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Synergizing education: Supplemental Instruction in a blended learning context

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This paper reflects faculty-mentored undergraduate research.

Synergizing education: Supplemental Instruction in a blended learning context

Introduction

The aim of this paper is to assess the effectiveness of student-led SI (SI) on student performance in an introductory business statistics using a blended learning approach. Blended learning is education that combines face-to-face classroom methods with computer-mediated activities. It is believed that a blended learning strategy can create a more integrated approach to learning and education for students. The "flipped class" aspect of the statistics class being analyzed refers to the fact that much of the work normally covered in traditional lectures is done by the students outside of class time, and unclear issues and applications are presented and discussed in the one class meeting each week. There is no consensus on a general definition of blended learning. The terms "blended," "hybrid," "flipped," and "mixed-mode" are often used interchangeably.

As mentioned above, the approach used in the course being analyzed is referred to as a "flipped class." Activities that are normally considered lecture activities are performed by students on their own, and normal homework assignments are covered in the one session held in-person with the students each week. Student instructors take on a much larger role in a blended learning course. They provide the bridge between class activities and grades, and attendance data for previous classes in statistics at NAU has demonstrated that students tend to utilize their student instructors more often and more effectively in a blended learning setting. Just what the effects are on student performance in the class is the subject of this inquiry.

An earlier analysis conducted on 39 sections of a statistics course at NAU (albeit non-blended-learning-versions) from Fall 1998 to Spring 2001 revealed a relatively high attrition rate (defining attrition as a D, F, or Withdrawal) ranging between 13% and 63%, with a mean of 31% (Ng and Pinto 2003). This is sufficient justification to include this course as one that could benefit from SI.

The data used for this analysis have been drawn from a course entitled "Introduction to Business Statistics." The course was offered in the Spring 2015 semester, and it was organized as a blended learning class. It is a required course for all students majoring in business in The W. A. Franke College of Business at Northern Arizona University and it has a relatively high attrition rate. By and large, the great majority of students are in their sophomore year. It is a requirement that the students pass this course with a grade of at least "C" to be able to apply to the College's business professional program at the end of their sophomore year.

The students met with the instructor once a week for a one-hour and fifteen-minute session. They were expected to complete reading assignments and pre- and post-lecture quizzes online. The students were strongly encouraged to attend the SI sessions that were offered during four different one-hour time slots during the week. As an additional incentive, they received one-quarter point in extra-credit for attendance at a session with a maximum of five points added to their overall point total for the course at the completion of the semester. Thus, the maximum points that could be obtained in extra-credit for a student's attendance is 5 points or 20 sessions (although some students actually attended more than 20 times). There were 118 students who completed the course, 89 of which attended at least one SI session,

and 29 completed the course but did not attend any SI session. The analyses in this paper will deal with the 89 students who did attend. Those who did not attend do so for a variety of reasons, and given that regression analysis is used in this paper, inclusion of those who did not attend would unrealistically bias the results.

Supplemental Instruction

SI can take various forms and titles. In Northern American contexts, it often referred to as SI (SI), in Australasian context this program is referred to as the Peer Assisted Study Sessions, and the United Kingdom address it as Peer Assisted Learning (Dawson and Van Der Meer 2014). It is not equivalent to what is termed Teaching Assistance. Student instructors do not undertake teaching. They are to review activities undertaken in class meetings with the professor and, in the case of statistics, clarification as to how problems are solved and results interpreted. This is particularly important in the case of a blended learning course in which class meeting are held once a week or, in any event, in reduced numbers. The student instructors provides a bridge between the activities in the limited time available in class and question-and-answer sessions. In addition, the sessions provide a vehicle for students to address additional questions and concerns to the professor. In a survey conducted by Longfellow et al. (2008) of 286 respondents 15% of the students felt they had a more opportunity and felt more comfortable asking questions in the SI session than in in-person lectures with the professor. The particular model of SI utilized at NAU was developed at the University of Missouri, Kansas City (UMKC) as early as 1973, to provide targeted assistance to learning in high-risk courses rather than high-risk students (Arendale 1997).

