Attachment 35

Sanger Learning Center

2018-2019 and 2017-2018 Academic Year 1-page Dashboards Followed by the Detailed Assessment Plan and Representative Reports and Publications Describing the Success of Sanger Tutoring Programs

VISION Every UT student should have access to high-quality academic support, regardless of family income or ability to pay.

MISSION To serve as the university-wide learning resource dedicated to students' mastery of course content and development of transferable academic and professional skills.

UGS Program Review
Fall 2019

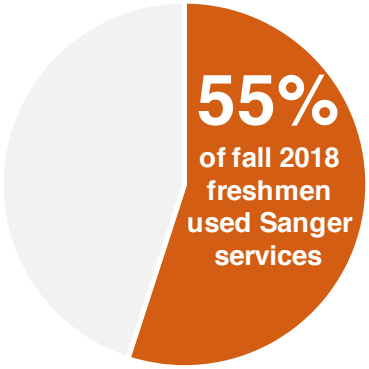
The University of Texas at Austin
School of Undergraduate Studies

Sanger Learning Center 2018 - 2019 Report

STUDENT POPULATION SERVED

11,881 unique students served

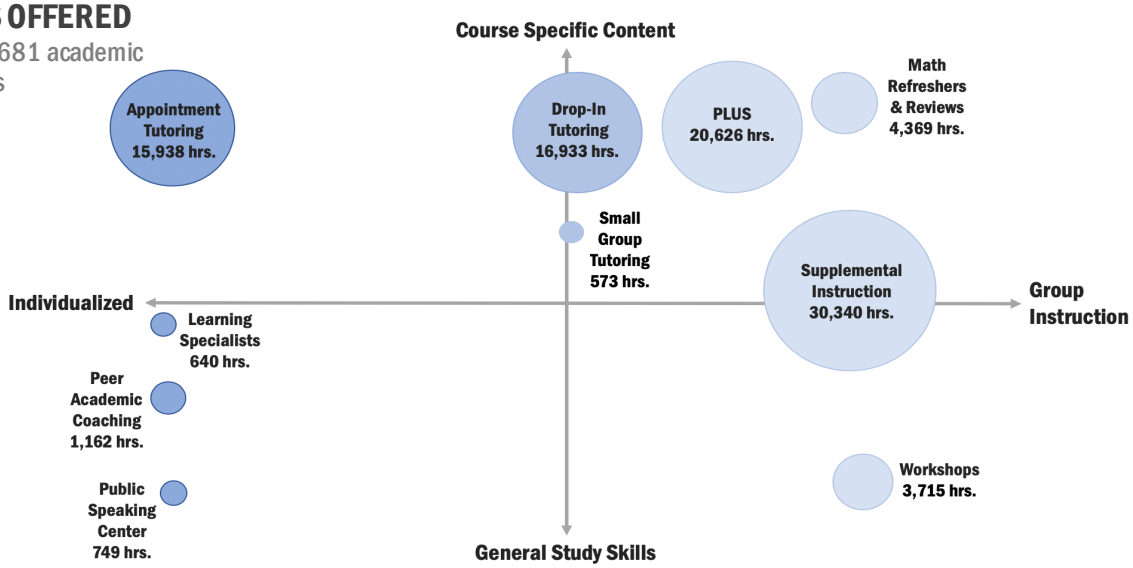
372 student employees



28% of Sanger users were 1st generation students

SERVICES OFFERED

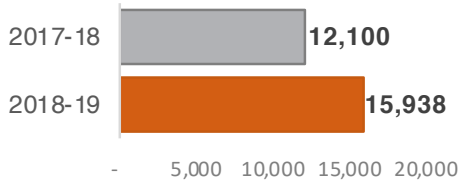
Provided 94,681 academic support hours



OUTCOMES

Appointment Tutoring

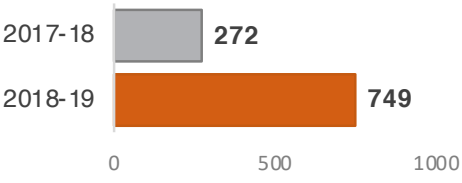
The number of tutoring sessions increased by 31.7%, but the number of student users stayed relatively stable, from 2,700 in 17-18 to 2,867 in 18-19.



90% of students surveyed reported increased confidence as a result of their tutoring session.

Public Speaking Center

Completed appointments increased by 175%, and unique student users increased from 191 to 532.

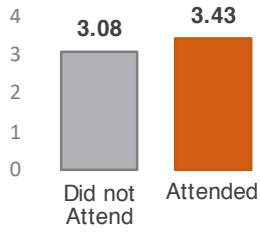


97% of students surveyed agreed that their consultant provided helpful feedback and strategies to improve.

Peer-Led Undergraduate Studying (PLUS)

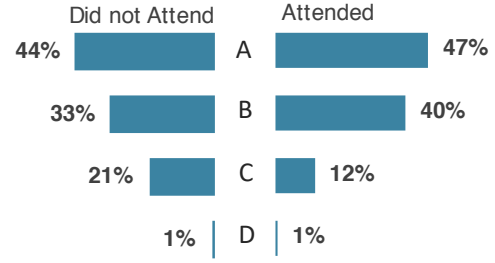
After controlling for gender, race, parents' education level, parents' income and SAT score, students who attended PLUS regularly in Fall 2018 averaged .35 points higher on their end of semester grade than those who did not attend PLUS. ($p < 0.001$, $n = 3,802$)

Comparison of mean course GPA



Hands-On Supplemental Instruction (HO-SI)

On average, students in BIO 311C who attended HO-SI tended to earn higher course grades than students who did not attend. While there is a small increase in HO-SI attendees earning As over non-attendees, the data demonstrate a strong shift in HO-SI attendees earning Bs over Cs.



The University of Texas at Austin
School of Undergraduate Studies

Sanger Learning Center 2017 - 2018 Report

STUDENT POPULATION SERVED

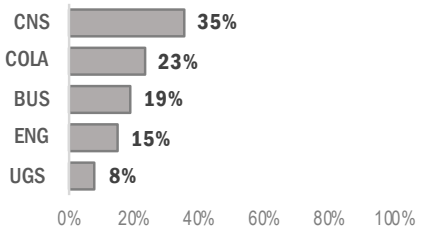
11,388 unique students served

532 student educators

28% of the entire undergraduate student body.

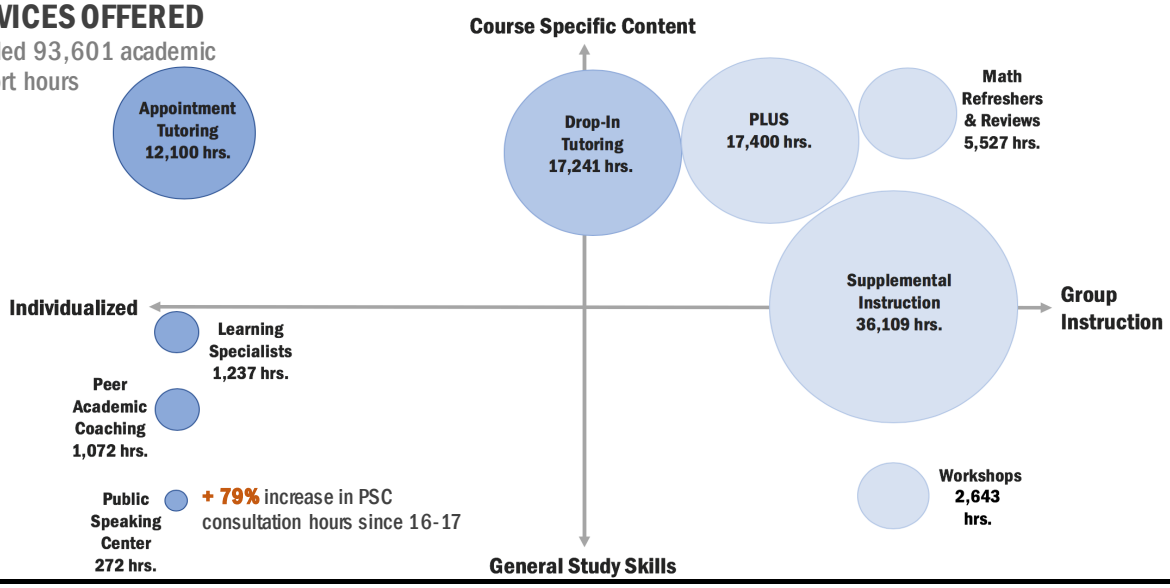
54% of Fall 2017 incoming Freshmen participated in Sanger services.

The majority of students who use SLC services come from the four largest colleges at UT and from our home college.



SERVICES OFFERED

Provided 93,601 academic support hours

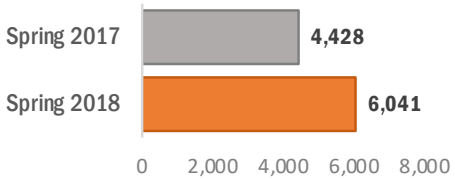


+ 79% increase in PSC consultation hours since 16-17

OUTCOMES

Appointment Tutoring

When SLC piloted unlimited free tutoring in Spring 2018, completed student appointments increased by 36%.



90% of students surveyed indicated that their tutor *"demonstrated a clear understanding of the course material."* (n = 569)

Supplemental Instruction

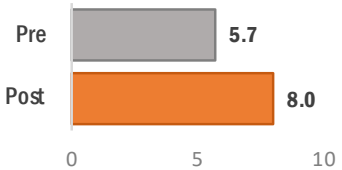
After controlling for gender, race, parents' education level, parents' income and SAT score, ECON 304 students who attended SI regularly averaged 0.34 points higher on their end of semester course grade compared to those who did not attend SI. ($p < 0.05$, n = 1,178)

Comparison of median course GPA

Public Speaking Center

Average pre-post survey results showed that students increased their public speaking confidence as a result of using the PSC.

(Right now, I would give my public speaking confidence the following score: 1 = very poor to 10 = excellent)

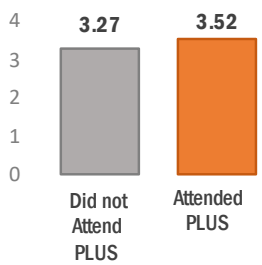


98% of students surveyed agreed that, they *"would recommend this program to others."* (n = 113)

Peer-Led Undergraduate Studying (PLUS)

After controlling for gender, race, parents' education level, parents' income and SAT score, students who attended PLUS regularly averaged 0.25 points higher on their end of semester course grade compared to those who did not attend PLUS. ($p < 0.01$, n = 961)

Comparison of median course GPA



The University of Texas at Austin
Sanger Learning Center
School of Undergraduate Studies

Mission: The Sanger Learning Center (SLC) is a university-wide learning resource dedicated to students' mastery of course content and development of transferable academic and professional skills.

Your Planned Work			Your Intended Results	
Desired Goals The following goals define your mission	**Activities/Services** **If** you want to accomplish your desired goals, **then** you will conduct or provide the following activities	**Evidence of Activities/Services** **If** you accomplish your planned activities, **then** you will hopefully deliver the amount of service that you intended (e.g., products, reports, number of services/events)	**Expected Outcomes** **If** you accomplish your planned activities to the extent you intended, **then** your participants will benefit in certain ways (e.g., changes in knowledge, skills, attitudes, behaviors)	**Expected Long-Term Impacts** **If** these benefits are achieved, **then** certain changes in groups or communities are expected to occur
1. SLC will monitor and adapt to UT students' changing academic support needs	Monitor visitation trends Provide on-demand services Program outreach initiatives	• # and type of students using SLC services • # and type of requests • # and type of SLC services provided • # and type of students that used SLC services	Students who are representative of the university population use SLC services Students are satisfied with SLC services	Continued use of SLC services from representative university population
2. SLC student educators will develop professional skills	Train student educators Program development and assessment initiatives Facilitate and encourage student educators to attend internal and external workshops Signature Course TA Support	• # of student educators trained • Report of center-wide processes and standards • # of workshops provided • # of student educators that attended workshops • # and type of SC TA support	Student educators develop generalized, work-related professional skills Undergraduate student educators will develop program-specific skills Graduate student educators use fundamental teaching skills	Student educators continue to apply professional skills throughout college and beyond
3. Students' mastery of course content will improve as a result of SLC services	**Sanger services:** • Tutoring services • Math Classes • Supplemental Instruction (SI) • Peer-Led Undergraduate Studying (PLUS) • DSP Weekly Calculus Review	• # of content support services offered • # of students that attended content support services	Students report gains in understanding course content Students demonstrate gains in understanding course content	Students attribute success in related courses to SLC services
4. Students will develop effective learning strategies as a result of SLC services	**Sanger services:** • Peer Academic Coaching • Learning Specialist Appts. • DSP Appts. • FIG Presentations • Workshops/Outreach • U-Transform Workshop • Public Speaking Center • Tutoring Services, SI, PLUS	• # of teaching/learning support services offered • # of students that attended teaching/learning support services	Students report using or intending to use new learning skills Students report increased confidence in their ability to new use learning skills	

	Your Planned Work		Your Intended Results	
Desired Goals The following goals define your mission	**Activities/Services** **If** you want to accomplish your desired goal, **then** you will conduct/provide the following activities	**Evidence of Activities/Services** **If** you accomplish your planned activities, **then** you will hopefully deliver the amount of service that you intended	**Expected Outcomes** **If** you accomplish your planned activities to the extent you intended, **then** your participants will benefit in certain ways (e.g., changes in knowledge, skills, attitudes, behaviors)	**Expected Long-Term Impacts** **If** these benefits are achieved, **then** certain changes in groups or communities should occur
1. **SLC will monitor and adapt to UT students' changing academic support needs**	**Monitor visitation trends:** Identify student visitation trends and requests **Provide on demand services:** Provide services based on student visitation trends and requests. Sanger will also expand, contract, or create new programs to meet student needs based on trends and student feedback **Program outreach initiatives:** Communicate and advertise SLC services to UT community	Number and type of students using SLC services and type of requests Number and type of SLC services provided Track requests for new or additional services (MYUGS) Number and type of students that used SLC services	**1.1 Students who are representative of the university population use SLC services** 15-16; 17-18 1. The rate at which students utilize the SLC will be consistent with the total number of undergraduate students (*Survey about awareness of SLC and support needs*) 2. Student participants and student educators will reflect the demographic background and gender diversity of the general student population (*Track student demographics)*	Continued use of SLC services from representative university population

	Your Planned Work		Your Intended Results	
Desired Goals The following goals define your mission	**Activities/Services** **If** you want to accomplish your desired goal, **then** you will conduct/provide the following activities	**Evidence of Activities/Services** **If** you accomplish your planned activities, **then** you will hopefully deliver the amount of service that you intended	**Expected Outcomes** **If** you accomplish your planned activities to the extent you intended, **then** your participants will benefit in certain ways (e.g., changes in knowledge, skills, attitudes, behaviors)	**Expected Long-Term Impacts** **If** these benefits are achieved, **then** certain changes in groups or communities should occur
2. SLC student educators will develop fundamental teaching and/or professional skills	**Train student educators:** SLC supervisors will train new undergraduate Supplemental Instruction Leaders, Outreach Assistants, Peer Academic Coaches, Tutors, Student Speech Consultants, Undergraduate Assistants, and Peer-Led Undergraduate Studying (PLUS) Peer Coordinators. All undergraduate student educators will be required to attend training before assuming an active program role **Program development initiatives:** -SLC staff will develop center-wide professional development model so that student educators are able to identify areas of professional development growth (NOTE: the PD model that the PD committee developed) -Each SLC program will develop training protocols specific to their programs' goals and desired outcomes (appointment tutoring, drop-in tutoring, Peer Academic Coaching, Peer-Led Undergraduate Studying, Outreach, Public Speaking Center) **Program assessment initiatives:** -SLC staff will develop pre/post workshop questionnaire to assist student educators in measuring their personal growth areas (NOTE: survey by the Assessment Committee, based on the PD model mentioned above) -Each SLC program will implement a process by which undergraduate student educators and program staff can evaluate training efficacies **Facilitate and encourage student educators to attend internal and external workshops**:	Number of student educators trained Report of center-wide student educator professional skills, performance standards, assessment measures, curriculum and PD protocols Number of internal and external student educator workshops Number of student educators that attended internal and external workshops Number and type of Signature Course TA cohort support	**2.1 Student educators develop generalized, work-related professional skills** 16-17 1. **≥25%** of student educators will attend generalized training events *(Track training/workshop event attendance)* 2. **100%** of student educators reporting workshop attendance will complete a pre/post workshop questionnaire *(Post workshop questionnaire)* 3. **≥75%** of student educators completing workshop questionnaire will demonstrate increased understanding of the workshop-related professional development skill *(End of workshop assessment)* 18-19 4. All student educators who attend workshops will answer **≥90%** of post-workshop questions correctly or demonstrate understanding through workshop reflection (*End of workshop assessment)* 5. All student educators will demonstrate understanding and value of professional skills (*Professional skills portfolio*) **2.2 Undergraduate student educators will develop program-specific skills** 15-16; 17-18 1. **100%** of undergraduate student educators will attend pre-service training *(Track training attendance)* 2. **100%** of undergraduate student educators will complete their program's assessment process in their first semester of SLC employment *(program-specific assessment procedures)*	Student educators continue to apply teaching and/or professional skills throughout college and beyond

