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Supplemental Instruction: Shaping Future Engineers

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Supplemental Instruction: Shaping Future Engineers

Introduction

Supplemental Instruction (SI) is a cooperative learning model used to enhance student learning for the retention of students [1]. This cooperative model is implemented with after class study sessions associated with high-risk courses. The authors define a *High-Risk Course* as a course with one or more of the following characteristics: (1) a 30% or higher failure rate, (2) taken within the first two years of a traditional student study program, (3) infrequent exams, (4) large amounts of reading, (5) large class sizes, and (6) voluntary/unrecorded class attendance. These classes are commonly referred to as "gatekeeper" or "weed out" courses [2]. The SI model was first introduced to help the retention of a 6-year medical school program in 1973 by University of Missouri-Kansas City (UMKC) as Peer Assisted Learning (PAL) or Peer Assisted Study Sessions (PASS). The implementation of the SI model at UMKC was deemed successful and expanded to other courses [1], [3]. As of 2008, the SI model is used in 29 countries and over 1500 universities [4]. SIs are considered a resource for both students and instructors to enhance undergraduate courses. These PAL models, where certain students are selected to assist in enhancing education, were implemented at the University of South Alabama in the College of Engineering (COE). The SI model is associated with the following courses: Statics, Mechanics of Materials, Economics and Ethics, Dynamics, Engineering Thermodynamics, Electrical Circuits, Fluid Mechanics, and Material and Energy Balances.

A point of interest for the survey and influential factor in the resulting study is the coronavirus pandemic (COVID) which took place from 2020 to 2021. During the recorded period, SI constantly evolved based on feedback, shifting leadership, availability of funds, and the pandemic. On March 13, 2020, a campus-wide stand-at-home mandate was issued. As a result, all on-campus activities (including tutoring and SI) were suspended [8]. On July 22, 2021, the administration announced that the campus would reopen for all students and faculty for the fall semester of 2021 with restrictions to combat COVID. Events and instruction resumed with the restrictions. Individuals were required to wear masks, enact 6-feet distancing, and recommended to stay if feeling unwell. The documented challenges that the faculty and student instructors overcame are the following:

1. *Lack of developed online materials* [9]. Existing services at this university consisted of in-person appointment services which were underutilized by existing students in lieu of walk-in tutoring services. With funding from Higher Education Emergency Relief Fund (HEERF), this university pivoted to utilize online education resources/infrastructure and to support students learning with integrated courses [10].
2. *Student's Lack of Discipline and Studying Skills*. With online learning during COVID, the students had to become driven learners and the regulation of their own learning became pivotal [12], [13]. In the new virtual environment, students now had the option to form new negative behaviors of turning off their camera during lectures and tuning out faculty. Students' participation and engagement was deemed unsatisfactory for their learning [14].
3. *New Social Environment*. The lack of in-person interaction and visual feedback has been shown to adversely impact the delivery and quality of learning material from faculty[15]. At this university, SI student instructors had to run sessions differently than in-person study

sessions they got trained on. SI student instructors faced challenges of needing more sessions to accommodate the smaller groups of attendees and the competition of resources approved space for in-person sessions.

4. *Misuse of Technology*. A study in 2012 reported that roughly two-thirds of students at the college level cheat [16]. To cheat, students would gravitate to websites like Chegg, Course Hero, and Bartleby for answers [17]. From 2019 to 2020, Chegg grew over 69% to 3.7 million subscriptions [17]. Faculty were given the solutions of watermarking exam materials, using unique data sets, and observing student submissions for irregularities of language/citations [17]. Universities spent millions on companies like Honorlock and Examity to survey students during online examinations [18].

A better understanding of how SIs have impacted instructors and students, especially during the COVID-19 pandemic is useful not only for evaluating University of South Alabama's teaching methods but also for looking at how COVID-19 impacted teaching at all universities.

Purpose

The following proposed study is a work in progress examining the costs and benefits of SI, retention of students in classes with the SI model, and the development of a survey to assess the effectiveness of the implemented SI model at the University of South Alabama with the corresponding training and effects of COVID. This study aims to identify the adaptations made by SI instructors and faculty during difficult and unexpected times. This study seeks to find the balance between quantitative and qualitative evidence toward the impact of SI to undergraduate engineering courses. The authors hope to find factors that will contribute to knowledge retention in undergraduate students and maintaining enrollment. SI programs are not unique to the University of South Alabama and other universities, but the adaptations made during SI programs and training during the unprecedented COVID period are of quiet value. and The understanding of factors and their impact on retention and academic unit costs can be applied to other similarly sized state institutions.