Very positive results of the SI program at the University of North Carolina at Charlotte were also found (Congos and Schoeps 1993). Student grades were found to be significantly higher for SI attendees as compared to non-attendees. In this paper, a presentation of three basic modes of operation for SI sessions was given. These are:

1. Reviewing and completing notes from lecture sessions;
2. Problem-solving for possible examination questions; and
3. Reviewing test questions from previous exams.

The role of the instructor in this overall process should remain small. Regular encouragement to attend SI sessions is important, and consideration can be given to awarding extra-credit for the attendance.

SI should be viewed as a nontraditional form of tutoring that focuses on collaboration, group study, and interaction for assisting students in undertaking "traditionally difficult" courses. SI targets courses with a relatively high number (approximately 30%) of students that drop, withdraw, or fail, and then provides a trained peer who has successfully negotiated the course to assist its future students. Through four optional 60-minute SI sessions per week, students are provided with course-specific learning and study strategies, note taking and test taking skills, as well as the opportunity for a structured study time with peers.

The U.S. Department of Education (Dawson, van der Meer, Skalicky, and Cowley 2014) has identified three potential benefits of SI programs. These are:

- Students participating in these sessions will earn a higher final grade;

- Students will experience higher success and lower attrition; and
- Those who participate will demonstrate higher retention rates at the institution than those who don't attend SI sessions.

Numerous studies have found evidence supporting these claims. In a study conducted by the UMKC team encompassing 1,477 SI supported courses at 49 higher education institutions with an undisclosed number of participants, students who participated in SI sessions were found to have an average course grade of 2.39 as opposed to 2.09 for students who did not participate, and the attrition rate (defined as average % receiving a D, W, or F) was 23% for those participating in SI as opposed to 38% for those who did not participate (Martin and Arendale 1992). Numerous subsequent studies have been conducted which have reported similar findings, supporting the claim that students who attend SI sessions on average receive higher mean course grades than those who do not, they have lower drop rates, and they have higher retention in the school (Arendale 1997) (Kenney and Kallison 1994)(Hensen and Shelley 2003). Another analysis (Bowles 2008) concluded that, everything else held constant, those who attended SI session had increased timely graduation by approximately 11%. This could well imply that attendance and use of SI sessions carries over to improve student performance in other classes (Malm, Bryngfors and Mörner 2012). A systematic review of literature published from 2001 through 2010 concerning the effectiveness of SI programs concluded that all of the available literature supported the Department of Education claims. (Dawson Van Der Meer 2014). And, SI has been found to improve student performance in those who may have performed poorly in pre-college or university classes (Ning and Downing 2010).

With these results in mind, the current study differs from previous SI studies in the sense that it is based on a blended learning course, with an emphasis on revealing the quantifiable effectiveness of each SI session. Unlike most previous work, this analysis uses multiple regression techniques to determine the effectiveness of the SI program while looking at other factors that contribute to the final course grades. This technique illuminates the potential benefits that each SI session attended may have on a student's final course mark. Our research revealed only one other study, done at The University of Texas at Austin, which used multiple regression analysis with two different control groups (one in which SI attendance was mandatory and one in which SI sessions were not offered) to compare previous GPA with SI attendance. Those who did not attend the SI sessions had a GPA of 2.51 while those who did attend had a GPA of 2.95 (Kenney 1989). This tends to indicate that there is a direct relationship between GPA and the propensity to attend SI sessions.

Other studies have Chi-square analysis (Fayowski and MacMillan 2008; Hensen and Shelley 2003). These studies have found that there is sufficient evidence from their data to conclude that SI programs have a positive impact on student's course grades. These researchers reported that students who attended the sessions reported significantly better pass rates at the $p < .05$ level (Peterfreund et al. 2008.). While these studies concluded that SI programs are effective, only limited information is given on the type of data used to reach the conclusions. It needs to be pointed out that previous studies have been criticized because they often do not deal with variation in the number of SI visits, they use high school performance or SAT/ACT test scores as measures of preparedness for learning (McCarthy, Smuts, and Cosser 1997). The present study uses the actual number of SI visits during the semester and student cumulative GPA as explanatory variables for student performance.