	Your Planned Work		Your Intended Results	
Desired Goals The following goals define your mission	**Activities/Services** **If** you want to accomplish your desired goal, **then** you will conduct/provide the following activities	**Evidence of Activities/Services** **If** you accomplish your planned activities, **then** you will hopefully deliver the amount of service that you intended	**Expected Outcomes** **If** you accomplish your planned activities to the extent you intended, **then** your participants will benefit in certain ways (e.g., changes in knowledge, skills, attitudes, behaviors)	**Expected Long-Term Impacts** **If** these benefits are achieved, **then** certain changes in groups or communities should occur
	SLC staff will encourage student educators to attend training workshops/events through notification to student staff of professional development events (e.g., SEED workshops) **Signature Course TA Cohort Support:** A 5-week training that teaches TA's fundamental skills used to support student learning.		**2.3 Graduate student educators use fundamental teaching skills** 15-16; 17-18 1. **100%** of graduate student educators will attend pre-service training, excluding Signature Course TA's *(Track training attendance)* 2. **100%** of graduate student educators will complete their program's assessment process in their first semester of SLC employment, excluding Signature Course TA's *(program-specific assessment procedures)* 3. Pre-post data are collected	

	Your Planned Work		Your Intended Results	
Desired Goals The following goals define your mission	**Activities/Services** **If** you want to accomplish your desired goal, **then** you will conduct/provide the following activities	**Evidence of Activities/Services** **If** you accomplish your planned activities, **then** you will hopefully deliver the amount of service that you intended	**Expected Outcomes** **If** you accomplish your planned activities to the extent you intended, **then** your participants will benefit in certain ways (e.g., changes in knowledge, skills, attitudes, behaviors)	**Expected Long-Term Impacts** **If** these benefits are achieved, **then** certain changes in groups or communities should occur
3. Students' mastery of course content will improve as a result of SLC services	**Tutoring Services:** *Appointment Tutoring:* one-to-one course content support led by peers. *Drop-In Tutoring:* course content support led by peers for lower division Chemistry, Math, and Physics. **Math classes:** ***Mathematics Refresher Class:*** Helps students solidify prerequisite material at beginning of their calculus courses. ***Mathematics Exam Review Classes:*** Assists students in preparing for each of their three regular course exams. ***Mathematics Final Exam Review Class:*** Assists students in preparing for their course final exam. ***DSP Weekly Calculus Review:*** Weekly one-hour meetings with Discovery Scholars Students enrolled in M408K or M408L. **Supplemental Instruction (SI):** Weekly discussion sections led by undergraduate (ECO) and graduate-level instructors that cover historically difficult large-format courses. Students master course content while strengthening learning and analytical skills. **Peer-Led Undergraduate Studying (PLUS):** Class-specific, weekly study groups for historically difficult courses.	Number of content support services offered Number of students that attended content support services	**3.1 Students report gains in understanding course content** 16-17; 18-19 1. **≥95%** of survey respondents A/SA that they met objectives from Tutoring, Math Classes, SI and PLUS. Benchmarks will be set according to the Likert scale used in each survey *(Survey gauging impact of content support in 16-17*) 2. There will be a positive correlation between attendance and class grades (*Attendance-Grade Assessment from 15-16 data)* **3.2 Students demonstrate gains in understanding course content** 16-17; 18-19 1. For programs calculating such measures (SI and PLUS), there will be a positive correlation between attendance and class grades *(Attendance-Grade Assessment from 15-16 data)*	Students continue to pass their subsequent courses in similar subject area

	Your Planned Work		Your Intended Results	
Desired Goals The following goals define your mission	**Activities/Services** **If** you want to accomplish your desired goal, **then** you will conduct/provide the following activities	**Evidence of Activities/Services** **If** you accomplish your planned activities, **then** you will hopefully deliver the amount of service that you intended	**Expected Outcomes** **If** you accomplish your planned activities to the extent you intended, **then** your participants will benefit in certain ways (e.g., changes in knowledge, skills, attitudes, behaviors)	**Expected Long-Term Impacts** **If** these benefits are achieved, **then** certain changes in groups or communities should occur
4. Students will develop effective learning strategies as a result of SLC services	**Peer Academic Coaching:** one-to-one tutoring session led by peers, focusing on learning effective study skills. **Learning Specialist Appointments:** one-to-one tutoring session led by professional staff, focusing on learning effective study skills. Mandatory for students on probation. **DSP Appointments/FIG Presentations**: Learning specialists meet one-on-one with Discovery Scholars Students and also present in FIG meetings. **Workshops and Outreach:** On-demand workshops/classes delivered for FIGs and Mandatory study skills sessions during orientation. **U-Transform Workshop:** one-hour workshop delivered to all incoming transfer and first-year students, emphasizing the transition to college learning. **Public Speaking Center:** Individual or group consultation services led by trained student speech educators for students working on communication assignments. **Tutoring Services, Supplemental Instruction (SI), and Peer-Led Undergraduate Studying (PLUS):** (see above)	Number of learning support services offered Number of students that attended learning support services	**4.1 Students report using or intending to use new learning skills** 15-16; 17-18 **1.** Benchmark TBD 15-16. (*Immediate Post-Workshop Survey*) 2. Benchmark TBD 15-16. (*Prolonged Post-Workshop Survey*) **4.2 Students report increased confidence in their ability to use new learning skills** 15-16; 17-18 1. **≥90%** of students report an increase in learning skills capability. (*Comparison of Pre and Post Self-Rating Tests*) 2. **≥80%** of students report increased confidence in their ability to use new learning skills. (*Comparison of Pre and Post Self-Assessment of Public Speech Confidence Tests*) 3. Responses will indicate a favorable interaction with learning specialist and use of learning skills (*DSP Annual Survey*) 4. Responses to the question "What was the most valuable part of Orientation?" will reference the U-Transform Workshop (*New Student Services Annual survey*)	Students continue to use their effective learning strategies in subsequent courses.

Assessment of Supplemental Instruction Programming and Continued Academic Success

Jenell Wilmot, University of Texas, Austin

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Dr. Nina Kamath Telang, University of Texas, Austin

Nina Telang is a senior lecturer in the Department of Electrical and Computer Engineering at the University of Texas at Austin. She received the B.Tech degree in Engineering Physics from the Indian Institute of Technology, Mumbai in 1989, and the M.S. and Ph.D. degrees in Electrical Engineering from the University of Notre Dame in 1992 and 1995 respectively. Her teaching interests are in the area of circuits and devices, computing, and logic design. Dr. Telang works closely with success programs for freshman engineering students.

Assessment of Supplemental Instruction Programming and Continued Academic Success

Abstract

A main aspect of the Supplemental Instruction program's mission is to help students develop transferable study skills that will improve their academic performance in all of their university coursework. At the University of Texas at Austin, the Electrical and Computer Engineering (ECE) department partnered with the learning center to provide Supplemental Instruction programming to the freshman-level course Introduction to Electrical Engineering (EE 302) in fall 2015. This course is the first part of a two-course sequence, the second of which is Circuit Theory (EE 411). Of the students enrolled in EE 411 in the spring 2016 semester, students who attended SI sessions during the fall 2015 EE 302 course had higher course grades than the non-attendees, even though this group's spring 2016 end of semester grade point averages were lower and this group's course grades in EE 302 were lower. To continue to investigate the long-term implications of SI attendance and gain a better understanding of what the SI program can offer students in the ECE program at UT Austin, future studies will benefit from additional data as students continue to progress through their program, and the inclusion of qualitative measures for a mixed-methods approach.

Introduction

This complete research paper will examine the continued effects of an SI program on the academic performance of ECE students by analyzing the relationship between prior SI attendance and academic performance in subsequent related courses and semesters. The SI program offers optional, non-remedial discussion sessions to students enrolled in a required freshman-level course with historically high rates of D's, F's, drops, and withdraws (DFQW rate). The SI program was first established to support the EE 302 course in fall 2015. This study analyzes the ongoing academic performance the student populations who either did or did not attend the SI sessions as they continue onto subsequent coursework.

I. Review of Literature

The purpose of the first year of any engineering program is to expose students to the principles of engineering, provide students with the foundation required for subsequent discipline specific courses, and to acclimate students to the rigors of a college education. Most programs offer students assistance in the form of advising, tutoring, and remedial support. With freshman classes, these support structures are built to help students with the transition (both academic and social) from high school to college, and to assist with difficult coursework.

Some institutions have implemented the SI program for freshman level engineering coursework [1-10]. Most studies have looked at the correlation between SI attendance and student performance in the course offering the SI program. There is only limited literature on the effect of SI on the transferability of the skills gained to upper level engineering coursework. Analysis of SI attendance and grade performance has shown that SI attendance may have a relationship to

improved persistence in the degree program with fewer leaving the degree [4, 10] and completing more credits in their first year [9, 10]. The transferability of skills to subsequent coursework has been studied previously in disciplines related to engineering such as the natural sciences [11].

II. Motivations and Limitations of Study

One of the main objectives of the supplemental instruction program at UT Austin is to impart study skills that will help students not only in the course that is supported by SI, but in their subsequent coursework as well. Another objective of the SI program specific to engineering is to help students develop problem solving skills needed for all engineering coursework. By investigating the long-term effects of SI attendance on academic performance, we will better understand the transferability of study skills and technical skills developed by the SI program. Considering the long-term relationships between SI attendance and academic success along with the observed short-term relationships reported in previous studies [12], we will better identify the aspects of SI that are most beneficial to students. This information will allow program administrators to revise the SI program to best prepare students for long-term academic success in their major coursework.

Given that student participation in the SI program was voluntary, it is likely that the more motivated students were attending the SI sessions. Therefore, this study's findings face limitations in comparing student performance and attendance. For this reason, the students mean standardized test scores and predicted GPAs were also compared as a way to better understand their level of preparation. Future studies will benefit from controlling for students' motivation and proclivity for help-seeking behavior.

III. Research Questions

To assess the relationships between SI attendance in EE 302 and performance in spring coursework, particularly EE 411, this study addresses the following research questions:

1) Is there any correlation between SI attendance in EE 302 and performance in EE 411?
2) Is there a relationship between SI attendance and future semester grade point averages?

IV. Definitions Used in Study

The following terms utilized in this study are defined according to the authors' and the university's use:

- **Drop:** students may leave a course without it being noted on their transcript up to the 12th class day.
- **Fail:** a student earning below a D- has failed a course.
- **Q-Drop:** students may leave a course after the 12th class day with a "Q" noted on their transcript [13].

Design and Implementation

I. Course Content and Student Enrollment

The objectives of the Introduction to Electrical Engineering (EE 302) course are to introduce the freshman student to the basics of electrical engineering through the study of DC circuits. Students learn all the basic laws that govern circuits such as the power conservation law, Kirchhoff's current and voltage laws, and Ohm's Law, followed by circuit analysis techniques such as nodal analysis, mesh analysis, superposition, and circuit equivalency using Thevenin's and Norton's equivalent. The course concludes with a unit on Operational Amplifiers. Students are advised to enroll in EE 302 during their first semester in the Electrical Engineering program at the university. Typically, this is during the student's freshman fall semester.

The EE 302 course is followed by a 4 credit Circuit Theory (EE 411) course taken by students in either the spring semester of the freshman year, or the fall semester of the sophomore year. The course objectives include first-order and second-order circuits, sinusoidal steady state analysis using phasors, AC power analysis including three-phase power, and frequency response. To be eligible for enrollment in the course, students must have successfully completed the EE 302 course as well as an introductory Physics course, Calculus 1 (derivative and integral calculus) and 2 (series, sequences, and multivariable calculus), with concurrent enrollment in Calculus 3 (differential equations and linear algebra).

In the fall 2015 semester, 401 students enrolled in EE 302, divided between six lecture sections with about 65 students in each section. Of these students, 86 enrolled in EE 411 for the spring 2016 semester, which had a total enrollment of 124 students divided between four lecture sections. The majority of the students (83 of the 86) who progressed from EE 302 to EE 411 had successfully completed EE 302 in their very first attempt in fall 2015.

Considering the prerequisites for EE 411 enrollment, we can note that at least 83 of the 124 students enrolled in the spring 2016 sections of EE 411 completed introductory physics and multivariable calculus courses by the time they concluded their first semester in the ECE program. The remaining student population may have delayed their enrollment in EE 411 due to unmet prerequisites or other unknown circumstances.

II. The SI Program Structure at UT Austin

Mastery of the course content for both EE 302 and EE 411 requires students to apply basic principles to difficult engineering problems. The objectives of the SI program in supporting EE 302 were to increase student academic success in the course and to impart study skills that would transfer to subsequent coursework for continued academic success. Given the nature of the EE 302 and EE 411 coursework, the SI sessions focused on modeling and developing the problem-solving skills needed for solving engineering problems. While the SI sessions engaged students in solving problems directly related to the course, extra emphasis was placed upon on conceptual understanding and application to a variety of different problems.

Leaders of the fall 2015 SI sessions in EE 302 were carefully selected from a pool of senior undergraduate ECE students who had completed several lower and upper division coursework.

SI leaders were encouraged to draw from their own junior and senior level coursework (especially their senior design projects) to help students gain perspective, and learn how to apply fundamental laws to more difficult and complex circuits. The purpose was to help these freshman students understand why EE 302 is a foundational course in the curriculum, and SI leaders participated in weekly professional development meetings to discuss best practices in directing student learning of both the content and study skills. Leaders maintained detailed lesson plans and were asked to identify content and study skill objectives for each week's lesson. Four SI sessions were offered weekly and efforts were made to ensure that the sessions did not conflict with lecture or lab times

III. Methods

By collecting and analyzing quantitative data in the form of student grades and SI attendance, we gain a better understanding of the potential benefits SI attendance may have on students' continued academic performance. This type of analysis allows us to see trends between student's use of the SI program and success in coursework with similar objectives, and analyze whether or not the SI program meets its objective of developing transferable skills

Two forms of quantitative data were utilized in this study:

- **SI Program Usage:** at the beginning of each session, students signed in with both their name and university unique identification number.
- **Grade Data:** course grades and semester grades, and pre-semester and post-semester cumulative GPAs for all students enrolled in the course were gathered. Additional information such as standardized test scores and predicted GPA and graduation rate were collected.

We categorized the students attending zero or one session as the no-SI group, whereas repeat attendees (those attending two or more sessions) were categorized as the SI group. Students who were enrolled in EE 302 prior to fall 2015 did not have an option to attend or not attend SI sessions, and were categorized as the pre-SI group. Comparisons involving the pre-SI group are complicated by the existence of additional, and unknown, variables that may have contributed to the fact that these students did not enroll in EE 411 directly after completion of EE 302. As a result, the majority of the analyses are focused on comparisons between the no-SI and SI groups.