Background

At the University of South Alabama, the chosen student instructors delivering SI are individuals who have previously taken the course, demonstrated great academic performance, and possess exceptional soft skills. Great academic achievement is indicated by the achievement of an "A" (90-100) in the course, and typically, a faculty member identifies these potential candidates. Candidates are interviewed by the university's Center of Academic Excellence (CAE). This organization verifies the interviewee has demonstrated one or more of the following soft skills: teamwork skills, professionalism, adaptability in teaching, strong communication skills, and empathy[5]. Following acceptance, the student enters a training program conducted by this organization. CAE has a Level 1 certification for the International TUTOR Training Program Certification (ITTPC) by the College Reading & Learning Association (CRLA). This training program provides students with additional education about their role, how to be an effective teacher, empathize with learners, expectations of a SI session, metacognition, post-session expectations, and operational processes. During the semester, the student instructors are

required to establish weekly office hours and between 2 and 4 after class teaching sessions per week. During these teaching sessions, the attendees solve problems, answer mock exams, and receive class-specific mentoring. Student Instructors are expected to bill a range of 10-15 hours per week. Due to growing demand for additional educational resources for engineering students, SI resources expanded into introductory courses- such as Engineering 101 (EG-101). EG-101 Peer Academic Leaders (PALs) are hired to help mentor freshmen, provide students with more holistic views of all available career paths, help the instructor with assignments during class, answer students' questions, and serve as academic coaches for students. This EG-101 experience serves as the first introduction of attendees to SI services. These early interactions help build trust with the attendees for SIs that they will see later in their academic career. The SI model evolved to include CRLA certification for student training. Early attempts of training at the university involved student instructors attending a 1-day training seminar at the beginning of the academic year. In 2020, due to COVID-19, tutoring training transitioned to an online course named Peer Academic Leadership Training. This training program provides students with additional education on their role, being an effective teacher, empathizing with learners, and expectations of a SI session, metacognition, post-session expectations, and operational processes.

Methodology

In this analysis, a survey is to be conducted to determine the effectiveness and educational value of SIs in retaining students. Additionally, a cost-benefit analysis is conducted to determine whether the investment in SIs is cost-effective in addition to being pedagogically sound. The survey uses a descriptive-analytical method and 5-point Likert type scale to evaluate surveys sent to 4601 college students and faculty. Response from survey questions will range from "Strongly Disagree" to "Strongly Agree". The students surveyed were enrolled in the COE between the years of 2019 to 2023. The faculty surveyed will be teaching staff of courses that use the SI model. Many of these students will take, have taken, or are taking courses with SI models. Data collection will take place by sending invitations for Google Form programmatic assessment surveys to students and faculty at the end of the Spring 2024 semester. There will be two types of surveys: one survey pertaining to student's interactions with the SI model and one survey pertaining to faculty about the implementation and effectiveness of SI in their course. Table 1 contains some of the preliminary questions that will be used in the student survey.

Table 1. Preliminary Student Survey Questions

	Items
1	If I had an SI during COVID, did they help with learning the information for the course?
2	Supplemental Instructors (SI's) have played a key role in continuing my education in my current track.
3	Supplemental Instructors (SI's) have played a key role in my ability to retain information conveyed in the course.

Both the student and faculty surveys record demographic information (i.e. gender, age, and major). The student surveys differ from faculty surveys with questions investigating student awareness and usage of SI services. Further questions investigate the quality of the teaching, the

quality of sessions, and the impact on the students' learning of the material. Additionally, students self-report their grades in classes with SIs to quantify the impact of instruction. The responses from students and faculty help with the understanding of usage of SI during the COVID-era and post-COVID. The surveys help administrators set the standard for the effective training of student instructors, gauge the effectiveness of SI on the retention rates of students, and identify opportunities to innovate on teaching styles. Faculty surveys investigate the effectiveness and perceived value of SI within their courses. Using the distribution of class and level, the study's sample size (n) for necessary participants was calculated using the equation (1) below:

$$n = \frac{\frac{z^2 \times \sigma(1-\sigma)}{E^2}}{1+(\frac{z^2 \times \sigma(1-\sigma)}{E^2 N})} \tag{1}$$

