A Regression Analysis of Student Motivation and the Effect of Supplemental Instruction on Student Success

By

Kathryn Galston

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The members of the Committee approve the thesis of

Kathryn Galston presented on May 26, 2017

_____

Dr. David Welsch, Chair

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Dr. Matthew Winden

_____

Dr. Yuhan (Cathy) Xue

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Under the Supervision of Dr. David Welsch

This paper examines the effects of the Supplemental Instruction (SI) program on student achievement at a two-year commuter college. SI offers free and optional review sessions lead by upper-level students who have successfully completed the course. The SI program targets historically difficult courses with the intent to increase grades and decrease withdrawal rates. With sessions being optional, however, the program creates a self-selection bias and thus correlations are not sufficient in determining the true impact of the program. When not accounting for this endogeneity concern, there is a positive association between attendance and grades. Similarly, a Baseline Value-Added Education Production Function finds similar relationships while controlling for previous student performance. Using a two-stage least squares regression to account for endogeneity, results do not find SI to be a beneficial program.

1. Introduction

In post-secondary education, many entry-level courses produce large numbers of withdrawals and/or low grades. Entry-level arts and sciences courses, considered 'historically difficult' (Blanc, Debuhr, & Martin, 1983) have high levels of Ds and Fs and a 30% or higher withdrawal rate. Supplemental Instruction (SI) was created to target these courses with the intent to improve final grades and decrease withdrawal rates, as well as, increase future grades, decreased future withdrawals, and increase graduation rates (International Center For Supplemental Instruction, 2017) SI offers optional instructional sessions outside of class in which students can review course material, study with peers in groups, and work through questions they may have on course material with the SI Leader; an upper-level student who has already successfully completed the course and received an A for their final grade.

Not only is SI thought to be beneficial to students, but the program can also support faculty and the institution itself. Seen as a potential 'Faculty Development' program (Zerger, Clark-Unite, & Smith, 2006), students and parents are increasingly demanding accountability and a higher quality in education while faculty may be unaware of their opportunities for improvement. SI leaders are required not only to facility the sessions but also meet with their faculty to provide feedback on the status of their reviews, how difficult content is being portrayed, and what strategies are working best for the students. Through this feedback, faculty are able to realize what is and what is not going well and adjust their methods for delivering difficult content in the future.

Since SI sessions are optional, the program creates a self-selection bias. It may be that highly motivated and successful students are more likely to attend SI; or, possibly, students who are struggling or find the course material to be more difficult may be more likely to attend. Thus, even the direction of the bias is unknown. The endogeneity of who attends can skew the outcome of the program resulting in a bias of its true impact on students. If highly motivated students who would normally be successful in a course were the students more likely to attend, then the bias would be upwards (i.e. overestimating the impact of SI on final grades). If struggling students who may not be as strong with the course material are more likely to attend, then it would bias the effect downward (i.e. underestimating the impact of SI on final grades).

The rest of the paper proceeds as follows: Section 2 will discuss the SI program and review previous studies that have examined SI and its impact on students. In Section 3, I will discuss the potential impact of the self-section bias and possible instruments to control endogeneity. In Section 4, I will analyze the relationships between SI attendance and student grades using student data from a two-year commuter college in Wisconsin using two separate models: a Baseline Value-Added Education Production Function that does not take into account the self selection bias and a Two-Staged Least Squares (2SLS) model that accounts for the self selection bias by using instrumental variables. In Section 5, the results of the two models will be analyzed and noted. Finally, Section 6 will include a discussion on the program and its potential and concludes the paper.

2. Background and Literature Review

2.1 Background on SI

Created by Dr. Deanna Martin in 1973 at the University of Missouri Kansas City (UMKC), the SI program has spread to more than 2,500 institutions across the world (Summers, Acee, & Ryser, 2015). In 1981, the program was recognized by the U.S. Department of Education as an Exemplary Education Program (Martin & Arendale, 1994). The program itself is a non-remedial approach to learning that targets high-risk courses instead of high-risk students (The International Center For Supplemental Instruction, 2017) The use of the program is free for institutions and requires a Program Coordinator to be trained and certified from the International Center for SI UMKC.