To examine the effects of SI on student academic performance, course grades were converted from categorical to continuous data as per the university's numerical grade point equivalencies [14]. As the distributions of the grades are skewed and not normal, median and interquartile ranges (IQR) were compared. SI attendance data, final course grades and end of semester GPA were analyzed with correlation and hypothesis tests to study the relationships between fall 2015 SI attendance and academic success in the spring 2016 semester.

Findings and Discussion

I. Student Academic Performance in EE 302 and EE 411

To investigate the differences in academic performance between the no-SI and SI groups from fall 2015 EE302, final course grades were compared for the two groups. Figure 1 shows different median course GPAs for the SI and no-SI groups. There is more than a half letter grade difference between the median course GPAs of the two groups.

Figure 1
Median Course GPA Based on Prior SI Attendance

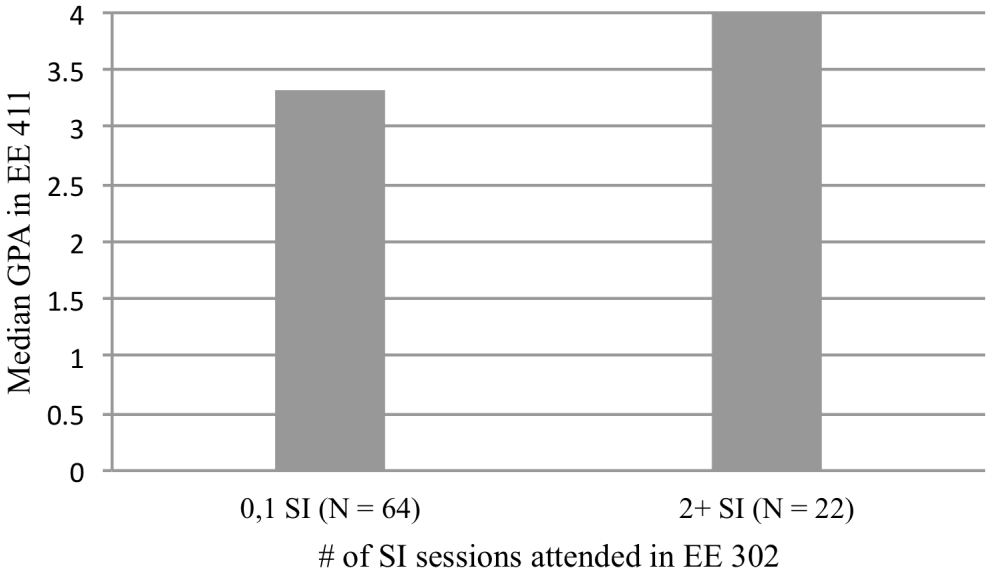

Table 1 provides a deeper look into the grade outcomes for the pre-SI, no-SI and SI groups. Although the SI group outperformed the no-SI group in EE 411, the SI group's course grades for EE 302 were lower. Comparing the mean SAT scores and predicted GPAs sheds some light on these students' level of preparation. The data show that the no-SI group had an 8% higher mean SAT score, and about a 4% higher predicted GPA compared to the SI group. However, the median EE 411 grade of the no-SI group was more than half a letter grade lower than the SI group. The correlation between SI attendance in EE 302 and EE 411 course was not significant $r(86) = 0.165, p = 0.129$. Chi squared tests also revealed that the differences in EE 302 and EE 411 course grades for the no-SI and SI groups are not significant X2 (11, N = 86) = 12.51, p = .327. $\chi 2\ (11, N = 86) = 12.51, p = .327.$

Table 1

SI Group	N	EE411 Median Grades (IQR)	EE302 Median Grades (IQR)	Mean SAT Score (SD)	Mean Predicted GPA (SD)
no-SI (1, 0 sessions)	64	3.33 (1.34)	3 (1.34)	2062.39 (215.05)	3.80 (0.33)
SI (2+ sessions)	22	4.00 (0.67)	2.83 (1.08)	1895.71 (277.70)	3.63 (0.37)
All fall 15 EE302 (no-SI and SI)	86	3.33 (1.34)	3.00 (0.67)	2023.50 (239.4)	3.79 (0.35)
pre-SI (EE302 prior to fall 15)	38	3.00 (1.00)	2.66 (1.00)		
All	124	3.00 (1.34)	3.00 (1.33)		

II. Fall SI Attendance and Spring Semester GPA

To determine if SI attendance had a relationship to the overall academic performance of students as they continued through their coursework, comparisons were drawn between the no-SI and SI groups' spring 2016 end of semester grade point averages. Table 2 shows that the no-SI group's end of semester grade point averages were higher than the SI attending group for the spring 2016 semester.

Table 2

SI Group	N	Spring 2016 Median End of Semester Grade Point Average (IQR)	Fall 2015 Median End of Semester Grade Point Average (IQR)
no-SI (1, 0 sessions)	64	3.22 (0.65)	3.51 (0.66)
SI (2+ sessions)	22	3.16 (0.99)	3.39 (0.73)
All fall 15 EE302 (no-SI and SI)	86	3.22 (0.66)	3.49 (0.60)
pre-SI (EE302 prior to fall 15)	38	3.34 (0.73)	
All	124	3.24 (0.78)	

There was no significant correlation between SI attendance in the fall 2015 EE302 course and the end of semester GPA for students in the EE411 course $r(86) = 0.027, p = 8.08.$

Conclusions and Recommendations

Students who attended SI for EE 301 in the fall 2015 semester were potentially less prepared for the rigors of university level coursework than the students who chose not to attend. Despite having lower grades in the fall course, their improved grades in the second indicate that they may have gained problem solving skills to improve their ability to solve engineering problems and apply the EE 411 course content in the spring semester. Considering the element of self-selection of attendance in SI during the fall 2015 course may contribute additional insight and explanation as to why the SI group's course grades were lower in fall EE 302 but higher in spring EE 411.

The results are hopeful to indicate that SI attendance may have a lasting impact on student performance in the problem-solving skills required for academic success in the EE 302 – EE 411 course sequence, though this is unable to be said with certainty based on the current quantitative analysis alone.

Despite earning higher EE 411 course grades, the SI group had a lower median overall GPA for the spring 2016 semester, indicating differences in the academic performances in other coursework, details of which are unknown. These results beg the question: if SI did play a part in the academic success of students in EE 411 by providing transferable academic skills, were the skills developed so specific to the EE 302 – EE 411 problem solving requirements that they transferred only to related engineering courses and did not prove to be profitable for academic success in other coursework?

As the quantitative analyses investigating SI attendance and grade outcomes were not statistically significant, additional methods for analysis will be provide more depth to the understanding gained in future evaluation. Incorporating qualitative data and performing a mixed-methods analysis will allow for more accurate interpretations of the quantitative results, and could aid in the identification of the problem solving and general academic skills that are most beneficial to student success in their academic coursework at the university.

Acknowledgements

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Supplemental Instruction Pilot Program for an Introductory Electrical Engineering Course

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***Abstract* - Each fall over 400 incoming Cockrell School of Engineering students enroll in the University of Texas' EE302 Introduction to Electrical Engineering, a required course for all Electrical and Computer Engineering (ECE) majors. Many students are underprepared for the rigorous curriculum and difficult coursework; as a result this course has one of the highest rates of D's, F's, drops, and withdraws ("DFQW rate") in the department. Charged with improving four-year graduation rates, the ECE department partnered with the Sanger Learning Center to provide Supplemental Instruction (SI) sessions to support the academic success of students enrolled in this course. SI is a non-remedial model that emphasizes the development of study skills through the delivery of content review sessions. A fall 2015 pilot program employed two SI leaders, provided four study sessions per week, and reached 59% of the class population with 37% attending more than one session. A mixed-methods analysis reveals that session attendance positively impacted exam scores and DFQW rates, and that students held favorable perceptions of the SI program. Analysis additionally revealed a need for further study of continued academic performance and retention within the engineering program.**

Index Terms – Academic support, Four-year graduation rates, Peer instruction, Student success and retention, Supplemental instruction.

INTRODUCTION

This paper explores the effects of SI on student performance in the EE302 Introduction to Engineering course. Specifically, this study identifies how the SI program affected students' study behaviors and in what ways the program impacted student academic performance and DFQW rates for the fall 2015 semester.

The following sections provide institutional context preceding implementation of the SI program, describe the structure of the program's organization, discuss the resulting student performance and perceptions of the SI program, and offer insights for further implementation and study.

I. Background Context

The University of Texas at Austin, the flagship institution of the UT system, enrolls approximately 40,000 undergraduate students each academic year across 18 different colleges. In 2011, UT's Task Force on Undergraduate Graduation Rates made recommendations to increase the four-year graduation rate of first time in college students from 51% in 2011 to 70% by 2016 [1]. In the Cockrell School of Engineering, this rate was as low as 31% in 2011 [2], and has responded in part by investing in student centered instruction and support models [3].

Review of the ECE undergraduate curriculum and first year student success rates revealed that in 2011-2012, the EE302 course had a DFQW rate of 23.7% [4]. A general engineering discussion section was created to support at-risk student populations enrolled in this course, and as a result DFQW rates were reduced. Looking to provide support to all student populations, the ECE department partnered with UT's Sanger Learning Center in spring 2015 to develop an SI program to launch for the 2015-2016 academic year.

II. Significance of Study

When developing the SI program in EE302, we found the body of research regarding SI in engineering in the United States to be limited. This study aims to broaden the resources available for other institutions interested in peer instructional support applied to engineering programs. By conducting this study, we investigate the efficacy of this type of academic support in engineering and conclude how we may continue to improve student academic success in this and other introductory engineering courses. Given that student participation in the SI program was voluntary, this study's findings face limitations in comparing student performance and attendance. Future studies will benefit from deeper consideration and covariation of the student's aptitude for success as it relates to attendance and performance outcomes. This initial study will set the framework for further analyses as the program gains longevity and additional data is accumulated.

III. Research Questions

To assess the magnitude of SI's impact on student achievement and identify which components of the programming are responsible for those affects, we focus this first study on our engineering SI program with the following research questions:

1. How does the SI program affect student academic performance in EE302?
2. How does the SI program affect DFQW rates for EE302?
3. What is the perceived benefit of SI by participating students?

IV. Definitions Used in Study

The following terms utilized in this study are defined according to the authors' and UT Austin's use:

- **Drop:** students may leave a course without it being noted on their transcript up to the 12th class day.
- **Fail:** a student earning below a D- has failed a course.
- **Q-Drop:** students may leave a course after the 12th class day with a "Q" noted on their transcript [5].
- **Low Socioeconomic Status (SES):** parental income reported as below $40,000.
- **First Generation:** neither parent of the student has completed a bachelor's degree or higher.
- **Underrepresented Minority (URM):** federal ethnicity reported as Latino/Hispanic, Black, Multi-Racial, Hawaiian/Pacific Islander, or Native American [4].

DESIGN AND IMPLEMENTATION

SI is an international model of academic support targeting large and historically difficult classes. Developed at the University of Missouri-Kansas City in 1973, SI's peer-assisted study sessions employ active and collaborative learning strategies to review class material and develop transferrable study skills [6]. For over 30 years, The Sanger Learning Center has coordinated SI programming at UT and supports departments within the College of Liberal Arts and the College of Natural Sciences.

I. The SI Program Structure at UT

SI staff coordinators work with partnering departments to tailor programmatic goals and procedures, employing graduate students as SI supervisors for each content area. Supervisors are responsible for the professional development of SI leaders and conduct weekly meetings, observations, and semester orientations. SI leaders are selected for their interest in teaching and learning, and may be graduate or undergraduate students depending upon departmental agreement. Leaders hold two SI sessions per week, attend weekly meetings, observe faculty and peers, administer mid-semester feedback surveys, catalog teaching documents and resources, and complete a legacy report to end the semester. Funding for SI supervisors and leaders is shared between the department and the learning center, with agreements detailed in a memorandum of understanding.

II. SI Leader Training and Development

SI leader training is completed over two days prior to the start of the semester. Orientation addresses the logistics of the program structure and job responsibilities, and the pedagogical basis of SI, diving into theoretical and practical components of active and collaborative teaching methods.

In the weekly meetings, supervisors oversee continued development of the leaders' practical skill set and pedagogical framework. SI leaders receive evaluation and feedback after being observed by the supervisor and conduct a self-reflection, which is shared with the SI coordinator at the close of the semester.

III. The Pilot EE302 SI Model

In addition to following the structure outlined above, a faculty member from the department was appointed to work alongside SI coordinators to develop the program's structure and meet weekly with the SI supervisor and leaders to identify crucial course content and best practices for discussing these concepts. The total cost of the EE302 SI pilot program, employing one graduate student at 10 hrs/wk, two undergraduate students for 8 hrs/wk, additional supplies and training costs, was ~$3,000 for the fall 2015 semester.

The objectives of the course are to introduce incoming freshman students to the basics of electrical engineering through the study of electric circuits. While the focus is only on DC circuit analysis techniques, there is a substantial emphasis on the application of these basic principles on difficult engineering problems. In an effort to structure the material, the course content is divided into three units, with a common midterm exam at the end of each unit. The emphasis of each exam is on approximately 4 weeks of instruction. Having common midterm exams allowed for a fair comparison of exam scores between different student populations based on SI attendance. Exam problems were designed to engage higher levels of thinking, more than the usual textbook or homework problems.

In the fall 2015 semester, 401 students enrolled in 6 lecture sections with about 65 students in each section. Four SI sessions were offered weekly and efforts were made to ensure that the sessions did not conflict with lecture or lab times.

IV. Summary of Current Research

Current studies of SI in engineering courses show that students attending SI sessions perform better on exams and SI attendance was positively correlated with final course grades [7]-[14]. SI attendance improves persistence in the degree program with fewer leaving the degree [9] and students attending SI complete more credits in their first year [14]. The benefits gained in SI are transferrable to non-SI courses [15] and provide benefits to the SI leaders themselves [16]. The SI program provides learning opportunities that are otherwise unavailable to students [11], and reaches greater proportions of under-represented student populations (females and minorities) [8]-[11].

Areas for caution in implementation relate to use and perceptions of the program: favorable student and faculty reception may take years to build [15] and students may become dependent upon the sessions [17].

Despite the depth of these findings, there is a lack of recent, formal study on the effects of SI programming. The majority of current studies have been presented as conference proceedings with few articles published in journals. David Arendale, former National Project Director of SI, maintains an annotated bibliography on peer cooperative learning programs [18]. In this bibliography, roughly 60 papers focus on SI and engineering students. Of those, approximately 30 papers are written regarding SI in engineering courses (as opposed to calculus or chemistry), of which 11 are from institutions within the United States.

There is need to further investigate the usage and effects of SI in engineering programming for the benefit of students' academic success, persistence and development of transferrable skills.

METHODS

This study utilizes a mixed-methods approach to collecting and analyzing data to answer the research questions. By collecting both quantitative data in the form of student grades and attendance, and qualitative data in the form of a student perception survey, we gain a better understanding of the effect SI has on the student's academic performance, and more specifically what students believe helps their academic performance as they participate in SI. This type of analysis helps us set grade and attendance benchmarks for student academic success in this course and possible ways to reach those benchmarks.

I. Quantitative Data Collection

Three forms of quantitative data were collected:

- **SI Program Usage:** at the beginning of each session, students signed in with both their name and university unique identification number.
- **Grade Data:** course grades, and pre-semester and post-semester cumulative GPAs for all students enrolled in the course were gathered. Additional information such as hours completed, transferred, failed, high school graduation percentile, standardized test scores, and predicted GPA and graduation rate were collected.
- **Student Demographics:** information on gender, race, citizenship, first-generation student status, family income, parent's education levels, probationary status, declared major, and classification was collected.

Students attending SI sessions either signed in at the start of each session with their name and their identification number or swiped their identification cards through a card reader for electronic collection. SI Leaders using the sign-in method manually entered attendance information into a spreadsheet that could later be uploaded into the SI program attendance database by the SI coordinator. For SI Leaders utilizing the swipe method, this information was automatically entered into the spreadsheet.