A confidence interval (z) of 95% was chosen for the z-score with a margin of error (E) of 7%. A standard deviation (σ) of 0.5 given the large population size. N is the total population size of all the students enrolled from 2019 to 2023. This statistic resulted in a sample of 188 students. From the answered pool of surveys, 188 of those surveys will be randomly selected to represent the opinions of the College of Engineering classes and faculty of 2019 to 2023. Three statistical methods of means, materiality, statistical relations, and Cronbach's Alpha (2) will be used to analyze and understand the results of the survey. Cronbach's Alpha, a tool intended to evaluate if tests or scales are fit for research purposes, will be used to articulate the reliability of the survey.

$$Cronbach's\ Alpha\ (\alpha) = \frac{k}{k-1}(1 - \frac{\Sigma s_i^2}{s_t^2}) \tag{2}$$

where: k = number of items

s_i = variance of every item

s_t = variance of the total scale

The study will gain the expected results of determining the extent of use of SI services during COVID period, the advantages/disadvantages of hybrid SI services from faculty and student perspective, identification of obstacles for SI services in a hybrid session, and impact of virtual training for SI instructors. Another factor of consideration for the justification of SI is the cost. From interviews of previous management personnel from the SI program, it was determined that student instructors work approximately 13 hours per week. This university has approximately 15 weeks a semester. According to the employee handbook established by the COE this university, employees are paid at minimum wage of $7.25 per hour. The college tuition per student accounts for a 16-credit hour semester to graduate in 4 years, as specified in the COE student handbook [6]. To determine the cost of a student instructor, the product was determined from hours worked per week, weeks in a semester, and hourly wage. For college tuition of a COE student, costs were based on University of South Alabama's COE credit hour rate and amount of credit hours per semester. Cost per credit hour is $404 for in-state students or $808 for out of state students [7]. The distribution of in-state versus out of state students was determined by 2019-2023 enrollment of students at the University of South Alabama. Using the aforementioned information, tuition of a student was determined by multiplying the cost of both in-state and out-of-state students, and then adjusting the cost to represent the distribution of in-

state versus out-of-state students. Dividing the employment cost of a student instructor by the cost of tuition determines the breakeven point. Dividing the cost of tuition of a student by the employment costs of a student instructor determines how many student instructors can be hired based on the retention of 1 student.

Results and Discussion

This study will examine responses between Fall 2019 and Fall 2023. Progress to discover the value of SI is ongoing with hopes of the survey being conducted at the end of the Spring 2024 semester. Currently, the research team has determined the necessary sample size to be statically significant for a represented opinion of respondents. Additionally, this research team is working on finalizing two surveys to conduct the research for the student and faculty perspective of SI usage and effectiveness. This research team is working on Institutional Review Board approval for distribution of the surveys. The statistical analysis methods of means, materiality, and Cronbach's alpha will be used to assess the value of the SI model and the value of the survey. Other work done by the research team is justifying the cost of a student instructor to fully evaluate the value of student instructors. Student Instructors are estimated to cost approximately $2K per semester at the rate of $10.00 per hour for 13 hours at 15 weeks per semester, not accounting for overhead costs. The average cost of tuition per COE student per semester is $8.8k assuming a 16-credit hour load for the 2023 rate of college tuition with adjustments for in-state to out-of-state ratio. The cost to employ a student instructor is 20% of the college tuition for a COE student at this university. Alternatively, 4.4 student instructors can be hired based on the retention of a 1 student excluding cost for administrative overhead and faculty. Hiring supplemental instructors for these high-risk courses can be deemed inexpensive. With the implementation of educational services (such as the SI model), this university has more than doubled its 4-year student graduation rate from 14% (2010) to 45% (2023) and increased its retention rate of first year students up to 76% (2023).

Conclusions

In this initial study, the authors outlined the history of the implementation of SI to this university, performed a cost-benefit analysis to convey how many students an SI needs to "retain" to be cost effective, and discussed the impact of the pandemic toward education. In a later study, the authors will compare results from surveys sent to both students and faculty to gauge the effectiveness of SI. With preliminary findings revealing University of South Alabama's current SI model to be highly effective for a university of its size. These results and our model have the potential to lead other similarly sized universities to the same results. With future works expanding on the paper so that a plan for other universities is included. It is expected that the results of the survey will show the positive correlation of SI services with the retention of students. However, the impact of COVID on SI sessions is unknown.

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