SI Coordinators, along with faculty of the courses offering SI, find students who would serve as SI Leaders for the out-of-class sessions. These Leaders are previous students who successfully completed the course and received notable grades. The Leader attends the course, similarly as a student, so they can be "in-tune" to what is being taught and facilitated in the course, as well as take their own notes and refresh on the content. The Leader holds bi-weekly hour-long sessions where students of the course are free to attend and work through reviews of the previous class period's content, meet with other students, and develop study skills to help them not only in the current course, but future courses. SI is not intended for the SI Leader to help students complete their homework or take-home assignments.

One of the aspects of SI that makes the program so popular is its flexibility and the potential for it to adjust to an institution's needs. SI is not a set model that a

institution must fit to. Not only do the Coordinator and Institution receive a certification to offer SI, they will then also receive financial and support-based incentives to help answer questions, troubleshoot any issues, and offer discounts to SI Conference registration, reducing training fees, and discounted training materials (The International Center For Supplemental Instruction, 2017).

The International Center For Supplemental Instruction has published three sets of National SI data and the impact the program has on students. These findings include descriptive statistics and correlations that present SI is a beneficial program that increases grades for those who attend in comparison to their peers who did not attend. Although the International Center has found high positive correlations between attending SI and final course grades, their analysis does not include controls that may impact a student's grade and associated with likeliness of attending SI. Correlations need to be interpreted with caution since they do not account for the endogenous issues mentioned above. If SI attendance is positively correlated with final grades, then it could be interpreted that attending SI is beneficial in improving final grades; however, this does not account for who is attending, previously performance of the students, and other factors, not to mention the selection bias.

Previous studies have also found that students who attend SI experience positive results in that attending SI improves final grades. If this relationship is true, then all students should be attending SI and colleges not offering the program should start. However, if SI is found to not be beneficial, perhaps colleges should eliminate or scale

back the program, as it is expensive and time exhausting. The question that this paper tries to examine is: how does SI actually affect student achievement?

2.2 Literature Review

Bowles and Jones (2002) used a variety of empirical models to explore what type of student attends SI and how single OLS regression cannot be used to adequately measure the program's effects on student grades because SI attendance and the outcome of SI attendance are jointly determined endogenous variables. When examining SI and its effectiveness, the selection bias that arises from the students who attend SI under-estimates the benefit to student achievement when using a single-equation OLS model. While controls in single-equation models can account for student characteristics that affect outcome, such as ACT score, there are still unobserved effects that impact both SI attendance and outcome and therefore bias the result estimations. Bowles and Jones found students who attend SI tend to be students who, in the past, were average achievers. Using maximum likelihood estimation and simultaneous equations, they estimated probit and Poisson structured models. Their first model measured the correlation between SI attendance and the error term, which was then imposed as a parameter in their second model, the Poisson. The Poisson model measured the effect of SI attendance on outcomes using unbiased estimates.

The results from the probit and Poisson models and the OLS regression both find SI increased outcome; however, the coefficient for SI attendance in the probit and Poisson models were not statistically significant. The probit and Poisson model, however, found the estimate of SI attendance to be twice the size of the estimate in the OLS

regression. Comparing these two models, they determined OLS must have underestimated the program's benefits due to the self-selection bias of the students attending and the limited options of dependent variables available for them to consider.

Bowles, McCoy, & Bates (2008) found that SI attendance in freshman-level courses had a statistically significant positive influence on the probability of graduation. Specifically, attending SI increased the chances of a timely graduation by approximately 11 percentage points. With 3,905 student-level panel-data, they utilized a bivariate probit model (two-equation model) to test the impact of SI attendance on freshman-level courses on graduation success. They used high school GPA as an instrumental variable for SI attendance over ACT score as they believed high school GPA better reflects a student's work ethic and attitude towards education whereas an ACT score was used as a better predictor for graduation success as it is a measure of academic ability. Their main dependent variable of interest in their second model was whether a student had graduated by Spring 2005 or had filed a graduation application by Fall 2005.

They find that when they do not control for the self-selection bias, the estimate for SI attendance was positive and significant, implying that SI attendance has a strong positive effect on graduation success. When controlling for the self-selection bias, the estimate for SI attendance was found positive and much more significant against graduation success. These results imply that when the self-selection is not accounted for, the effect of SI is underestimated.