At the conclusion of the semester, The Cockrell School of Engineering and the academic department provided additional student grade and demographic data. All attendance, grade, and demographic data were compiled into one spreadsheet linked by student identification number. To examine the effects of SI on student academic performance, course grades were converted from categorical to continuous data as per UT's numerical grade point equivalencies [19]. As the distributions of the grades are skewed and not normal, median and inter-quartile ranges (IQR) were compared. SI attendance data, final course grades and end of semester GPA were analyzed to study the correlations between SI attendance and academic success in EE302. Analysis of SI's effects on DFQW rates included a comparison to the course's historical DFQW rate data as well as an analysis of DFQW rate by level of SI attendance.

II. Qualitative Data Collection

SI Leaders administered a student perception survey monthly, three times during the Fall 2015 semester from September through November. This survey collected information about the attendees and their use of SI, including:

- **Student Demographics:** adding to the demographic information provided by ECE and the engineering school, students provided information about their length of time at the university, previous enrollment in the course, expected grade for the course, and how many SI sessions were attended that semester for the ECE course.
- **Student Understanding of SI:** students defined the practice of SI, rated the helpfulness of the components of SI, and articulated their reasons for attending SI.
- **Use of Additional Academic Support:** students identified their levels of use of faculty and TA office hours for the course, enrollment in the GE supplement to the course, and any SI for their additional courses.

The data for each set of completed surveys was entered into a spreadsheet. Demographic information was examined and analyzed to determine the common backgrounds and their use of other academic support resources. To examine participant perceptions of SI, an initial open coding process was used to determine general themes. Then an axial coding process was used to distill and aggregate those themes. The axial codes were further analyzed to identify trends for students' perceptions of SI.

The quantitative data was used to answer research questions about the differences between students' academic performance and DFQ rates for the Fall 2015 semester and previous semesters. While this data provided course and SI administrators with a clear understanding of that difference, qualitative data was used to identify specific factors that may have influenced change. The next sections will answer our research questions by further outlining the impact of SI on student performance, what specific aspects of the SI program may have facilitated change, and recommendations for future practice and study of SI for this course.

FINDINGS AND DISCUSSION

This study uses a mixed-methodology to determine how SI affects student performance and what aspects of SI most benefit students. We ask the following research questions:

1. How does the SI program affect student academic performance in EE302?
2. How does the SI program affect DFQW rates for EE302?
3. What is the perceived benefit of SI by participating students?

Overall, a better understanding of the impact of SI and how students receive this type of programming was reached to help the program administrators determine future directions for the program and its assessment.

I. Student Academic Performance

The total course enrollment was 401 students, with 387 students completing the course. SI sessions were held on 14 weeks during the semester, and 237 students (59%) attended at least one session. In Table 1 we provide a comparison of student outcomes and demographics, based on the number of SI sessions they attended (attending zero, one, two or three, and four or more sessions). Grouping this way allows for comparable sized groups to be compared.

Grade correlation analyses and T-tests do not show significance between SI attendance and grade outcomes. Although a weak negative correlation exists between attendance and final course grades for the entire population, $r(387) = -0.08$, examining the grades of students attending 2 or more SI sessions shows a weak positive correlation, $r(146) = 0.10$. A chi-squared test indicates significant differences in the grade distributions for students attending SI 1 or more times versus those who did not attend, $\chi 2\ (7, N = 387) = 12.27, p = .007$, though more analysis is required to read into these differences, considering that differences also exist between these populations due to self-selection into the program.

A one-way ANOVA between analysis of SAT scores and SI attendance shows significant variation among SI attendance groups, $F(3, 303) = 2.84, p = 0.038$. A post hoc Tukey test indicates the SAT scores between populations attending zero and four or more sessions differed significantly, $p = .02$. Chi-squared tests show significant differences in the proportion of first generation students attending SI $\chi 2\ (3, N = 326) = 8.05, p = 0.045$. SI was highly attended by first generation students and those with lower SAT scores. Further analysis should be considered to investigate the relationships between student groups, their aptitude to succeed in the course, their self-selection for attendance, and grade outcomes.

In an effort to assess the effectiveness of the program on the lower performing student, the minimum exam score on each midterm exam of different student populations based on SI session attendance is compared. For each exam period, we considered those students who attended at least two SI sessions (over a four week period) as those who utilized the program, as opposed to the population who attended zero or one session as those who did not utilize the program. Figure 1 shows the comparison of these minimum scores. The number *N* refers to the number of students who utilized the program for each exam. These data demonstrate that those lower performing students who attended SI sessions performed substantially better than the others who didn't utilize the program.

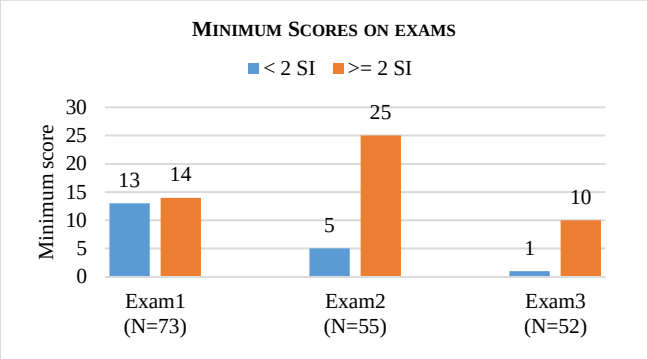

FIGURE 1
COMPARISON OF MINIMUM EXAM SCORES

While these data do demonstrate the value that the SI program brought to the EE302 freshman student experience, the median course GPA of these populations, which are listed in Table 1, did not indicate any significant improvement with more attendance. Given that the attendance was optional, and the SAT scores and predicted GPA for the higher SI attending population were lower, it is plausible that a substantial percentage of students who did not attend were indeed following lectures and not in need of additional help in the form of SI.

II. Course DFQW Rates

One of the major goals of implementing new forms of academic support for a course like this is to reduce DFQW rates in an effort to improve four-year graduation rates. The DFQW rate for the course in Fall 2015 was 10%, a 2% drop from the previous fall semester.

In Figure 2 we provide a comparison of the percentage of DFQW grades for different rates of student attendance student to demonstrate the efficacy of the SI program. The downward trend in the DFQW percentage suggests that there is a correlation between attending SI and passing the course.

While a chi-square test on the distribution of DFQW rates amongst the different attendance groups showed no significant relationship, $X^2\ (3, N = 401) = 1.89, p = .59$, there may be some relationship between SI attendance rates and DFQW rates to be investigated further with additional demographic and longitudinal data.

TABLE I
MEAN GPA COMPARISON

SI Attendance	N	% URM	% First Generation	% Low SES by Income	Median Course GPA (IQR)	Median Semester GPA (IQR)	Median Predicted GPA (IQR)	Mean SAT Score (Std Dev)
0 Sessions	164	23.81%	5.56%	16.30%	2.67 (1.34)	3.17 (1.048)	3.67 (1.05)	2059.17 (178.83)
1 Session	87	23.29%	2.74%	15.25%	3.00 (1.00)	3.33 (0.89)	3.54 (0.92)	2025.07 (178.14)
2-3 Sessions	74	30.16%	11.11%	23.40%	2.67 (1.00)	3.38 (0.64)	3.56 (0.86)	2020.67 (178.84)
≥ 4 Sessions	76	23.44%	14.06%	16.00%	2.67 (1.00)	3.15 (0.92)	3.51 (0.98)	1971.93 (195.67)

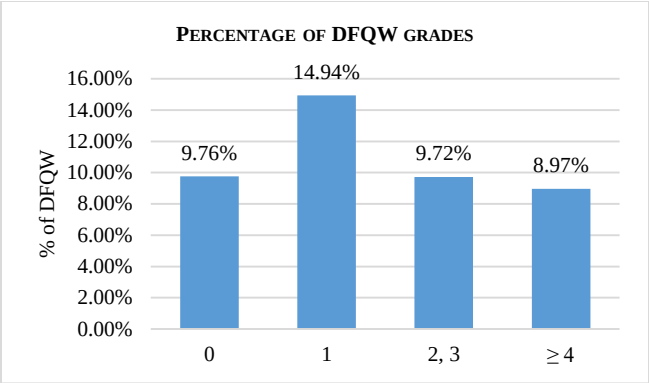

FIGURE 2
COMPARISON OF DFQW GRADES

III. Perceived Benefit to Students

Student participants' definition for SI centered on three themes: improving conceptual understanding, reinforcing class work, and providing help or support. Participant understanding of SI was generally accurate in that it is a practice designed to aid students with their understanding of course content. Table 2 summarizes students' definitions of SI and the change observed through the course of the semester.

TABLE 2
SURVEY RESPONSES: STUDENT SI DEFINITIONS (START, MID, END OF SEMESTER)

Student SI definition	Start	Mid	End
Practice that should improve their conceptual understanding	40%	23%	10%
Practice that should reinforce what is taught in class.	30%	61.8%	47.5%
Practice that provides some form of help or support.	16.7%	11.8%	32.5%

Student participants were asked to set goals for the semester. Overall themes for goals included improving knowledge of the course material, grade improvement, practicing problems, and improving critical/analytical thinking. A majority of students identified grade improvement as a goal, with that percentage increasing over the course of the semester. Table 3 lists students' goals and the change in these goals over the course of the semester.

TABLE 3
SURVEY RESPONSES: STUDENT GOALS (START, MID, END OF SEMESTER)

Student goals	Start	Mid	End
Improving content knowledge	83.3%	73.5%	10%
Improving grades	53.3%	61.8%	67.5%
Practicing problems/concepts	26.7%	32.4%	10%
Improving critical or analytical thinking	13.3%	14.7%	77.5%

The survey also asked participants to rate the helpfulness of each major aspect of the SI practice: small-group activities, large-group discussion, practice problems, concept/lecture review. Consistently, students rated practice problems the highest, with concept/lecture review just under that. Small and large group activities were considered the least helpful. Table 4 summarizes students' ratings given for each aspect of SI on a scale of 1 to 5 with 1 being least helpful and 5 being most helpful.

TABLE 4
SURVEY RESPONSES: SI HELPFULNESS (START, MID, END OF SEMESTER)

SI Helpfulness	Start	Mid	End
Small Group Activities	3.1	3.75	3
Large Group Activities	3.2	3.63	3.27
Practice Problems	4.5	4.9	4.56
Concept/Lecture review	4.3	4.57	4.41

Overall, the participants' definitions of the SI practice helping them better understand course materials are accurate. Participants also set realistic goals for their attendance of SI sessions. They indicated a desire to improve their understanding of the course material and improve their grades.

However, the participants ratings for the helpfulness of the different aspects of SI are concerning. The perceived helpfulness ratings peaked mid-semester, with end of semester ratings returning to the values given at the beginning of the semester. Future surveys should include additional question items to allow the study of these changes and identify whether there was a perceived change in quality or need for these practices. On this item, further study could also investigate a potential relationship between the perceived helpfulness ratings of different practices and differences in survey populations.

Another concern regards the comparison of these student perceptions against the traditional SI model, which uses group activities and discussions to help students better understand course materials. Participants indicated group activities and discussions were least helpful. This tension between the traditional SI model and what participants indicate was least helpful needs further examination, in addition to taking a closer look about what aspects of practice problems and lecture reviews are most helpful.

CONCLUSION AND RECOMMENDATIONS

The partnership between ECE and the Sanger Learning Center to implement SI to improve student performance and lower DFQW rates has provided ECE faculty and Sanger staff with greater insight into the effectiveness of SI programming and the type of assessment that will help with improving program outcomes. Though the difference in course grades for students attending SI versus those not attending is not significant, the decrease in DFQW rates and the perceived benefits require further, in-depth exploration.

Future directions for research and assessment include examining student outcomes based on students' predicted

GPAs when they are first admitted to the university. Comparing students who do and do not attend SI within a predicted GPA range will better tell us if the students this programming is intended to help are participating and if there is an improvement in their academic performance. It may also be helpful to study student participants' academic performance during their entire undergraduate year to see if there is a long-term effect.

In this study, student perceptions reveal that students understand the role and benefit of SI. However, these students rate activities typically deemed most beneficial as the least useful. This outcome will not only need further study; it will require SI administrators to test and develop activities and exercises not typically used in the traditional SI model. The ultimate hope for this initial study and future studies, as well as exploring and implementing variations of the SI model in the future will help faculty and staff supporting this course better understand the student experience and improve academic performance.

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Impact of Attending Supplemental Instruction (SI) Sessions on Course Grades
Fall 2017 and Spring 2018

INTRODUCTION

Question: For students in the ECO 304K classes, to what extent does attending SI sessions compared to not attending the sessions impact course grades for students who attended the study groups?

Overview of Answer: Attending sessions did increase course grades compared to not attending.

METHOD

Description of the Data

1) *ECO 304K 179-182.xlsx*: This data contains information on session attendance and grade for Fall 2017 and Spring 2018 classes. Variables included student name, EID, unique number of the course, the number of PLUS sessions that they attended, and the grade that they received.

2) *BASE_STUDENT-registrar-Assessment_LSE_gte_20179:* This data contains demographic information on undergraduate students enrolled in the University of Texas at Austin (UT) in the Fall 2017 and Spring 2018. We matched the EID's of students from the SI data above and this demographics data. Variables matched were sex, race, father's education, mother's education, and father's income.

3) *COLA Toolkit-scores-undergrads-20179.xlsx and COLA Toolkit-scores-undergrads-20182.xlsx*: This dataset contains ACT total and SAT verbal and math scores for undergraduate students enrolled in UT in Fall 2017 and Spring 2018. We combined the verbal and math scores to form total SAT scores. We used concordance data provided by ACT and the College Board to convert ACT scores to total SAT scores. For students who had missing SAT final scores but who did have ACT scores, we used the concordance data to fill in their SAT final scores. We matched students from the PLUS dataset to their SAT final scores based on their EID.

Variables

Treatment Group: We categorized students who attended zero to one SI sessions as the control group and those who attended more than one session as the treatment group. We created a dummy coded variable (0 = control, 1 = treatment).

Outcome: The main outcome variable of interest is the grade that the students received in their courses. We converted the letter grades that are in the data set to numeric grades following convention. We dropped students who had grades Q, W, X, and CR from analyses.

Control Variables: We controlled for variables measuring demographic information and students' prior achievement. The variables included are: sex, race, father's education, mother's education, father's income, and SAT final scores. Student's demographics and past achievement are likely to influence whether or not they attend PLUS sessions and also their course grades. Therefore, it is important to control for these variables in the analysis to reduce bias in estimation of treatment effect.

Missing Data

Several of the covariates had missing data. As is the convention in matching analyses, for the categorical variables, students with missing data were explicitly categorized as missing. For the continuous variable, we created a missingness indicator variable (0 = not missing, 1 = missing) and then we imputed the missing data with mean of the respective variable within each class and within each treatment group. We used these missingness indicator variables and imputed variables to match and run analyses.

Data Analytic Approach

We used matching technique to analyze the data. We take the treatment group and find people from the control group who are similar to the treatment group in terms of the control variables. After we match, we should have treatment group and control group that look very similar to each other and therefore, we can compare the outcome to obtain the causal effect. Matching methods are better than using multiple regression as the analysis results are less dependent on the exact specification of the outcome model. For the current analysis, we matched the groups using MatchIt package in R (version 3.5.0). We had 1519 records initially. We used one-to-one nearest neighbor matching method within each unique course number. Balance results showed adequate balance on the covariates within each course.

To analyze the outcome, it is common to also include the control variables and run a multiple regression after matching. This increases precision of treatment effect estimates. We used heteroscedasticity robust standard errors that corrects violation of homoscedasticity and normality assumption. We took the weighted average of the estimates, weighting by number of students in the treatment group in each unique course to obtain the final estimates.

We present regression results and boxplots showing impact of SI attendance. Multiple regression analyses hold constant the control variables. While boxplots do not include control variables, matched data were used to create boxplots so the graphs are comparing students with similar characteristics. Therefore, boxplots can be used as a visual for the impact results. The mean differences may be slightly different on the boxplot compared to the results from multiple regression analyses. Differences are not significant.

