Alum/Graduate

7: Are you a first generation student? (A First Generation College Student can be defined as a student whose parents or guardians did not complete a four-year college degree.)

Yes, No

8: Generally, how often did you attend SI sessions?

Never, Rarely, Occasionally, Often, Every time offered

9: My Supplemental Instructor (SI) made me want to learn more about Engineering.

Strongly disagree, Somewhat disagree, Neither agree nor disagree, Somewhat agree, Strongly agree

10: My Supplemental Instructor (SI) has helped me overcome setbacks in Engineering.

Strongly disagree, Somewhat disagree, Neither agree nor disagree, Somewhat agree, Strongly agree

11: Having a Supplemental Instructor (SI) in the class helps me feel like I belong at the College of Engineering.

Strongly disagree, Somewhat disagree, Neither agree nor disagree, Somewhat agree, Strongly agree

12: My Supplemental Instructor (SI) helped me perform better on my exams in Engineering.

Strongly disagree, Somewhat disagree, Neither agree nor disagree, Somewhat agree, Strongly agree

13: Supplemental Instructors (SI's) have played a positive impact in continuing my education in Engineering.

Strongly disagree, Somewhat disagree, Neither agree nor disagree, Somewhat agree, Strongly agree

14: Supplemental Instructors (SI's) have played a key role in my ability to retain information conveyed in the course.

Strongly disagree, Somewhat disagree, Neither agree nor disagree, Somewhat agree, Strongly agree

15: Supplemental Instructors (SI's) have played a key role in improving my overall class performance.

Strongly disagree, Somewhat disagree, Neither agree nor disagree, Somewhat agree, Strongly agree

16: My Supplemental Instructor (SI) has helped instill confidence in my ability to understand engineering (inside or outside of class).

Strongly disagree, Somewhat disagree, Neither agree nor disagree, Somewhat agree, Strongly agree

17: Did you take a class during COVID with an SI?

Yes, No

18: If you had a Supplement Instructor (SI) during COVID, they helped with learning the information for the course.

Strongly disagree, Somewhat disagree, Neither agree nor disagree, Somewhat agree, Strongly agree

19: State any comments related to your experience with your SI.

20: My instructors see me as an engineer.

Strongly disagree, Somewhat disagree, Neither agree nor disagree, Somewhat agree, Strongly agree

21: My peers see me as an engineer.

Strongly disagree, Somewhat disagree, Neither agree nor disagree, Somewhat agree, Strongly agree

22: I have had experiences in which I was recognized as an engineer.

Strongly disagree, Somewhat disagree, Neither agree nor disagree, Somewhat agree, Strongly agree

23: I enjoy learning engineering.

Strongly disagree, Somewhat disagree, Neither agree nor disagree, Somewhat agree, Strongly agree

24: I find fulfillment in doing engineering.

Strongly disagree, Somewhat disagree, Neither agree nor disagree, Somewhat agree, Strongly agree

25: I am confident I can understand engineering in class.

Strongly disagree, Somewhat disagree, Neither agree nor disagree, Somewhat agree, Strongly agree

26: I am confident I can understand engineering outside of class.

Strongly disagree, Somewhat disagree, Neither agree nor disagree, Somewhat agree, Strongly agree

27: I understand concepts I have studied in engineering.

Strongly disagree, Somewhat disagree, Neither agree nor disagree, Somewhat agree, Strongly agree

28: Other students ask me for help in engineering courses.

Strongly disagree, Somewhat disagree, Neither agree nor disagree, Somewhat agree, Strongly agree

29: I can overcome setbacks in engineering.

Strongly disagree, Somewhat disagree, Neither agree nor disagree, Somewhat agree, Strongly agree

30: Do you have any comments related to the questions above?

31: I feel a sense of belonging at the College of Engineering.

Strongly disagree, Somewhat disagree, Neither agree nor disagree, Somewhat agree, Strongly agree

32: I feel comfortable being myself in the College of Engineering.

Strongly disagree, Somewhat disagree, Neither agree nor disagree, Somewhat agree, Strongly agree

33: I feel valued at the College of Engineering.

Strongly disagree, Somewhat disagree, Neither agree nor disagree, Somewhat agree, Strongly agree

34: I feel like a part of the community at the College of Engineering.

Strongly disagree, Somewhat disagree, Neither agree nor disagree, Somewhat agree, Strongly agree

35: I feel like a part of the community at the University of South Alabama.

Strongly disagree, Somewhat disagree, Neither agree nor disagree, Somewhat agree, Strongly agree

36: Do you have any comments related to the questions above?

Strongly disagree, Somewhat disagree, Neither agree nor disagree, Somewhat agree, Strongly agree