Summers, Acee, and Ryser (2015) found a positive effect of SI attendance on course success and a negative association with course absence. They used student-level

data from three high enrollment, introductory-level history courses at a large, public Hispanic-serving University. They utilized a conditional indirect-effects model to analyze the effects of SI attendance on class absence and success. In their study, they noted a meta-analysis conducted by Credé, Roch, & Kieszczynka (2010) that suggested that course attendance (absence) may have a strong impact on final grades and student GPA. Thus, class attendance (absence) may then be the best predictor for student success than any other predictor for academic performance.

Of the students in their data, 57.5% of the students successfully completed the history course and 42.5% earned a D, F, or W (withdrawal). They found that students with fewer absences were more likely to succeed in the course. Overall, their results suggested that minority students benefited more from attending SI than white students and that students with lower SAT/ACT score were more likely to attend SI which increased their chances of succeeding in the course.

Blanc, Debuhr, and Martin (1983) looked at student data from an urban institute with 746 student observations within seven art and science courses. Of the student observations, two groups were created of students who participated in the program and those who did not participate. To categorize those who did not participate, they placed the students into two more groups: motivated and unmotivated students. Students who indicated high interest in attending but could not due to scheduling conflicts were placed in a motivated group, and those who did not indicate any interest were placed in an unmotivated group.

They found when looking at descriptive statistics alone that motivation was not the only account for differences in achievement of the three groups. Regardless, a student being motivated and participating and being motivated and not participating, attending SI may be the impacting difference in final grades and not motivation.

Analyzing just descriptive statistics, Goomas (2014) examined a newly implemented SI program at an urban community college in downtown Dallas, TX. He found students enrolled in a general psychology course who regularly attended SI received an average of an 83% of success in the course while those students who did not attend received an average of a 64%. Groomas' analysis also went further in studying the SI Leader's themselves and their academic performance. He found that of the 15 SI Leaders he tracked, two continued into a nursing and health program, six continued taking courses while at the same time conducting SI sessions, three went on to a 4-year university, and four entered the workforce.

3. Data and Self-Selection

3.1 Data

The SI program was implemented at the University of Wisconsin-Rock County (UW-Rock County) in the spring semester of 2011. UW-Rock County is a two-year commuter school located in Janesville, WI and offers courses that build a strong foundation in over 200 different majors. UW-Rock County offers the lowest tuition in the UW System and offers a Guaranteed Transfer Program that ensures admission into one of the four-year UW campuses after fulfilling certain credit and grade point average requirements (University of Wisconsin Rock County, 2017).

The original course offerings for SI were Anthropology, Economics, Calculus, College Algebra, and Psychology. Over the next semesters, SI began to include Zoology, Statistics, and Communication. Although UW-Rock County is a two-year commuter campus, the program was started with hopes to find similar results from other larger four-year institutions already offering SI.

Specifically, at UW-Rock County, SI Leaders hand out a survey on the first day of class and introduce themselves to the students. The survey asks the students their intended major, what grade they expect to get in the course, why they are taking the course (required, elected, etc.), and how likely they are to attend SI on a scale of 1-5 (1 being least likely to attend and 5 being very likely to attend). Also included on the survey are selected dates and times the Leader has already chosen to potentially offer the sessions. This gives the students the opportunity to choose a time that works best for their schedule and the session is offered with the intent of being available for most students. Using the information collected from the survey, the Leader decides when SI will be offered and holds bi-weekly meetings.

This paper uses data from the Spring 2011 semester through the Fall 2013 semester with 710 student observations. This data was made available by the SI Director and Coordinator and by first-day surveys that SI leaders hand out on the first day of classes with SI offerings. Other data was collected from the UW registrar and professors of the courses.

The dependent variable of interest in this examination is the final grade that a student receives in the course with SI at the end of the semester on a 4.0 scale. Control

variables included in this study were student-level characteristics such as age, gender, ethnicity, freshman or sophomore status, credits enrolled in, ACT score, previous cumulative GPA in college, previous attendance in SI, expected grade, and if the SI course was required for the student's intended major. Other course-level characteristics were used such as class size, gender of the professor, average size of SI session, whether or not SI was offered the same day as class, gender of the SI Leader, and the class average GPA.