RESULTS

Aggregate

Attending SI sessions increases course grade on average by **0.383 ($p < 0.05$, 95 % CI[0.294, 0.471], n = 1,178)** points compared to not attending SI sessions for ECO 304 K students who attended the sessions. Figure 1 below illustrates the impact of attending SI sessions (data from the matched students, but not controlling for the control variables). Means are represented by the dots. Overall students who attended the sessions have higher mean course grade than those who did not.

Figure 1. Boxplot showing the impact of attending SI sessions on course grades

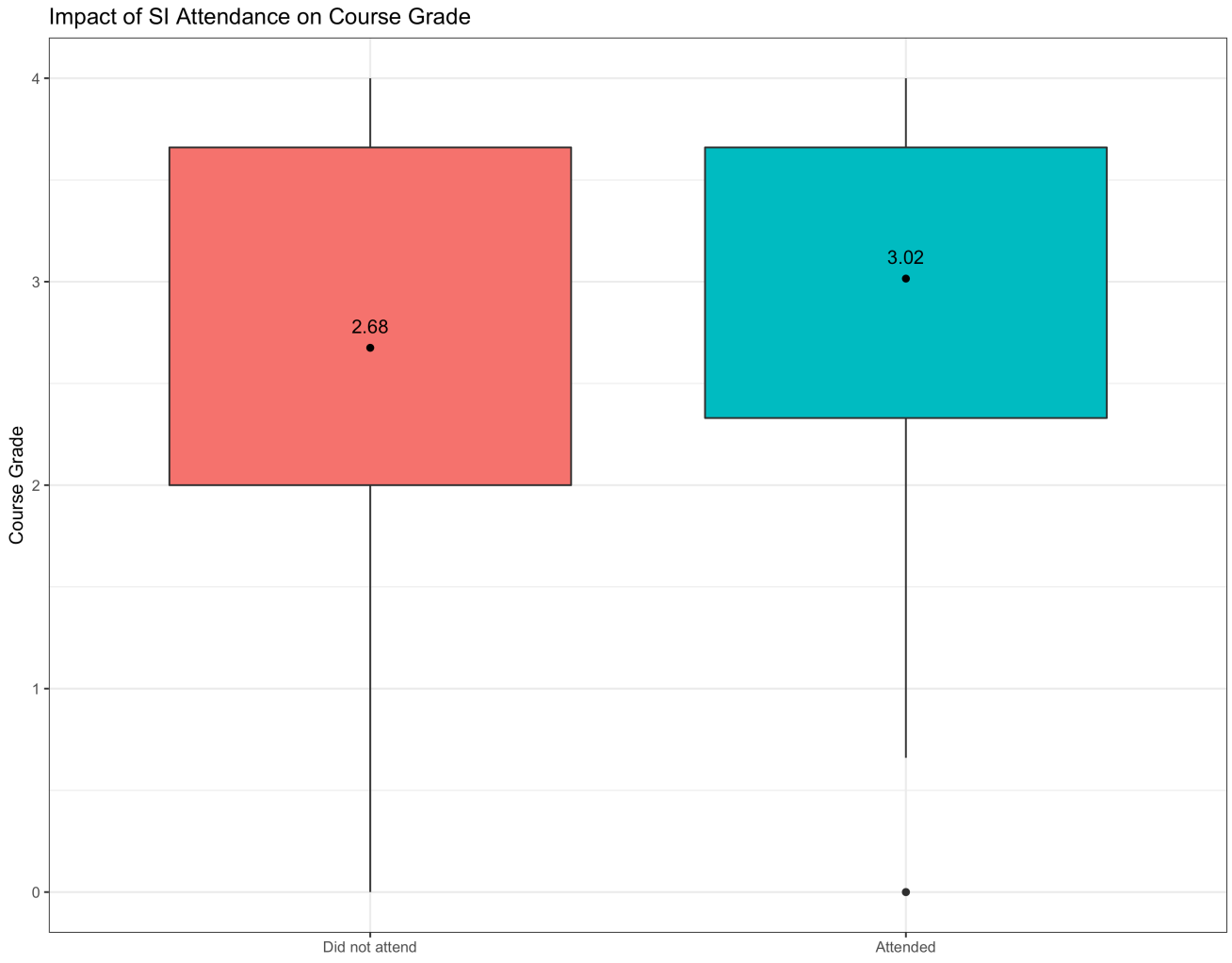


Table 1. The impact of attending SI sessions on course grades for each unique course

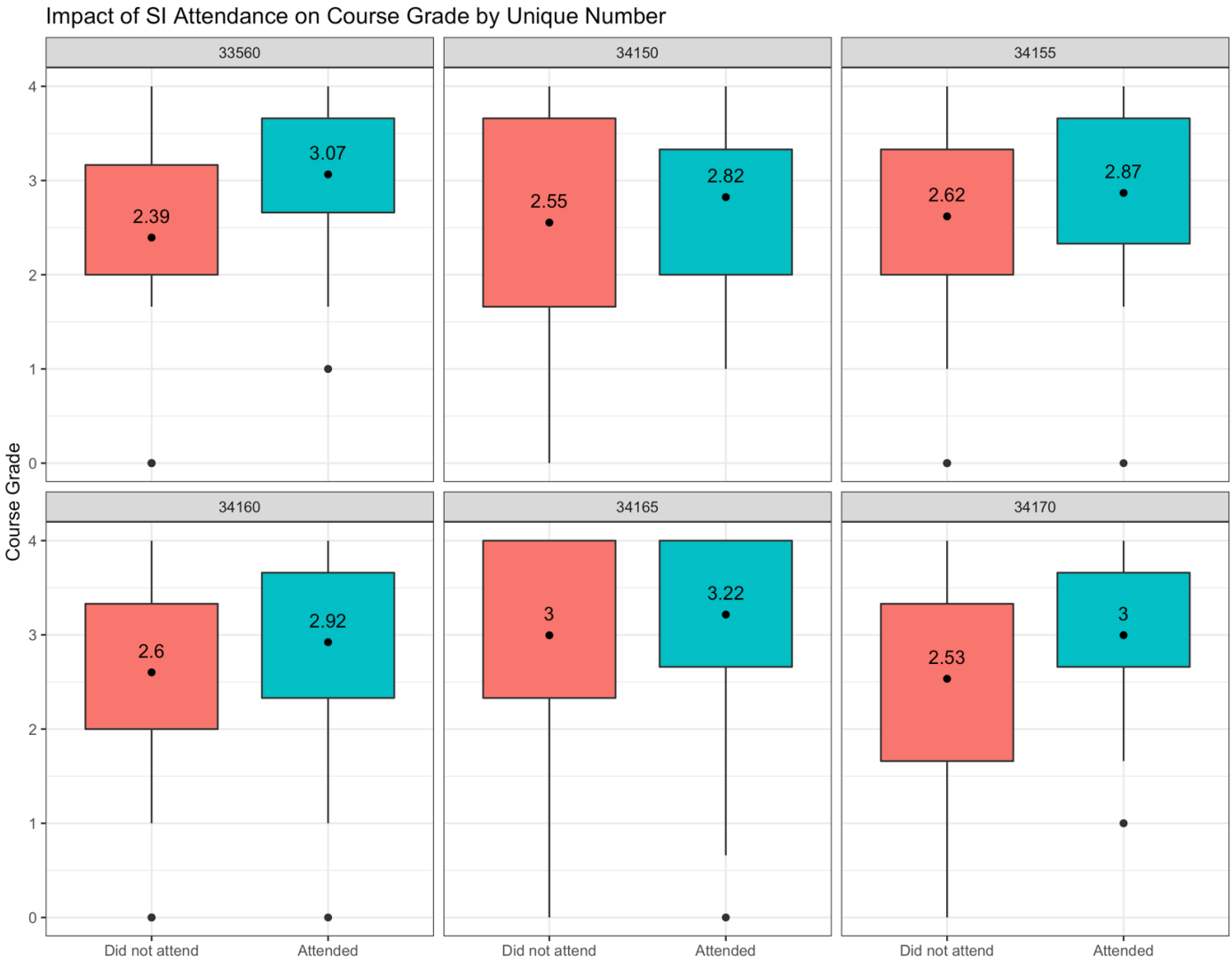
By Unique Course Number

Table 1 and Figure 2 below show results disaggregated by unique course number.

The table below presents the estimates within each unique course. The estimates are mean differences controlling for the control variables:

Unique Number	***Estimate***	***Standard Error***	***p value***	***Lower CI***	***Upper CI***	***# Students Treatment***
33560 (182)	0.664	0.118	0.000	0.430	0.897	83
34150 (179)	0.230	0.111	0.039	0.011	0.449	100
34155 (179)	0.366	0.138	0.009	0.093	0.639	75
34160 (179)	0.440	0.117	0.000	0.209	0.671	76
34165 (179)	0.216	0.087	0.014	0.044	0.388	173
34170 (179)	0.599	0.106	0.000	0.389	0.808	82

Figure 2. Boxplot showing the impact of attending SI sessions on course grades



Limitations

A possible limitation is omission of any other control variables that have major impact on SI attendance and course grades. Our analysis used all available data. We think it is quite thorough as we included demographics and SAT scores. Other variables that may explain the results other than SI attendance are: first exam grades, prior coursework taken, and attendance of any other academic support services on-campus.

Effectiveness of the Supplemental Instruction Program in First Year Engineering Courses - A Longitudinal Report (2015-2018)

Abstract

This Complete Research Paper examines the effectiveness of the Supplemental Instruction (SI) program implemented at our university in first year engineering courses from its inception in the fall semester of 2015 through the fall semester of 2018. The program offers two sessions per week outside of the course that incorporates peer and collaborative learning strategies, married with course material review, to help students be successful in the course. This report provides a longitudinal view of the effects of SI, an examination of aspects of the program that are successful, areas for improvement, as well evidence for expansion to other courses. The study utilizes a mixed-methods approach, incorporating quantitative data relating to grades and attendance with qualitative data relating to student perceptions about SI. An analysis conducted for every semester starting in 2015 showed a minimum of 8 percent decrease in DFWQ% rates for SI attendees (students who attended 2 or more sessions) vs. non-SI attendees (students who attended 0 or 1 session). In spring semesters, the difference was even more pronounced, with SI attendees' DFWQ% rates at minimum being less than half of that for non-SI attendees. An interesting finding was the pronounced effect that regular attendance had on course grades for SI attendees with lower SAT scores, which embodies the mission of SI to assist underprepared students persist and be successful.

Introduction

As student retention and four-year graduation rates are of institutional and national interest and frequently referred metrics for college success, the historically successful and well-studied Supplemental Instruction (SI) program was introduced at the University of Texas at Austin in 2015 through a collaboration between the Cockrell School of Engineering and the Sanger Learning Center. The supported courses included Introduction to Electrical Engineering (EE 302) and Introduction to Computing (EE 306). These are required courses for the Electrical and Computer engineering students at the university, and report high percentages of D's, F's, Q's (drops), and W's (withdraws). In the fall of 2016 this program was expanded to the Network Analyses course (BME 311) in another engineering department at the university.

The SI program is an internationally recognized academic support program created in 1973 at the University of Missouri in Kansas City, to improve grades in historically "difficult" classes, promote student retention and increase graduation rates. In the thirty years since its creation, it has become widespread and is considered an effective academic support model [1]. The Supplemental Instruction (SI) program provides optional, non-remedial sessions designed to deliver content review and additional practice opportunities while developing transferable study effectiveness skills to benefit the student in all coursework at the institution.

Results from other studies have revealed that regular session attendance positively impacted exam scores, overall course grades and DFWQ% (Ds, Fs, Q-drops, Withdraws) rates, and that participants had an overall favorable perception of the SI program [1]-[5]. Some works have sought to determine factors that affect attendance in SI sessions, by using qualitative data on students attitudes to predict behaviors of attendance [6], [7]. This work in particular found that influential individuals (such as peers and professors) promoting attendance to SI sessions improved students' perceptions of the utility of the program and their self-reported intentions to attend sessions. We have similarly been interested in determining factors that influence or improve attendance to our engineering SI sessions, which we hope to leverage to better address the needs of the student population and to promote the Supplemental Instruction sessions as an effective intervention to address retention and fail rates.

There are a very limited number of reported data on the effect of supplemental instruction in pre-engineering and engineering courses. Current studies of SI in engineering courses show that students attending SI sessions perform better on exams and SI attendance was positively correlated with final course grades [2], [3], [8]-[15]. SI attendance improves persistence in the degree program with fewer leaving the degree [8], [14] and students attending SI complete more credits in their first year [2]. The benefits gained in SI have been shown to be transferable to non-SI courses [3] and affect both attendees and the SI session leaders themselves [15]. The SI program provides learning opportunities that are otherwise unavailable to students [3], and reaches greater proportions of underrepresented student populations (females and ethnic minorities) [9]-[13].

I. Motivation for Study

This study investigates the efficacy of the SI model in the Introduction to Electrical Engineering course (EE 302) since its inception in 2015 to the latest year, 2018, and more recently in the Introduction to Computing (EE 306) course in spring and fall of 2018. The SI model is well established in other departments at the university, implemented in economics, history, math, and other departments since the 1980s. Careful attention has been paid to individualize these programs to emphasize the academic skills students need to be successful in these specific courses. Over the course of the three years since implementing the SI program in EE 302, we have endeavored to identify the components necessary to individualize this program to engineering without compromising the authenticity of the SI model. Encouraged by our findings in EE 302, we offered SI to students in EE 306 and have now accumulated two semesters worth of data for the SI program in this course.

This longitudinal report of the SI program's three year operation will detail our findings, which we hope will be beneficial for further development of SI for this course, other engineering courses at the university and for other administrators of similar programs.

II. Limitations of Study

Limitations of assessing correlations between grade outcomes and SI session attendance occur due to the voluntary nature of the program. In order to control for self-selection bias, we considered standardized test scores (SAT and ACT) as indicators of student preparation for college level coursework. However, this only accounts for one of many factors that could impact grade outcomes such as possible qualitative moderators/mediators, such as student's prior and current educational experiences, variations in level of student preparation, help-seeking behaviors, overall motivation and type of mindset are just a few of the factors that make the analysis of student performance and SI attendance difficult. Future studies would benefit from exploring ways to account for these factors.

A review of the current literature revealed no one standard for comparing students according to their attendance to SI sessions; these levels are defined differently by each author [2,3]. Some studies group students enrolled in a class with SI support as no-, low-, medium-, and high-levels of use, categorized by a certain range of sessions. Other studies use a binary system, comparing non-attendees and attendees. A more recent study [16] on a variety of sophomore level engineering courses has indicated that the dependence of student performance on number of SI sessions attended is proportional, and that the cutoff could be considered to be as low as 1 or 2 sessions. Considering the lack of a consistent n-value for student SI usage in EE 302 or 306 between the fall and spring semesters, we defined the "SI" group as students attending 2 or more sessions (or returning students) and the "no SI" group attending 1 or has none.

Another limitation with respect to the qualitative data is our use of self-reported perceptions of the program. In general, we have found that student perceptions of the traditional SI model, which uses collaborative group activities and discussions to help students better understand course materials, were rated least preferred. This creates a tension with what has been shown in numerous studies [1], which is that SI's use of peer and collaborative techniques promotes the socio-emotional interactions within an educational environment that improves learning and retention. In future work, we are interested in assessing metacognitive awareness factors of students, prior to their involvement in SI, to see if these factors are affected or improved by the program's intentional implementation of peer and collaborative learning strategies.

IV. Definitions Used in Study

The following terms utilized in this study are defined according to the authors' and the university's use:

- Drop: students may leave a course without it being noted on their transcript up to the 12th class day.
- Fail: a student earning below a D- has failed a course.
- Q-Drop: students may leave a course after the 12th class day with a "Q" noted on their transcript [17].
- DFWQs: the number of students in the course who Q-dropped the class, made a D, F, or

withdrew (and received a W on their transcript)
- DFWQ% rates: the percentage of students in the course who Q-dropped the class, made a D, F, or withdrew (and received a W on their transcript), in comparison to the whole student population for that course.
- SI group: students who attended 2 or more sessions.
- non-SI group: students who attended 1 or no sessions.