In general, SI programs can be justified on four grounds: behavioral, pedagogic, economic, and political (Goldschmid and Goldschmid, 1976; Hill and Helburn 1981). First, SI has been reported to foster a number of behavioral changes and development in both supplemental instructors and students (Collier 1980; Hill and Helburn 1981). These include maturity, reduction of student anxiety, increased learning, and the promotion of teamwork, leadership, empathy, and responsibility (Hill and Helburn 1981, 150). Second, SI is often associated with instructional (or pedagogic) concerns, notably through individual and personal active learning strategies as opposed to passive ones. Here, SI may serve to motivate participation in learning more than in the classroom alone, and reduces inhibitions emanating from the absence of personal responsibility in the learning process (Cornwall 1980). Third, apart from these benefits, SI can be justified on the basis of economic considerations. SI can help reduce high student/teacher ratios in a cost effective manner (Goodlad and Hirst 1989; Malm, Bryngfors and Mörner 2012). Combining this with a blended learning approach, in which classes meet once a week, can result in significant cost saving for schools through the reduction in space requirements and an increase in student intake per class. However, these cost savings can be reduced by the need for supplying suitably-sized classrooms given the increase in class sizes, supplemental instructor selection and training, etc. Finally, the concept of SI has been justified on the grounds of empowering students and changing relationships that exist both within the professional teaching staff community and between professors and supplemental instructors (Hill and Helburn 1981, 152).

Context

The SI sessions being analyzed in this study are facilitated by academically successful students known as SI leaders, who have previously excelled in the course and have received training to be able to guide collaborative group study sessions. SI leaders attend all assigned lectures, take thorough notes, and participate in the same fashion as other students in the course. SI leaders plan and use a variety of teaching and learning methods within four 60-minute sessions to demonstrate effective study strategies that a student can apply to any class thus providing an opportunity for students to learn *how* to learn while learning *what* to learn.

The model followed by NAU requires the SI leader to attend all in-person class meetings and to hold four 60-minute study sessions each week at fixed times. The SI leader is an undergraduate peer tutor who has demonstrated superior academic performance in the targeted course. In contrast to other forms of teaching assistance and regular tutoring, SI is a non-remedial, proactive, voluntary opportunity for all students to improve their understanding of course materials by directly assisting in the development of their study skills. It seems self-evident that the success of any SI program relies heavily on the quality of SI leaders (Congos and Schoeps 1993). SI leaders who are good (have excelled in the course they are supporting and get on well with the students) typically have higher attendance rates and resulting in higher final grades for the students they are assisting. For these reasons, Student Instructor selection and training take on major importance in the success of the students that are being helped.

The SI program at Northern Arizona University is widely used to support courses that are historically recognized as difficult for the majority of students. While the statistics course in the College of Business is recognized as one of those courses, the SI program is also used to support courses in accounting, economics, finance, health sciences, psychology, biology, chemistry, engineering, astronomy, physics, and mathematics. The program has been in operation at NAU for well over a decade. It began initially to

cater to introductory science courses, and it was expanded to support additional lower-division course as the benefits were recognized. Attendance at SI sessions in the statistics course of this study is voluntary, and a small amount of extra-credit is given toward the final grade for the number of sessions attended during the semester. While it may be assumed that giving the students an incentive to attend these sessions (such as a small amount of extra credit) will encourage higher attendance, some schools and researchers believed otherwise. At UMKC, it was pointed out that student should not receive extra credit for attendance because not all students have flexibility in their schedules to attend the sessions (Arendale, 1997). While any incentive to attend remains discretionary, it is foreseen that a future study will attempt to determine the benefit/impact such an incentive has on student's attendance.

The data

A blended learning course requires a strong online learning tool, since much of the work done by the students is outside of the class meetings. For this course, the system used is one offered by Hawkes Learning Systems dealing specifically with business statistics. It needs to be stressed that, by-and-large, the theory of statistics is the same no matter what the field of specialization and application. The difference occurs primarily in the type of application. For example, hypothesis testing can be applied to pre-testing a new drug in the pharmaceutical industry or to quality control on an assembly line. The former can be labelled medical research whereas the latter is business research. Yet both use essentially the same techniques.

