Assessment of Supplemental Instruction Programming and Continued Academic Success

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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

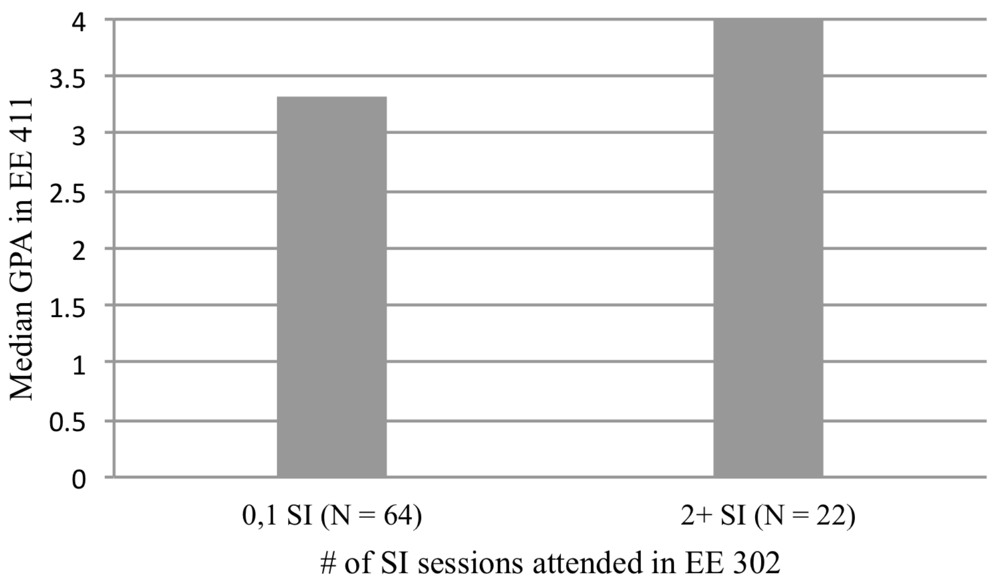

Table 1 provides a deeper look into the grade outcomes for the pre-SI, no-SI and SI groups. Although the SI group outperformed the no-SI group in EE 411, the SI group's course grades for EE 302 were lower. Comparing the mean SAT scores and predicted GPAs sheds some light on these students' level of preparation. 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

Appreciation is due to Laura Costello, Director of Assessment for the School of Undergraduate Studies at UT Austin for her assistance and consultation in data analysis.

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