Research Questions

To assess the impact of SI on freshmen engineering participants, this report addresses the following questions:
1] What are the trends of DFWQ% rates between students who attend SI versus students who do not attend over the three year period (fall 2015 - fall 2018)?
2] What are the trends in student motivation for attending SI over the three year period? How have they changed?
3] What are the trends in program perception and benefits of SI by participating students over the three year period?

Design and Implementation

The Supplemental Instruction model is a peer-assisted learning (PAL) model which employs active and collaborative learning strategies to review class material and develop transferable study skills. The SI program employs 2-3 undergraduate upper-class ECE students as SI leaders to lead two identical SI sessions each week for course enrollments of 200-300 students, providing multiple opportunities for students to attend a session each week. SI leaders are required to participate in pre-service training (9 total hours spread between 2 days) and to participate in weekly professional development meetings with SI leaders for other courses and the SI program coordinator within the Sanger Learning Center. These meetings provide the SI leaders with ongoing development of facilitation skills, content direction and continuous feedback. Regular observations were conducted by the SI Program Coordinator. The SI leaders were also responsible for collecting attendance at each session and administering programmatic assessment tools throughout the semester.

In an effort to continually improve the program, the SI Program Coordinator reformed the training activities for the fall 2017 semester, based on the learning outcomes of the University of Missouri Kansas City's Supplemental Instruction Training Conference program in the summer of 2017. The program strongly emphasized implementing peer-led, collaborative practices inside SI sessions, conducting observations early and often, and requiring all SI leaders to plan their sessions with engaging activities that they submitted prior to the session for feedback and iterative cycles of improvement.

At the end of each semester, the SI coordinator collates all attendance data, end of course grades and GPA, SAT scores and student demographic data. An end of semester survey is created and sent to all SI participants, to collect qualitative data on student perceptions of the program, aspects that are most beneficial and feedback on how to improve the program.

Methodology

This study uses a mixed methods approach to investigate the research questions. By collecting both quantitative and qualitative data we gained a better understanding of the student population choosing to attend the SI sessions, their motivations for attending, and the perceived value of the sessions. Considering a combination of quantitative and qualitative measures, we took an interpretative approach to examine the relationship between SI attendance and student's academic performance.

As the SI program's effectiveness is aimed at reducing the the D's, F's, W's and Q drop rates (DFWQ%) rates in first year engineering courses and in turn retain more students to the ECE program, the collaborators have collected multiple types of data, including students' SI session attendance and grade outcome in the course, students' demographic data, and DFWQ% rates for attendees and non-attendees. As mentioned in the limitations section, the voluntary nature of the program does create some difficulty in making a direct link between higher SI attendance and student success. We, therefore, used SAT scores to group students with similar high school preparation, for a more accurate reflection of the effects of SI. Qualitative data was collected in the form of end of semester surveys administered to attendees from 2015-2018.

I. Quantitative Data Collection

Two forms of quantitative data were collected:
SI Program Usage: at the beginning of each session, students signed in with both their name and university unique identification number.
Grade Data: course letter grades and GPAs for all students enrolled in the course were gathered.
Attendance data was documented by the SI leader at the start of each session and reported to the Learning Center, where the SI coordinator maintained a database that connected with the university's registrar. The SI coordinator exported additional data regarding student information such as limited demographics and SAT scores. Additional demographics were provided by the School of Engineering's office of academic affairs.

Students attending zero or one session were categorized as the *no SI group*, whereas repeat attendees (those attending two or more sessions) were categorized as the *SI group*. With this definition of the *SI group* as those who returned, the quantitative data focuses on the outcomes for students who showed investment in using this resource versus those who did not. To examine the effects of SI on student academic performance, course grades were converted from nominal to ordinal data as per the university's numerical grade point equivalents.

II. Qualitative Data Collection

Qualitative data was used to answer research questions regarding students' perceptions of SI, its influence on attendance, and the perceived benefits of SI by participating students. The method of qualitative data collection was post-surveys. The survey comprised of 10-12 questions and was administered around the end of semester, on reading days before final exams. The survey was modified over the course of the three year period, improving on structure and verbiage to collect more accurate information, as well as the inclusion of new questions as trends emerged from past semesters, or removal of questions as the program evolved. In general, the survey collected students' names and university identifier numbers, and then polled the students on their awareness and intention of using the SI program. Students who used the SI service were asked to rate several aspects of the program, including the SI leaders, the group work model and perceived benefits of SI sessions and non-attendees were asked what factors would have improved their chances of attending SI sessions.

Findings and Discussion

In this study we examined the attendance data to gauge how well utilized this program has been over the past 7 semesters. The data in Figure 1 show that less than 40% of the students attended the sessions in all fall semester offerings of this course, prior to Fall 2018. A survey conducted to better understand the behaviors governing student attendance in optional SI sessions revealed that students preferentially utilize resources led by experts rather than peers, unless they are self-selected peer study groups [6], [7], [16]. This survey also revealed that students preferred activities where they were led through working the problems, rather than working through problems collaboratively [6], [7]. In fact only 60% of the students surveyed indicated a desire to attend these sessions, whereas more than 80% of the students planned on attending instructor and teaching assistant office hours, and peer study groups [7]. Given that not all students exhibit help-seeking behaviors, it is difficult to dramatically increase attendance in SI sessions.

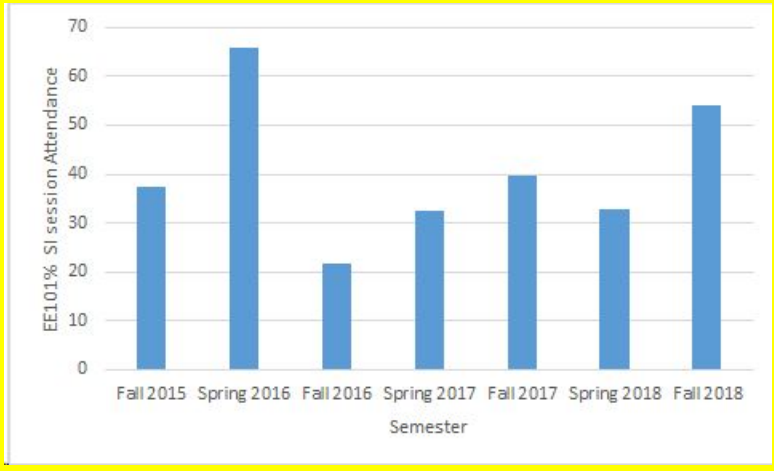


Figure 1: Percentage attendance in SI sessions in EE 302 (2015-2018)

In Table 1 we have listed the number of students who attended SI in each semester cohort. The spring semester enrollment in this course is significantly lower (12% to 18% of the fall enrollment), and the SI session attendance in those semesters has varied from ~32% to 66%. With small class sizes, attendance can be influenced by many factors such as marketing strategies implemented by SI leaders to promote the program in the classroom, and exceptional SI leaders devoted to teaching. These factors possibly explain the attendance spike in Spring 2016. The spike in Fall 2018 may be attributed to both SI leaders for this course offering exam reviews for each exam, meaning six sessions that students could attend, without attending regularly scheduled sessions. While those students who attend more than 2 sessions are considered the SI group, exam reviews do not tend to follow the SI session format (peer and collaborative activities) but do provide problem-solving practice.

Table 1: Number of students taking the course each semester in the no-SI and SI groups.

	No- SI group	SI group
Fall 2015	251	150
Spring 2016	16	31
Fall 2016	308	85
Spring 2017	35	17
Fall 2017	212	139
Spring 2018	43	21
Fall 2018	141	167

In Figure 2 we compare the DFWQ percentages between the *no SI* and the *SI groups*. In each semester we see that SI session attendance has a positive impact on passing the course, suggesting that there is a relationship between attendance and course completion. These percentage differences are more pronounced in each of the spring semester course offerings. As mentioned earlier, the spring cohort is significantly smaller in size, allowing for many more opportunities for one-on-one instruction, and smaller group work in SI sessions.

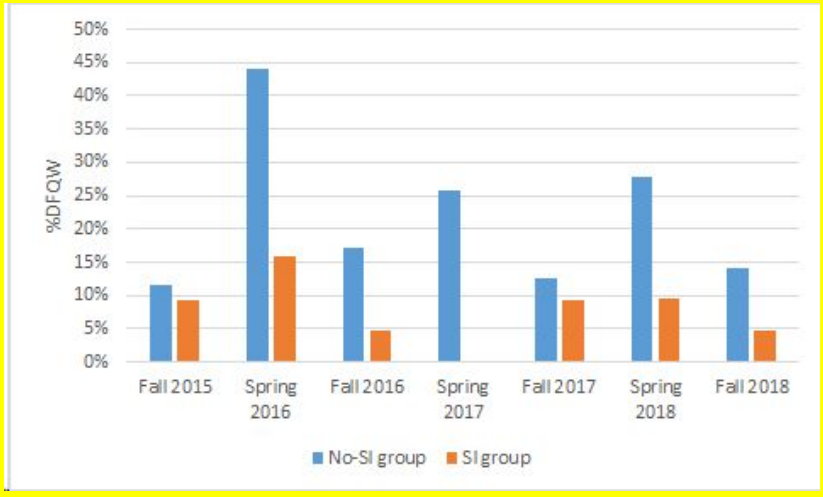


Figure 2: Comparison of %DFQW for SI and no-SI groups for EE 302

A chi-square test on the distribution of DFWQ percentages amongst the different attendance groups showed varying significance across semesters, as seen in Table 2. What is encouraging is when all semesters are combined, we see a highly significant difference between no-SI and SI groups.

Table 2: chi-square test on DFWQ%, Fall 2015- Fall 2018

	No - SI		SI		p-value
Semester	**Pass**	**DFQW**	**Pass**	**DFQW**	
Fall 2015	222	29	136	14	0.4868
Spring 2016	9	7	26	5	0.0390
Fall 2016	255	53	81	4	0.0038
Spring 2017	26	9	17	0	0.0214
Fall 2017	185	27	126	13	0.3293
Spring 2018	31	12	19	2	0.0948
Fall 2018	121	20	159	8	0.0043
All semesters combined	849	157	564	46	0.000002

In an effort to better compare student performance based on predictors of preparedness for college, the student population was divided into five groups, each with a 120 point range of SAT scores and then analyzed for course GPA and DFWQ% rates between *no-SI* and *SI* attendees. As seen in Tables 3 and 4, the data shows that students in the lowest SAT category (which we interpret as being underprepared) see the biggest gains from attending SI regularly, both by having higher course GPAs and lower DFWQ% rates than similar students who do not. It is difficult to conduct a statistical analysis on this categorized data, as the lowest SAT category changes each semester and thus makes a comparison unreliable.

Table 3. Mean Course GPA for EE 302 for different SAT score ranges, Fall 2015-Fall 2018.

	Fall 2015		**Fall 2016**		**Fall 2017**		**Fall 2018**	
SAT scores	**SI**	**no SI**	**SI**	**no SI**	**SI**	**no SI**	**SI**	**no SI**
1000-1120	2.66	1.88	n/a	1.86	2.22	1.66	n/a	n/a
1130-1250	2.22	2.17	2.25	1.92	1.9	1.86	2.33	n/a
1260-1380	2.92	2.71	2.68	2.27	2.12	2.45	2.49	1.92
1390-1510	2.66	2.78	2.85	2.74	2.6	2.69	2.81	2.57
1520-1600	2.78	3.2	3.35	2.99	3.27	3.16	3.25	3.13

Table 4. DFWQ% rates for EE 302 for different SAT score ranges, Fall 2015-Fall 2018.

	Fall 2015		**Fall 2016**		**Fall 2017**		**Fall 2018**	
SAT scores	**SI**	**no SI**	**SI**	**no SI**	**SI**	**no SI**	**SI**	**no SI**
1000-1120	25.0%	60.0%	n/a	50.0%	25.0%	0.0%	n/a	n/a
1130-1250	18.8%	16.7%	0.0%	39.3%	14.3%	0.0%	n/a	n/a
1260-1380	3.8%	10.9%	5.6%	24.3%	13.0%	8.8%	5.9%	14.3%
1390-1510	3.8%	6.6%	3.3%	8.8%	7.5%	8.0%	5.2%	13.3%
1520-1600	33.3%	3.5%	5.6%	5.9%	3.7%	11.5%	2.2%	9.5%

These results more accurately reflect our predictions of the impact of SI when comparing similar students. For certain semesters (fall 2016 and fall 2018), we did not see any students with the lowest SAT score category in the *SI group*, and therefore could not compare with the *no SI group*. There is evidence from other studies [2] that often the most underprepared students exhibit lower help-seeking behaviors, so we expect that while there are some students with low SAT scores who could benefit from SI but who do not attend. Additionally, the University of Texas' R1 admissions standards would likely produce a smaller number of students with low SAT scores, which could account for semesters where we see a small number or no students in the lowest range. One limitation is that between five and twenty percent of the student population did not have recorded SAT scores for any given semester, so were not included in this comparison.

The attendance and DFWQ% for EE 306 are shown in Figures 3 and 4. While the data is limited (from only 2 semesters), the trends are similar to those in EE 302. Especially notable is the sharp decline (from 23.8% to 5.26%, and 18% to 0%, in the two semesters respectively) in the DFWQ percentage with SI attendance. A similar chi-square test was performed for the EE 306 DFWQ% distributions for both semesters combined (Spring 2018 and Fall 2018), producing a p-value of 0.0047, indicating that it is a statistically significant difference between no-SI and SI groups for the EE 306 course, similar to the EE 302 statistical data.

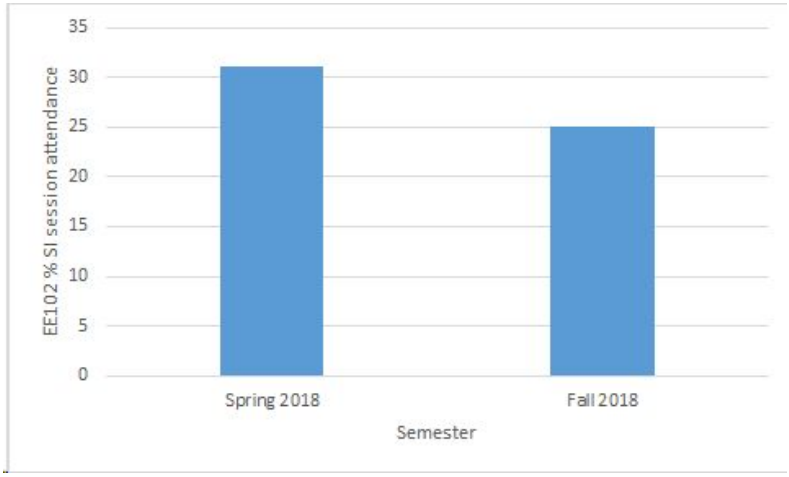


Figure 3: Percentage attendance in SI sessions in EE 302 (Spring 2018-Fall 2018)

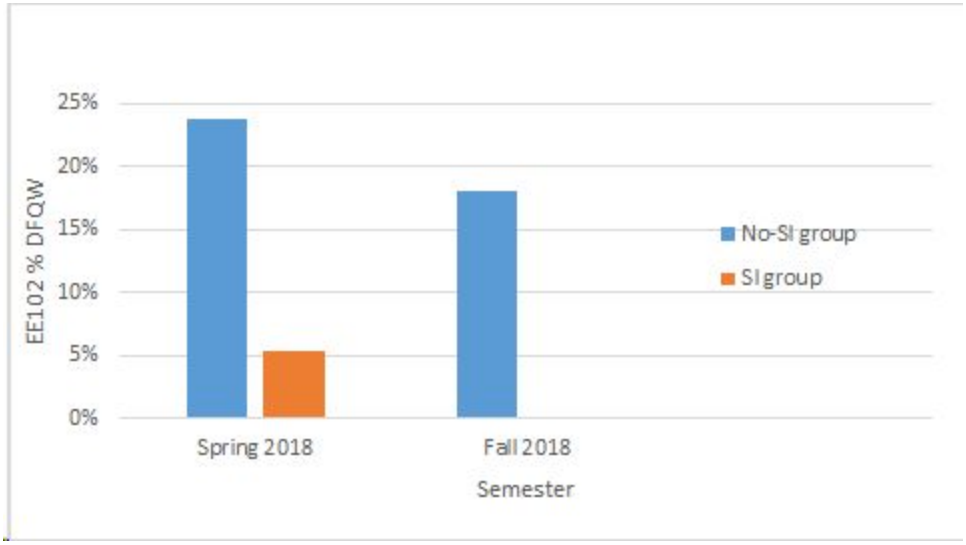


Figure 4: Comparison of %DFWQ for SI and no-SI groups for EE 306, Spring 2018-Fall 2018.