To account for any missing data of control variables, an additional variable was added (imputation dummy[1]) to indicate that the variable for that observation was missing and the missing value was replaced with the mean. For example, UW-Rock County does not require students to submit their ACT score when they apply for admission if they have been out of high school for more than two years. With all of the data that was collected, missing ACT scores for some students were substituted with the mean value ACT score of all the submitted ACT scores in the sample and a new variable for no ACT score submitted was assigned to student observations missing the ACT score originally.

Table 1 features the descriptive statistics of all the variables that were used or considered in this study. What is notable from the table is that the average ACT score is a 21, which is larger than the ACT score requirement for admission into UW-Waukesha, another two-year campus in the UW system. The average ACT score criteria for UW-Whitewater, a four-year campus further is 22. Also notable in Table 1 is that the previous

[1] Imputation dummy variables are variables used for missing data that take on the value of the mean of all other non-missing values for the same variable.

cumulative GPA for the students in the sample is a 2.71, which is low on a 4.0 scale. From these statistics, we can assume that a large amount of the students in the sample are lower performing students.

Table 1: Descriptive Statistics

	N	Mean	Standard Deviation
Student-Level Characteristics			
Final Grade Point	710	2.065	1.224
SI Attendance	710	1.66	3.878
Female	710	0.451	0.498
Age	710	22.493	6.844
Non-Traditional Student	710	0.201	0.401
Minority	710	0.089	0.285
Sophomore Status	710	0.424	0.495
Credits Enrolled	710	12.62	3.191
ACT Score	710	21.039	3.237
No ACT Score Submitted	710	0.261	0.439
Previous Cumulative GPA	710	2.709	0.47
New Freshman Status	710	0.415	0.493
Previously Attended SI	710	0.08	0.272
Required Course	710	0.406	0.491
Expected Grade Point in Course	710	3.36	0.561
No Survey Submitted	710	0.142	0.35
Course-Level Characteristics			
Class Size	710	22.911	8.672
Female Professor	710	0.451	0.491
Average SI Size	710	2.589	1.218
Same Day as Class	710	0.541	0.499
Female SI Leader	710	0.575	0.495
Class Average GPA	710	2.065	0.344
Instrumental Variables			
Student Likeliness	710	3.62	1.067
Miles	710	12.097	54.504

Most importantly from the table, the statistics for final grade point and SI attendance are listed. The average final grade point in the courses from the sample is a 2.065 with a standard deviation of 1.224. This reveals that on average, students in the sample received about a C in the class as a final grade. The average for the number of SI sessions attended per student each semester was 1.66 with a standard deviation of 3.87. From these numbers, it is shown that from the sample, most students only attend about

two SI sessions each semester. To SI experts at UMKC, three sessions is the 'magic number' of sessions a student should attend to help them learn better studying habits (The International Center For Supplemental Instruction, 2017). That being said, the average number of sessions attended from the sample is not far from the ideal number of sessions attended.

3.2 Self-Selection Bias

With SI sessions being completely optional, comparing students who are attending and who are not with regard to their final grade is not an apples-to-apples comparison. If there are students in a class who attended SI and received a higher grade, on average, in the course, than the students who did not attend, it may be due to the fact that more motivated students choose to attend SI. These students may have received equally high grades in an environment without SI. This will upward bias the estimated coefficient of SI.

There may also be students who struggle with the course material who are the main students attending SI and generally receive lower grades. Those students, being lower performers, would create a downward bias of the estimated coefficient of SI and show a dissenting outcome for the program. Students who are lower performing may be better off using a different method to study and attending SI may have a negative impact on them. Essentially, if more motivated and higher-performing students are the ones attending SI, the program then will appear to have the effect it is intended to have. If unmotivated and low-performing students are the ones attending, then the program would appear to be non-beneficial.

The motivation of a student that encourages them to attend SI also has an impact on their final grade in the course. The impact of not controlling for the endogeneity of motivation results in SI attendance being correlated with the error term and thus biasing the impact on final grade. The difficulty in controlling for motivation is that it is an immeasurable and unobserved variable. Different instruments can be used to help measure motivation but can be limited and hard to produce using data.