From the course offered in the Spring of 2015, several important variables were available to gauge the effect of each on student performance. These variables include:

1. Student Grade Point Average upon entering the course. From university records it is possible to obtain the cumulative grade point average for each student at the time of entering the course. The assumption made in including this variable is that GPA is a measure of ability. On the other hand, it needs to be kept in mind that these students, for the most part, are sophomores so that the cumulative GPA of each student is based on a relatively small number of primarily required courses. The value of GPA varies between 1 and 4.

2. Gender. This is a dummy variable set equal to "0" for females and "1" for males.

3. Time spent on homework assignments. The online system used in the course offers summary slides of textbook chapters, practice problems, pre-lecture and post-lecture quizzes, and exams. Statistics are available from the instructor's grade book for the amount of time students have logged into their account for each of the activities. To keep the analysis uncomplicated and to avoid value judgments concerning the importance of various activities, the total number of hours for all activities has been used in the regressions. No bounds apply to this variable.

4. Participation in weekly class lecture. A student's grade for Participation is based upon attendance and correct responses by clicker to questions posed during the lectures. Generally speaking, a semester encompasses 15 weekly lectures with, on average, 3 questions per lecture. Therefore, the maximum point value for this variable is 60, but for purposes of grading and in the regression analysis, each student's grade has been converted to a percentage.

5. Number of SI sessions attended during the semester. Student Instructors are required to hold hour one-hour sessions per week. Attendance by students is optional, and they can attend more than one session per week. Extra credit for attendance at SI sessions is given. A student receives 0.25 of a point for each session attended up to a maximum of five points. This means that extra-credit is given for up to 20 SI visits during the semester, and this is the upper limit of this variable. A student's semester total is added to his/her overall point total for the course after all other factors are taken into account.

6. Semester Point Total. A student's final grade in the course is the dependent variable in the regression equations, and it is based upon the weighted total of course elements used for grading. Each element is converted to a percentage of the possible points, and the components are weighted in the following way:

Table 1. ECO 201 - Spring 2015 Grading

2 Mid-Term Exams	20%
Certification Quizzes	10%
Post-lecture Quizzes	15%
Team Project	25%
Final exam	20%
Class Participation	10%
SI Extra Credit (0.25 points per session attended)	Max. 5 points

It needs to be kept in mind that a student's total score for the course can exceed 100 percent. With the exceptions of the Team Project and Class Participation, students can potentially obtain more than 100 points for the other components of their grade. This extra credit is earned more for attitude and effort in the class than for ability.

7. Sample Size. In total there were 118 students in the course in the spring semester of 2015. Of these, 89 attended at least one student instructor session and 29 did not attend any. In the regression analysis, the 29 who did not attend were excluded from the data that were analyzed. The motivation for not attending sessions differs as between students, and this will be the subject of a separate analysis. To have included non-attendees in this analysis would have biased the results of the regression analysis for including too many zeros for students with very different reasons for not attending. It is for this reason that previous analyses have used cut-offs or loosely defined classes for their analyses.

The table below summarizes descriptive statistics for the students in the statistics course during the spring 2015 semester:

Table 2. Summary Statistics of Students Attending SI Sessions

Variable	All Students			Males		Females	
	All	Attending	Not Attending	Attending	Not Attending	Attending	Not Attending
Number	118	89	29	45	20	44	9
GPA	3.05	3.14	2.79	3.07	2.67	3.19	3.03
Homework (hrs.)	26.13	27.83	20.93	27.49	18.56	28.17	26.2
Participation (%)	68.51	72.25	57.03	71.22	48.76	73.29	75.42
SI Visits	6.29	8.34	0	8.93	0	7.73	0
Final Exam (%)	77.06	84.79	53.31	86.99	44.39	82.54	73.14
Total Points (%)	77.86	82.47	63.72	83.36	57.98	81.56	76.47

Several results stand out in the table. First, a higher proportion of females attend SI sessions as compared to males. While this is the case, for those males that attend, they have a higher number of sessions attended as compared to females. In addition to this, students who attend SI sessions, on average, have a higher GPA, tend to spend more time on homework assignments, and perform significantly better on the final exam. All of this leads them to have a higher point total for the course, and consequently, a higher final grade. Interestingly, there appears to be larger differences in the values of all the variables for men attending and not attending as compared to those for women.