For continuity, we analyzed the course GPAs for EE 306, comparing students in the *SI* and *no SI* groups with similar SAT scores (as was done with EE 302) for spring and fall 2018 semesters (see Figure 5 and 6, respectively). In spring 2018, there were no students in the *no SI group* that

had SAT scores under 1120, but we saw that the *SI group* with the lowest SAT scores had an average course GPA similar to those students in the higher SAT categories, and was almost always higher than the *no SI group*. The only outlier was the second to last SAT range (1130-1250), who outscored all the other SAT categories, *SI* and *no SI*.

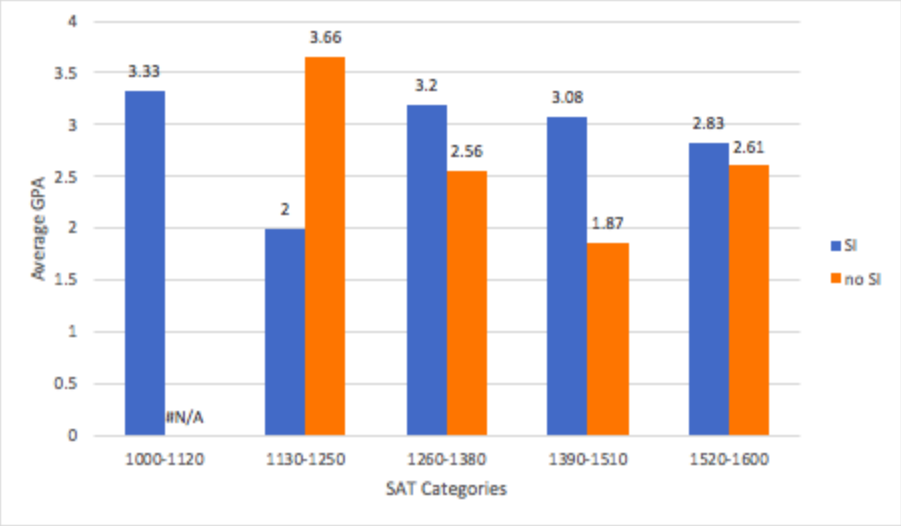


Figure 5: Average GPA for SI and no-SI groups, categorized by SAT score, for EE 306 in Spring 2018

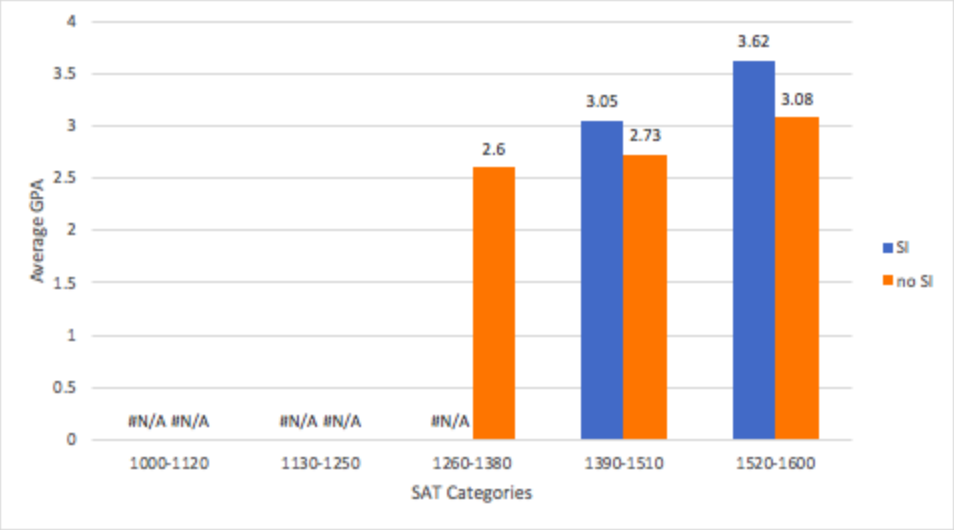


Figure 6: Average GPA for SI and no-SI groups, categorized by SAT score, for EE 306 in Fall 2018

For fall 2018, there were no students in the lowest two SAT ranges in the *SI group* or *no SI group*, and therefore could not compare them. However, we still see that the *SI group*

outperforms the *no SI group* for the other SAT categories. We expect that the University of Texas' admissions standards into the Cockrell School of Engineering would lead to a very small, if non-existant population of students in the lower SAT range. However, we are still bolstered by the results that students who may come in underprepared can highly benefit from regular SI attendance.

To address our third research question (What are the trends in program perception and benefits of SI by participating students over the three year period?), we compared answers from the post-surveys that had been administered fall 2015, fall 2017 and fall 2018 (the survey was not administered in fall 2016). Results of the survey can be seen Table 5. We see the percentage of students that agreed or strongly agreed (SA/A) that "SI sessions helped me to gain a better understand of the subject matter" increased significantly from fall 2015 to fall 2017 (52% to 72%) and then returned to about 57% in fall 2018. One positive outcome is that the majority of survey participants consistently SA/A that "SI sessions helped me perform better on exams" (about 60%, Table 5). Lastly, while this question was not present in the fall 2015 post-survey, from fall 2017 to fall 2018, we see a consistent increase in the percentage of participants who SA/A that "SI sessions helped me gain good study habits and self-discipline" (from 32% in fall 2017 to 56%). We see this an important measure of improvement, as the aspect of study strategies were not emphasized at the inception of the program, but is integral to the ultimate success of the programs and the students who participate.

Table 5. Student attendees rating of perceived benefits of SI sessions in EE 302, Fall 2015-Fall 2018 (Fall 2016 survey data unavailable)

	Agree/Strongly Agree		
	Fall 15	Fall 17	Fall 18
SI sessions helped me to gain a better understand of the subject matter	52%	72%	57%
SI sessions helped me gain good study habits and self-discipline	N/A	32%	56%
SI sessions helped me perform better on exams.	62%	60%	60%

We present below specific student comments that were collected in open ended questions on the survey, that highlight student perceptions of SI sessions in EE 302.
For the question, "Please tell us in your own words why you went to SI Sessions.":

- “It’s always nice to be retaught a difficult subject in different ways so that you’ll be sure to understand it”

- “I went to some to try to get a better understanding of the material. I don’t think they helped as much as they could have, as the instructors only went over a few problems quite quickly. More class interaction would be helpful, but I can't imagine how it should be implemented.”

- “I expected the SI sessions to get me ahead but they felt more like remedial classes.... way too slow”

In response to the question, “Anything else you’d like to tell us?”:

- “The SI session tutors were very helpful, especially their review sessions before exams. I do wish that there was less group work in daily SI sessions though. Reviewing the material at the beginning of the SI session for everyone, and then doing the problems together as a class on the white board was most helpful for me.”

- “There would be times where some professors were slightly ahead of others so in the SI session many students would be at different levels of understanding of the material learned that week.”

As mentioned in the data collection section, the survey was updated to include other questions of interest, as well as modify the language of some questions to more accurately gauge students perceptions of the program. In fall 2018, we administered the post survey to students enrolled in EE 302 and EE 306, as SI sessions were offered for both courses. 83% of survey participants reported they would recommend SI sessions to a friend for the EE 302 course and 95% reported they would recommend SI sessions to a friend for the EE 306 course. Specifically looking at the results for the updated EE 306 survey in fall 2018, survey participants SA/A 80% or higher on aspects such as SI’s impact on end of semester grade outcomes, understanding of course material and exam performance (see Table 6). We are encouraged by these results and will continue to analyze these trends to better understand students’ motivations and perceptions of the SI program.

Table 6. Student attendees rating of perceived benefits of SI sessions in EE 306, Fall 2018

	Agree/Strongly Agree
As a result of attending SI, I'm more likely to get a higher grade in this course.	85%
As a result of attending SI, my understanding of the course material improved.	92%
SI sessions helped me perform better on exams.	83%

Again, we present below specific student comments that were collected in open ended questions on the survey, that highlight student perceptions of SI sessions in EE 306.
For the question, "Please tell us in your own words why you went to SI Sessions.":

- "I went to SI Sessions because the professor goes through the material to quickly for me and I end up just copying what he write and not understanding it. I have to go back later and learn the material. I need to practice more problems or practice specific skills such as identifying supermeshes/nodes. Algebra is easy peasy."

- "EE 306 was a very challenging class for me, and I went to SI Sessions because they helped reinforce my understanding of key concepts and helped me prepare for exams and do homework that I didn't necessarily understand before the session."

- "Other members of my fig went and I went with them."

In response to the question, "Anything else you'd like to tell us?":

- "I like to learn at my own pace rather than at others'"

- "One of the leaders for SI Sessions was good, but the other was too fast for me. After a few sessions, more people came who understood the material better than me so the sessions went by more quickly and I couldn't follow so they became unhelpful in the end."

- "SI sessions were very helpful for the assignments and for the preparation of the exam. They explained exams problems and tricks not taught in class"

Summary

Since fall 2015, we have sought to perform a type of continuous improvement cycle for the SI program, that includes planning the SI program intervention, implementing the SI program, evaluating the intervention through multiple forms of data collection and analysis, and finally making needed changes to the intervention. While we see specific trends play out within each academic year, we also wanted to take a birds-eye view of our data, to report overall findings and answer research questions that were not possible within singular semesters.
Every semester since its inception, we see that the student population who attend SI sessions regularly have a lower DFWQ rate than those who do not, which has been shared with the following cohort of students in the next semester's course. While we have compared end of course GPAs for these two groups, we have learned a more accurate comparison can be accomplished by controlling for SAT scores and indeed, we see larger impact for students with the lowest SAT scores.

We do not see a consistent trend from semester to semester, in terms of percentage of students who attend SI sessions, in relation to the entire course enrollment, despite creating and sharing marketing materials that highlight the GPA differences seen between SI and no SI groups at specific points in the semester. We interpret some of this variation as related to the course enrollment, student perception of their preparedness, preference of type of academic support and other time commitments. Other studies have shown that behaviors of attendance can be influenced by peer or professor promotion [6], [7]. Some SI programs require that students register for SI sessions at the beginning of the semester, in an effort to control for student attendance. Other programs target students after the first exam performance, again inviting students who may have performed poorly to take advantage of a well-recognized support program that has vast evidence of positive impact to student outcomes. In future, we may choose to explore a registration system for SI sessions in EE 302.

From our survey data, we found that students who participated in SI sessions had an overall favorable perception of the program. Every semester since its initial execution, over 50% of students agreed or strongly agreed that attending SI sessions helped them gain better understanding of the material, as well as perform better on exams. We also saw an improvement in the program's ability to instruct students on employing more effective study habits and strategies. Most compelling has been the positive outcomes (both GPA, DFWQ rates and qualitative survey data) that are seen with SI usage in the EE 306 course. We plan to continue our data collection and iterative improvement cycle in implementing SI into this course. In comparing outcomes for EE 302 and EE 306, we can see that SI is even more successful for the EE 306 course. We interpret this to mean that expansion of SI to other freshmen engineering courses would be a worthy investment and offer our findings as evidence for other administrators and faculty who are looking to implement a similar program.

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Understanding Behaviors of Attendance in Supplemental Instruction and Subsequent Academic Success in a First Year Engineering Course

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Abstract

As student retention and four-year graduation rates are of institutional and national interest and frequently referred metrics for college success, the Supplemental Instruction (SI) program aims to reduce D's, F's and Q drop rates in historically difficult classes. Although previous work done by this group revealed that attending SI sessions for a first-year course (Introduction to Electrical Engineering) positively impacted exam scores and subsequent course grades [1], the program continues to experience low participation rates. Emerging questions of student behaviors in relation to attendance at SI sessions are addressed in this article.

The study utilizes a mixed-methods approach, incorporating quantitative data relating to grades and attendance with qualitative data relating to student awareness, use and perceptions about SI. These analyses serve to gain an understanding of the effects of SI and identify components of the program that students value. Quantitative data was collected in the form of session attendance logs, grade data, and student demographics. Qualitative data was collected in the form of pre- and post-surveys administered during the third and final week of the semester.

1. Introduction

Supplemental instruction (SI) was created in 1973 at the University of Missouri in Kansas City, to improve grades in traditionally "difficult" classes and in turn promote student retention and graduation rates. In the thirty years since its inception, it has become one of the most widespread and effective academic support models [2].

In response to The University of Texas Task Force on Undergraduate Graduation Rates' recommendations to increase the four-year graduation rate of first time in college students in the Cockrell School of Engineering (31% in 2011 [1]), the Electrical and Computer Engineering (ECE) department partnered with UT's Sanger Learning Center in Fall 2015 and piloted SI sessions for the 2015-2016 academic year.

Results from this study revealed that session attendance positively impacted exam scores and DFQW (Ds, Fs, Q-drops, Withdraws) rates, and that participants had an overall favorable perception of the SI program [3]. These results were similar to previously reported studies [2], [4], [5], that have also shown a positive relationship between SI session attendance and overall course grades. However, we have found that attendance in these (optional) SI sessions has remained low. Furthermore, the student perceptions of the traditional SI model, which uses collaborative group activities and discussions to help students better understand course materials were rated least helpful. This creates a tension with what has been shown in numerous studies [2], which is that SI's use of collaborative techniques promotes the social interaction within an educational environment that improves learning and retention.

Other works have sought to determine factors that affect attendance in SI sessions, by using qualitative data on students attitudes to predict behaviors of attendance [6]. This work also found that influential individuals may be able to promote attendance to SI sessions. However, this work was performed in an accounting class, whereas our interest is in first-year engineering courses, where little research has been performed. Our study focuses on a first-year engineering course, and uses a mixed method analysis to determine factors that affect attendance and how increased attendance may lead to improved outcomes for students. We hope to use our findings to better address the needs of the student population and to promote attendance in the Supplemental Instruction sessions as an effective intervention to address retention and fail rates.

2. Design and Implementation

The Supplemental Instruction model is a peer-assisted learning model which employs active and collaborative

learning strategies to review class material and develop transferable study skills. Sanger Learning Center has coordinated SI programming at UT Austin for over 30 years, and has supported departments within the College of Liberal Arts and the College of Natural Sciences.

A partnership between the Sanger Learning Center and the ECE department was established in Fall 2015 to provide SI programming to support students enrolled in EE 302 Introduction to Electrical Engineering. The SI program employed undergraduate upper-class ECE students as SI leaders to lead bi-weekly study sessions. SI leaders were also required to participate in weekly professional development meetings with SI leaders for other courses and the program coordinator within Sanger. These meetings provided the SI leaders with direction and feedback. Regular observations were conducted by Sanger's SI coordinator. The SI leaders were also responsible for collecting attendance at each session and administering programmatic assessment tools throughout the semester.

In an effort to continually improve the program and boost attendance, the SI program coordinator attended the University of Missouri's Supplemental Instruction Training program and Conference in the summer of 2017. Based on her experiences and learning, the SI Leader training was revamped for Fall 2017, including a stronger emphasis on ensuring peer-led, collaborative practices inside SI sessions, observations conducted early and often, and the requirement for all SI leaders to plan their sessions with engaging activities that they submit for continual feedback and improvement. We believe these changes could have significantly impacted the attendance of the program and the subsequent student outcomes and would like to investigate further areas for growth.