3.3 Instruments for Motivation

Table 1 shows the descriptive statistics of instrumental variables that could be used in this study to control for motivation: how many miles they live away from campus and how likely they were to attend. These variables could be considered as instruments to create external variation in the study to help get at a measure of motivation to attend SI. The two requirements for these instruments are that they cannot be correlated with achievement (final grade in the course) and need to be correlated with SI attendance or student motivation to attend SI. The instrument 'Likeliness' was created using first-day surveys that all students filled out. On the survey, a student rates how likely they are to attend SI on a scale of one to five with five being very likely to attend. Those who signaled their motivation for attending as likely or very likely were then more inclined to attend SI.

The variable of student likeliness should not be correlated with achievement or final grades because this is simply a student's signaling of their likeliness to attend SI sessions and should have no relationship with their final grade. Their expressed likeliness to attend should have no impact on their final grade in the course. Student likeliness

should be correlated with attending SI, as it is their own admission to how motivated they are to attend. Through the student's SI attendance, student likeliness would then impact final grades. Thus then, the exogeneity requirements are held.

Using the number of miles a student lives from campus could also fit these requirements in that, how far they live from campus should have no effect on their final grade in their course but should have a correlation on their SI attendance as the further away they may live, the harder it is for them to get to campus to attend the sessions. Since UW-Rock County does not have dorms, all students have to commute to campus one way or another. The distance a student lives from campus only impacts student's final grade through their SI attendance. These variables, used as possible instruments, helped to remove the endogeneity bias of how many SI sessions were attended by a student and control for their motivation or final grade in the course.

As shown in Table 1, the average distance a student lives from campus is 12.09 miles with a standard deviation of 54.5 miles, which means there are several students that live far away from campus and have a long drive. An explanation for such a large standard deviation is that there are students who live in a surrounding city who commute to campus, to attend class. The largest surrounding city is over 40 miles away from the campus, which will increase the standard deviation if more students live there relative to the city campus is located in. A student's likeliness, from the table, has an average of 3.6 on a 1 to 5 scale. These results imply that a majority of students in the sample were unsure if they would attend SI or not.

4. Empirical Models

4.1 Baseline Value-Added Education Production Function

The Baseline Value-Added Education Production Function is an OLS model that takes into account the student's growth in achievement over their lifetime by including lagged performance (previous cumulative college GPA) as an explanatory variable (Artz & Welsch, 2014).

The following Baseline Model was used to determine the relationship between SI attendance and final grade point:

$$(1)\ GPA_{ijt} = \beta_0 + \beta_1 LnAttend_{ijt} + \varepsilon_{ijt}$$

where $GPA_{ijt}$is the final grade point of student *i* in class *j* in semester t, $LnAttend_{ijt}$ is the natural log of the SI attendance variable of interest, β_0 is the constant, and ε_{ijt} is the stochastic error term.

Looking at the logged number of sessions attended is valuable to this study because attending SI could have a huge impact to students in their first session. After the next few sessions, the program's impact on students potentially becomes less valuable than the first session. Logging the dependent variable also helps to possibly reduce any heteroskedasticity within the study, make estimates less sensitive to extreme values, and ensures the error term is normally distributed.

The following Baseline Value-Added Education Production Function was also estimated to determine the relationship between SI attendance and final grade point:

$$(2)\ GPA_{ijt} = \beta_0 + \beta_1 LnAttend_{ijt} + \beta_2 GPA_{ijt-1} + \alpha X_{ijt} + \delta W_{jt} + \varepsilon_{ijt}$$

where GPA_{ijt-1} is the lagged GPA performance of the student t calculated from student t's previous cumulative college GPA, X_{ijt} is a vector of student level characteristics such as gender, non-traditional student status, minority status, sophomore status, credits enrolled, ACT score, previous cumulative GPA, new freshman status, already attended SI in the past, required class or not, and expected final grade, W_{jt} is a vector of course level characteristics such as class size, gender of the professor, average size of SI sessions, whether or not SI is held on the same day as class, gender of the SI Leader, and the class average GPA excluding student t, $\beta_0$is the constant, $\beta_1, \beta_2, \alpha,$ and δ are estimatable coefficients, and $\varepsilon_{ijt}$is the robust standard error term.