Regression results

In this analysis, **ordinary least squares** (**OLS**) is used for estimating the unknown parameters in the linear regression model specified above. The goal is to minimize the differences between the observed responses in the dataset and the responses predicted by the linear approximation of the data (visually this is seen as the sum of the vertical distances between each data point in the set and the corresponding point on the regression line - the smaller the differences, the better the model fits the data). In the present analysis, the model can be specified as:

CP = f (HT, GPA, SI, G, P)

Where:

CP = Total points for the semester;

HT = Time spent on homework assignments;

GPA = Grade Point Average

SI = number of SI sessions attended;

G = Gender (1 for males, 0 for females);

P = Class participation during weekly lectures.

The OLS estimator is consistent when the regressors are exogenous and there is no multicollinearity, and they are optimal in the class of linear unbiased estimators when the errors are homoscedastic and serially

uncorrelated. Under these conditions, the method of OLS provides minimum-variance mean-unbiased estimation when the errors have finite variances.

Consideration was given to using other types of regression analysis, in particular, quantile analysis. This might have fit well with the analysis being undertaken, but one must consider the sample size. As it has been estimated, the total sample size of students who had attended SI sessions is 89. If a disaggregation of this sample size were done on the basis of characteristics and into quartiles, cell sizes would become too small to ensure unbiased estimators. In future work in this area, and once a larger sample size is obtained, alternative forms of analysis will be considered. In the present case, the analysis should be accepted as a first step in a continuing evaluation of the benefits of SI.

The results of the regression are presented in the following table:

Table 3. Regression Results

OLS Regression Table	**Coefficient**	**Standard Error**	**t-Value**	**p-Value**
Constant	20.65	6.15	3.3602	0.0012
Homework Time (HT)	0.31	0.07	4.4786	< 0.0001
GPA	7.79	1.86	4.192	< 0.0001
SI Attendance (SI)	0.73	0.15	4.9283	< 0.0001
Gender (G)	2.39	1.24	1.9318	0.0568
Class Participation (P)	0.29	0.064	4.7279	< 0.0001

$r^2 = 0.6418$

F-ratio = 29.74 (p-Value < 0.0001)

The value of r^2 is 0.6418. This is a very high coefficient of determination that indicates that the variables included in the regression explain 64.18% of the variation in grades. The F-ratio indicates that the equation as a whole is highly significant in explaining the variation in grades.

All of the coefficients are positive. *A priori,* this would have been the expectation. With the exception of gender, they are significant at a very high level. One would have thought that gender would have been an important determinant in a somewhat math-based course like statistics. The positive value of the gender coefficient (2.39) seems to indicate that men enter the class slightly more prepared than women. At the end of the course, however, there is not a statistically significant difference in grades of men and women. The tentative conclusion that can be drawn is that women work harder during the semester, and they glean more from each of the components in the course. This conclusion, however requires further investigation.

The other coefficients offer very interesting results. Clearly, the coefficient for GPA upon entering the course indicates that, generally, better students will perform better in the course. Each grade point increases the student's course point total by 7.79 percentage points.

The relationship between the remaining coefficients indicates that attendance at SI sessions will increase a student's performance by more than double the individual effects of an hour spent on homework or a point gained from attendance and class questions. This is a very significant finding, but it might be expected. A survey of the statistics class taken in a previous semester indicated that only a low percentage of the students complete the reading assignments in the course. The exposure they obtain to the various topics comes initially from lecture sessions and homework problems. Solutions to homework-type problems are a major concern of SI sessions, along with a review of the materials covered in lecture sessions. Thus, each SI session is a review of the materials for the specific topic, and since it is the second exposure to the materials plus detailed problem solutions, students absorb more from the SI sessions. As pointed out earlier, this may be one of the most important results concerning the use of SI and in a blended learning context. The Student Instructor and the SI sessions assume a much greater role in blended learning classes. They become almost a necessary element for success for many students.
In order to test for any possible multicollinearity in the data, a linear correlation table was obtained. The results are the following:

Table 4. Linear Correlation Table

	Hawkes Time	GPA	SI Attendance	Gender	Class Participation
Homework Time	1	0.291	0.229	-0.025	0.038
GPA	0.291	1	-0.009	-0.117	0.319
SI Attendance	0.229	-0.009	1	0.095	0.076
Gender	-0.025	-0.117	0.095	1	-0.066
Class Participation	0.038	0.319	0.076	-0.066	1

First, the above results indicate that there does not appear to be multicollinearity in the data. All of the off-diagonal coefficients are quite low. It is interesting to note, however, that there is a high correlation between time spent on homework assignments, GPA, and class attendance. This would seem to confirm the belief that students who receive higher grades spend more time studying and more frequently attended student instructor sessions. While this is hardly a surprising result, it is interesting to find that data confirm it.

Does attendance at SI Sessions ensure success in a blended learning context?

Not all students who attended SI sessions did well in the course. Of the 89 students who attended at least one session, seven students had total semester points below 60 percent. The reasons for this poor performance can be traced to other factors:

- With the exception of one student, all of them had 3 or less SI visits;
- All of the students had very low completion rates for homework assignments (less than 30 percent); and
- The students did not attend and participate in class activities on a regular basis (less than 40 percent).

It should go without saying that SI sessions do not substitute for other class activities. A student's grade is the result of a package of activities. The course was designed so that no one activity would be devastating to a student's final grade. But one activity does not substitute for another, and SI needs to be viewed in the context of a reinforcing and complementary activity in the overall course.

Conclusions and future directions

The analysis in this paper has shown that, using OLS multiple regression analysis and given the available data, there is a highly significant effect of attendance at SI sessions and final grades for the statistics class that has been analyzed. The addition per SI session attended to total course points is more than twice as much as the completion of homework assignments and participation in class activities. This is not to belittle the contribution of the latter two elements in the course, and future research may investigate interaction effects of the variables. The importance of SI in a blended learning class structure has been emphasized throughout this paper. It provides an opportunity to review activities and approaches to problem solutions, as well as reinforcing what has been covered in class meetings. And all of this is done in the more conducive atmosphere of student-to-student interaction.

It needs to be pointed out that the current analysis was designed ex-post once the course was completed. It is not a designed experiment. As such, there are a significant amount of questions that emerge, but that cannot be addressed given the available data. A survey of students is now in the planning stages at NAU to obtain the information necessary to investigate the following issues:

- Are there significant differences in the effects of SI attendance, homework completion, and class participation as between males and females? While the gender variable in the equation of this analysis is not significant, one needs to keep in mind that the effects on final grades are being analyzed for all students that attended SI sessions, and overall differences are being averaged out. If regressions were to be run separately for males and females, would significant differences in the coefficients emerge?
- Why don't students attend SI sessions? One can hypothesize four possible reasons;

    1. Students feel they can do well without SI attendance;
    2. SI attendance is voluntary and some students "just want to get by with a C";
    3. Students have a conflict with the fixed time slots of SI sessions;
    4. Some students just don't care about their grade.

- What is the effect of having taken a statistics course in another college (which was not transferable) or in high school on a student's performance?
- Students receive a small amount of extra-credit for attendance at SI sessions. What influences student attendance more, the extra-credit or the help they receive from the student instructor?

- Associated to the previous question, what are the student-perceived benefits of SI sessions? One might imagine the following possibilities:

    1. Extra-credit;
    2. Improved knowledge and understanding of course materials;
    3. Preparation for exams;
    4. Confidence in course activities;
    5. Assistance with homework problems;
    6. Improved study skills;
    7. Interaction with team members and other students; and
    8. Higher grades in the class associated with the SI.

The above questions can be the subject of a specially designed survey to be administered to students toward the end of the semester. A final area of inquiry that is somewhat outside the general aim, but that could be investigated in this survey, is whether there exists any alternative strategies to the SI model that have the potential to have a greater effect on student grades. Aside from the fact that there may be other vehicles currently used for the purposes of the SI model employed by NAU, students themselves may have ideas on how to improve the supplementary instruction system. It seems clear that a great deal of additional work needs to be undertaken in the future development and improvement of the SI program at NAU.

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