To assess the impact of SI attendance on student achievement, this study addresses the following research questions:

1] How does students' initial awareness and perceptions of resources influence SI attendance?

2] How does students' perceptions of SI and it's learning model (peer-led collaboration) influence SI attendance?

3] How does SI attendance affect academic performance in current coursework?

4] What is the perceived benefit of SI by participating students?

3. Methodology

This study used a mixed methods approach to investigate the research questions. By collecting both quantitative and qualitative data we gained a better understanding of the student population choosing to attend the SI sessions, their motivations for attending, and the perceived value of the sessions. Considering a combination of quantitative and qualitative measures, we took an interpretative approach to examine the relationship between SI attendance and student's academic performance, and applied these findings to further adapt the program to best meet the needs of the enrolled student populations.

3.1 Quantitative Data Collection

Two forms of quantitative data were collected:

1. SI Program Usage: at the beginning of each session, students signed in with both their name and university unique identification number.
2. Grade Data: course letter grades and GPAs for all students enrolled in the course were gathered.

Attendance data was documented by the SI leader at the start of each session and reported to the Sanger Learning Center, where the SI coordinator maintained a database that connected with the university's registrar. The SI coordinator exported additional data regarding student information such as limited demographics and SAT scores. Additional demographics were provided by the School of Engineering's office of academic affairs.

Students attending zero or one session were categorized as the non-SI group, whereas repeat attendees (those attending two or more sessions) were categorized as the SI group. With this definition of the SI group as those who returned, the quantitative data focuses on the outcomes for students who showed investment in using this resource versus those who did not. To examine the effects of SI on student academic performance, course grades were converted from nominal to ordinal data as per the university's numerical grade point equivalencies.

3.2 Qualitative Data Collection

Qualitative data was used to answer research questions regarding students' perceptions of SI, its influence on attendance, and the perceived benefits of SI by participating students. The method of qualitative data collection was pre- and post-surveys, which were developed by translating a similar survey created by Goldstein and O'Donnell [6]. The pre-survey comprised four questions and was administered in the third week of the semester; it collected students' names and university identifier numbers, and then polled the students on their

initial awareness and intention of using a list of academic support programs offered for the course. Some of these options included: one-on-one tutoring with a undergraduate tutor, study groups, office hours with a graduate TA or professor and Supplemental Instruction sessions led by a SI Leader. The two aspects of interest with each of these services were: 1. the type of expertise offered (high level content expert such as TA or professor versus intermediate expert such as a peer tutor or SI Leader versus low level expert such as peers in study groups); and 2. the student ratio and interaction (one-on-one interactions such as tutoring and office hours versus group interactions such as study groups and SI sessions). It is our belief that these aspects, either individually or together, impact SI attendance and therefore warranted some investigation.

The post-survey was more extensive; identifying information was once again collected in the form of names and university identifier numbers. Students were then asked to choose which academic support services they had intended to use for the course and which they actually used. Students who used the SI service were asked to rate several aspects of the program, including the SI leaders, the group work model and perceived benefits of SI sessions.

4. Findings and Discussion

The pre-survey responses (n=177) indicated that 60% of the students who were aware of the SI sessions planned on attending. In comparison, more than 80% of the students intended to engage in peer study groups, and attend teaching assistant and professor office hours. In Figure 1, we show the student responses to the question, "Which of the following support services are you aware of?" and in comparison, their answers to the question, "Which of these support services do you plan on using this semester for EE 302?". A significant decrease is shown between their awareness of one-on-one tutoring and SI sessions and their intention to use either or both of these services. These findings indicate that while students are highly aware of all the academic support services available to them, the aspect of content expertise is strongly valued in an academic support resource, unless students are using their own privately created peer study groups.

In Table 1 we summarize the student responses to our post-survey questions about their perceptions of SI. These student responses seem to indicate that the majority of the students found that the SI sessions helped them with the course content, and with their own perception of their exam performance. Student comments on the surveys corroborated these survey data. 80% of the students commented that they attended SI sessions because they benefited from them. They believed that the SI sessions helped them comprehend the subject matter better, helped them with exam preparation since the session leaders covered old exam problems, and helped with the particularly challenging aspects of the course.

In Table 2 we compare the mean course GPA of the ***Non-SI*** and the ***SI*** groups for Fall 2015 and Fall 2017. In Fall 2015 there was a 6% difference in mean course GPA between the Non-SI and SI groups. This gap was reduced to 5% between Non-SI and SI attendees in Fall 2017 (see Figure 2). Figure 3 displays the SI session attendance rate difference between Fall 2015 and Fall 2017 semesters. From Fall 2015 to Fall 2017, the attendance rate improved from 37.6% to 40.2%. One potential reason for the Non-SI group's higher average GPA in both academic years is the optional nature of Supplemental Instruction sessions. Therefore, students who come to the university highly prepared may not seek out additional support. To address this, we looked at the average SAT score for Non-SI vs SI attendees in Fall 2017 and found a 25 point difference. A similar difference was seen in the SAT scores of the student population of Fall 2015 [3]. In Fall 2016, the course was taught by multiple professors without standardization, in terms of course schedule, presentation of topics, and exam questions and level of difficulty; therefore results from that semester have not been included.

In an effort to better compare student performance based on predictors of preparedness for college, the student population was divided into five groups, each with a 120 point range of SAT scores and then analyzed for course GPA between non-SI and SI attendees. As seen in Table 3, four of the five groups showed higher course GPAs for SI attendees vs non-SI attendees. These results more accurately reflect our predictions of the impact of SI when comparing similar students. About twenty percent of the student population did not have recorded SAT scores, so were not included in this comparison.

Future studies will focus on examining correlations between SI session attendance and final course grades, and to determine whether there is any significant relationship between the distribution of the *DFQW* percentages amongst the different attendance groups. We also intend to test and implement activities and exercises that are more engaging for the engineering student, since the traditionally used active group work has been consistently rated the least helpful by students in our surveys.

4. Summary

From our qualitative survey data, we found that students were aware of the academic support resources offered by the University for this introductory course and their answers of intended use and actual attendance numbers indicate they intentionally made strategic choices in which of those services they took advantage of. We are also consistently finding that students prefer resources led by individuals with a high level of expertise and prefer group work only when they have created their own study groups. This could be a reflection of self-efficacy, control and self-direction that students value, and therefore influence their attendance to SI sessions. The consistency of the grade data comparisons for attendees versus non-attendees is shown over two years, but identifying similar students using standardized scores has allowed for a more accurate picture of which students benefit most from SI. Another important result is the lowering of the percentage of *DFQW* grades for the SI group. This trend was seen in both academic years. Overall, attendees continued to find SI sessions extremely helpful in clarifying confusing concepts and preparing them for exams.

Acknowledgement

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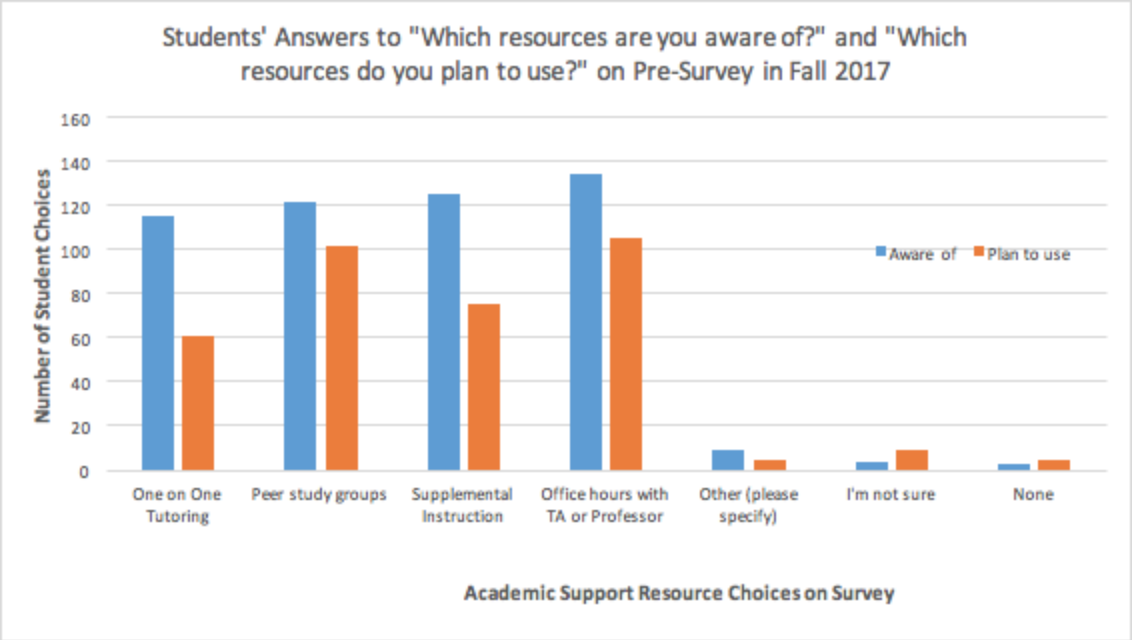

Figure 1. Polled students' awareness of and intention of use for selected academic support resources (n=177), Fall 2017

	Agree	Neutral	Disagree
SI sessions helped me to gain a better understand of the subject matter	72%	20%	16%
SI sessions helped me gain good study habits and self-discipline	32%	52%	16%
SI sessions helped me get information about exam materials	72%	20%	16%
SI sessions helped me perform better on exams.	60%	28%	12%

Table 1. Student attendees rating of perceived benefits of SI sessions, Fall 2017

	Fall 2015		Fall 2017	
	Non SI	SI	Non SI	SI
GPA	2.79 (N = 242)	2.62 (N = 146)	2.74 (N = 199)	2.6 (N = 134)
DFWQ%	11.6	9.3	12.7	9.35

Table 2. Mean course GPA and DFWQ rates for ***Non SI*** and ***SI*** groups in Fall 2015 and 2017.

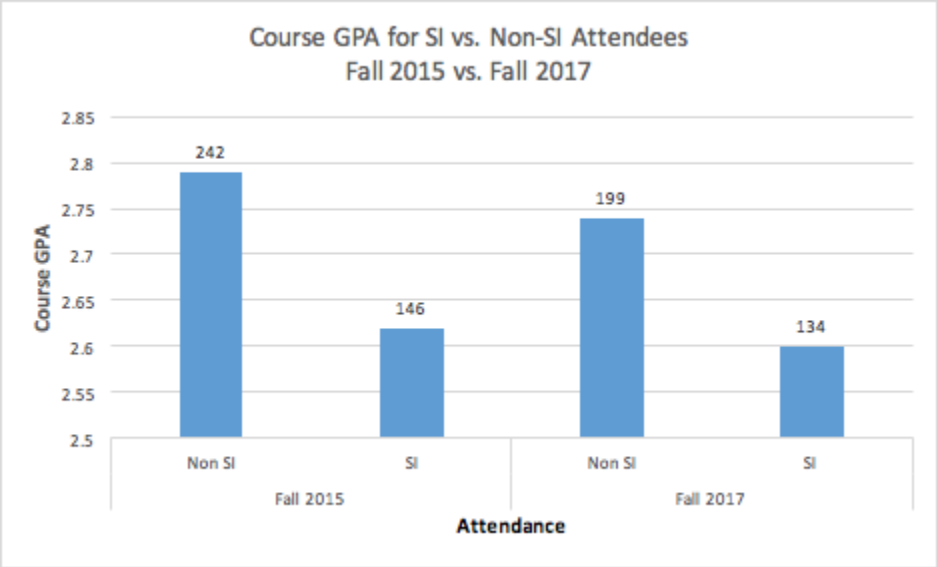

Figure 2. Mean course GPA for ***Non SI*** and ***SI*** groups in Fall 2015 and 2017.

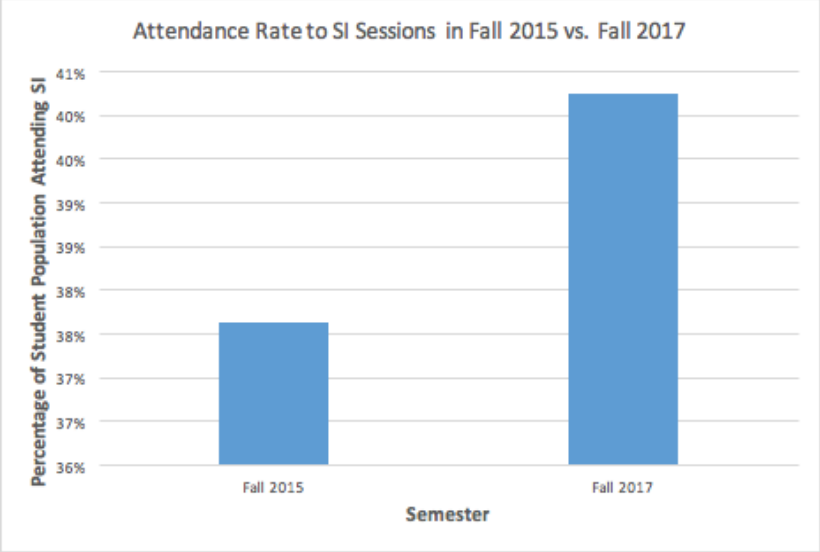

Figure 3: Comparison of SI session attendance in Fall 2015 and Fall 2017 semesters.

SAT scores	1000-1120	1130-1250	1260-1380	1390-1510	1520-1600
Mean GPA (SI)	2.22	1.91	2.25	2.61	3.38
Mean GPA (no SI)	1.67	1.87	2.24	2.64	3.18

Table 3. Mean Course GPA for different SAT score ranges (n=266), Fall 2017.

Effectiveness of the Supplemental Instruction Program in First Year Engineering Courses - A Longitudinal Report (2015-2018)

Abstract

This Complete Research Paper examines the effectiveness of the Supplemental Instruction (SI) program implemented at our university in first year engineering courses from its inception in the fall semester of 2015 through the fall semester of 2018. The program offers two sessions per week outside of the course that incorporates peer and collaborative learning strategies, married with course material review, to help students be successful in the course. This report provides a longitudinal view of the effects of SI, an examination of aspects of the program that are successful, areas for improvement, as well evidence for expansion to other courses. The study utilizes a mixed-methods approach, incorporating quantitative data relating to grades and attendance with qualitative data relating to student perceptions about SI. An analysis conducted for every semester starting in 2015 showed a minimum of 8 percent decrease in DFWQ% rates for SI attendees (students who attended 2 or more sessions) vs. non-SI attendees (students who attended 0 or 1 session). In spring semesters, the difference was even more pronounced, with SI attendees' DFWQ% rates at minimum being less than half of that for non-SI attendees. An interesting finding was the pronounced effect that regular attendance had on course grades for SI attendees with lower SAT scores, which embodies the mission of SI to assist underprepared students persist and be successful.

Introduction

As student retention and four-year graduation rates are of institutional and national interest and frequently referred metrics for college success, the historically successful and well-studied Supplemental Instruction (SI) program was introduced at the University of Texas at Austin in 2015 through a collaboration between the Cockrell School of Engineering and the Sanger Learning Center. The supported courses included Introduction to Electrical Engineering (EE 302) and Introduction to Computing (EE 306). These are required courses for the Electrical and Computer engineering students at the university, and report high percentages of D's, F's, Q's (drops), and W's (withdraws). In the fall of 2016 this program was expanded to the Network Analyses course (BME 311) in another engineering department at the university.

The SI program is an internationally recognized academic support program created in 1973 at the University of Missouri in Kansas City, to improve grades in historically "difficult" classes, promote student retention and increase graduation rates. In the thirty years since its creation, it has become widespread and is considered an effective academic support model [1]. The Supplemental Instruction (SI) program provides optional, non-remedial sessions designed to deliver content review and additional practice opportunities while developing transferable study effectiveness skills to benefit the student in all coursework at the institution.