This baseline model uses the value-added term of previous college GPA to help control for motivation. This term includes not only previous performance, but also other inputs and habits they acquired throughout their lives up until their current college semester. These other inputs could be, but not limited to, how their parents impacted them growing up. The value-added helps to recognize the effect SI has on grades relative to a student's previous performance. This then follows a value-added education production function at the student level.

4.2 Two-Staged Least Squares Model

The following two-staged least squares model was estimated to correct for the self-selection bias by introducing external variation using student likeliness as an instrumental variable to account for student motivation:

First stage:

(3) $\widehat{LnAttend}_{ijt} = \beta_0 + \beta_1 Z_{ijt} + \beta_2 GPA_{ijt-1} + \alpha X_{ijt} + \delta W_{jt} + \varepsilon_{ijt}$

where $LnAttend_{ijt}$ is the predicted value of the natural log of the SI attendance endogenous variable of interest, that were attended by student *i* in class *j* in semester *t* and Z_{ijt} includes the intended instrument of a student's likeliness to attend to add outside variation to the model and eliminate any self-selection bias, GPA_{ijt-1} is the lagged GPA performance of the student t, W_{jt} is a vector of course level characteristics, $\beta_0$is the constant, $\beta_1, \beta_2, \alpha,$ and δ are estimatable coefficients, and $\varepsilon_{ijt}$is the robust standard error term.

Within the two-staged instrumental variable model, the bias of motivation is eliminated. To do this, intended instruments were specified that would fit two characteristics: having a correlation with attending SI but no correlation with student motivation or final grades in the course. The first-stage of the model is meant to identify if the instruments are in-fact correlated with SI attendance as well as any other variables that may be correlated.

Second stage:

(4) $GPA_{ijt} = \partial_0 + \partial_1 Ln\widehat{Attend}_{ijt} + \partial_2 GPA_{ijt-1} + \alpha X_{ijt} + \delta W_{jt} + \mu_{ijt} + \partial_3 \varepsilon_{ijt}$

where the new predicted value of our endogenous variable of the natural logged number of SI sessions that were attended is included and measured against final grades. The error term from this first stage is included in the second stage of the equation with a mean of zero and is uncorrelated with final grade (motivation). From the second stage, while the correlation and bias is eliminated for motivation, the instruments are then dropped.

5. Results

From all three models mentioned above, results between the Baseline Value-Added Education Production Function and the Two-Staged Least Squares Model contradict one another. When not controlling for our endogeneity concern, SI attendance is found to have a positive impact on final grades. When controlling for endogeneity, we could find no evidence that attending SI improved final grades. Moreover, I find that students who had previously attended SI for another course, did not have a positive and siginificant relationship on their final grades. This suggests that not only is there no evidence to support SI attendance impacts final grades in this course, but there is also no evidence that it has a significant impact on future courses either, which is a goal and objective of SI.

The results of Baseline Model (equation 1) are depicted in Table 2, column 1. SI attendance is positive and significant at the 1% level. This correlation implies that attending SI 1 percent more will increase final grades by 0.004 grade points and ignores the self-selection bias of who is choosing to attend SI.

The relationship between SI attendance and final grade point from the Value-Added Education Production Function (equation 2) is shown in Table 2, column 2. SI attendance is also positive and significant at the 1% level. Controlling for student-level and course-level characteristics, the results imply that attending SI one percent more will increase final grades by 0.003 grade points. These results, while slightly smaller than the results from equation 1, still show that attending SI will have a positive effect on final

grades. The correlation results may have overestimated the impact due to the lack of controls in the model.

The results of the baseline model with the SI attendance variable finds that attending SI is significant and beneficial. With the variable having a positive coefficient and being significant, would mean that attending SI is improving final grades in the course. Using the value-added education production function, we can see that previous college performance and ACT score were also significant. This would mean that students, who had higher previous performance in school, are still higher preforming today.

In Table 2, column 3 lists the results from the two-staged least squares model (equation 4) that account for issue of endogeneity. Table 3 shows the results from the first stage of the equation using student and course-level controls. Included with the controls is the student likeliness to attend SI instrument used to include external variation and eliminate the self-selection bias. Significant variables within the first stage are variables that are correlated with SI attendance. With controls, student likeliness is still correlated with SI Attendance. Student Likeliness is significant in the first stage at the 1% level and measured a 10.85 on its strength of an instrument from it's calculated F-test. This would mean that it fits the characteristics of being correlated with attending SI.

Table 2: The Effect of SI Attendance on Final Grade

	OLS (No Controls)	OLS (Controls)	2SLS (Stage 2)
Student-Level Characteristics			
Ln (SI Attendance)	0.353***	0.293***	0.326
	(0.047)	(0.051)	(0.333)
Female[t]		-0.076	-0.084
		(0.085)	(0.116)
Non-Traditional Student[p]		-0.043	-0.049
		(0.147)	(0.157)
Sophomore Status or Higher[m]		0.185**	0.186**
		(0.094)	(0.094)
Minority[w]		-0.465***	-0.467***
		(0.141)	(0.14)
Credits Enrolled		0.045**	0.045***
		(0.015)	(0.015)
ACT Score		0.070***	0.071***
		(0.013)	(0.014)
No ACT Score Submitted[c]		0.319*	0.310
		(0.178)	(0.196)
Previous Cumulative GPA		0.586***	0.582***
		(0.077)	(0.087)
New Freshman Status[f]		-0.009	-0.006
		(0.127)	(0.127)
Previously Attended SI[g]		0.050	0.041
		(0.149)	(0.171)
Required Course[h]		0.093	0.094
		(0.096)	(0.094)
Expected Grade Point in Course		0.184**	0.183**
		(0.074)	(0.073)
No Survey Submitted[q]		-0.044	-0.034
		(0.123)	(0.161)
Course-Level Characteristics			
Class Size		0.004	0.004
		(0.006)	(0.006)
Female Professor[j]		0.086	0.095
		(0.153)	(0.171)
Female SI Leader[g]		0.124	0.123
		(0.131)	(0.130)
Average SI Size		-0.024	-0.028
		(0.049)	(0.066)
SI Same Day as Class[k]		-0.163*	-0.164*
		(0.093)	(0.092)
Class Average GPA		0.010	0.009
		(0.143)	(0.141)
Constant	1.894***	-2.500***	-2.498***
	(0.54)	(0.527)	(0.520)
Fit Statistics			
N	710	710	710
F-Statistic (P-Value)	42.71 (0.00)	17.71 (0.00)	14.93 (0.00)
R-Squared	0.057	0.257	0.257

The number in the parenthesis is the heteroskedastic-robust standard error
[t] the reference group is male student
[p] the reference group is students younger than 25
[m] the reference group is freshman
[w] the reference group is white
[c] the reference group is submitted ACT score (imputation dummy)
[f] the reference group is second semester freshman or sophomore student
[g] the reference group is not previously been offered SI
[h] the reference group is non-required course for intended major
[q] the reference group is no submitted survey (imputation dummy)
[j] the reference group is male professor
[g] the reference group is male SI leader
[k] the reference group is SI on non-class days
*** Signifies the coefficient is significantly different from zero with a 1% chance or less of a type 1 error for OLS estimate
** Signifies the coefficient is significantly different from zero with between a 1% and 5% chance or less of a type 1 error for OLS estimate
* Signifies the coefficient is significantly different from zero with between a 5% and 10% chance or less of a type 1 error for OLS estimate

Table 3: Dependent Variable is the logged number of SI sessions attended

	2SLS (Stage 1)
Student-Level Characteristics	
Student Likeliness to Attend SI	0.121***
	(0.407)
Female[t]	0.196***
	(0.062)
Non-Traditional Student[p]	-0.168
	(0.108)
Sophomore Status or Higher[m]	-0.044
	(0.065)
Minority[w]	0.040
	(0.107)
Credits Enrolled	0.008
	(0.010)
ACT Score	-0.015*
	(0.009)
No ACT Score Submitted[c]	0.264**
	(0.110)
Previous Cumulative GPA	0.144***
	(0.055)
New Freshman Status[f]	-0.073
	(0.077)
Previously Attended SI[g]	0.205
	(0.127)
Required Course[h]	-0.050
	(0.066)
Expected Grade Point in Course	-0.009
	(0.051)
No Survey Submitted[q]	-0.382***
	(0.083)
Course-Level Characteristics	
Class Size	-0.005
	(0.005)
Female Professor[j]	-0.193*
	(0.112)
Female SI Leader[g]	0.096
	(0.092)
Average SI Size	0.125***
	(0.034)
SI Same Day as Class[k]	0.004
	(0.067)
Class Average GPA	-0.018
	(0.105)
Constant	-0.352
	(0.407)
Fit Statistics	
N	710
F-Statistic (P-Value)	10.85 (0.00)
R-Squared	0.235

The number in the parenthesis is the heteroskedastic-robust standard error
[t] the reference group is male student
[p] the reference group is students younger than 25
[m] the reference group is freshman
[w] the reference group is white
[c] the reference group is submitted ACT score (imputation dummy)
[f] the reference group is second semester freshman or sophomore student
[g] the reference group is not previously been offered SI
[h] the reference group is non-required course for intended major
[q] the reference group is no submitted survey (imputation dummy)
[j] the reference group is male professor
[g] the reference group is male SI leader
[k] the reference group is SI on non-class days
*** Signifies the coefficient is significantly different from zero with a 1% chance or less of a type 1 error for OLS estimate
** Signifies the coefficient is significantly different from zero with between a 1% and 5% chance or less of a type 1 error for OLS estimate
* Signifies the coefficient is significantly different from zero with between a 5% and 10% chance or less of a type 1 error for OLS estimate

From the second stage, depicted in column 3 of Table 2, using the new predicted value of SI attendance with our instrument, SI attendance is no longer significant. These results then show that when accounting for the self-selection bias, attending SI at UW-Rock County, does not have a significant impact on final grades. Specifically, no evidence could be found that attending SI had an effect on final grades, holding all else constant. This would also mean that the simple correlations and relationships estimated before were biased in their effects of SI on student performance and the endogeneity of who is attending does have an impact.

What is notable from these results is that students who had higher ACT scores and higher previous cumulative GPAs did receive higher final grades in the courses. This meaning then those students previously performing higher continued to perform at the same level in this course. Also interesting are students who expected to be receiving a high grade in the course were in fact more likely to receive a higher grade. The impact on minority students who attended SI, however, was negative and significant. From these results it can be found that if a minority student were to attend one SI session, their final grade point in the class would decrease by 0.466 points, holding student gender, units enrolled in, ACT score, class size, previous cumulative GPA, new freshman status, if a student was already offered SI, if the class was required or not, a student's expected final grade point, average size of the SI sessions, whether class and SI were held on the same day or not, and gender of the professor constant. In this case, there is less than a 1% chance these results are wrong and being a minority student does not have an impact on final grade point in the class.

When comparing the overall magnitude of the OLS and 2SLS coefficients of SI attendance, overall, they are very similar. The OLS coefficient of SI attendance is a 0.293 whereas the 2SLS is a 0.326. What makes the SI attendance variable in the OLS model significant, however, is that the standard error of SI attendance is smaller than that of the standard error in the 2SLS model. The standard error of the 2SLS model is larger than the standard error of the OLS model because the first stage of our 2SLS model has a smaller R-squared (0.235) than the OLS model (0.257), therefore finding less precision in our estimates when we regress student likeliness on SI attendance. This could imply our instrument is weak, however, the F-test to measure the strength of our student likeliness instrument is a 19.59, which is above the minimum value of 10 (Staiger and Stock, 1997).

To check the robustness, Tables 4 and 5 list further tests of the results above. One test for robustness in Table 4 column 1 is a different instrumental model that uses student likeliness as the instrument: a limited-information maximum likelihood (LIML) model. While the 2SLS is the most common instrumental variable model, the LIML model may be a better model for this study due to the smaller sample size and strength of the instruments because it is a linear combination of the OLS and 2SLS estimates with weights that are able to approximate the bias within the 2SLS. Although the coefficients and standard errors are slightly different, they yield the same results in that SI attendance is not significant.

Table 4: The Effect of SI Attendance on Final Grade

	LIML (Stage 2)
Student-Level Characteristics	
Ln (SI Attendance)	0.326
	(0.333)
Female[t]	-0.084
	(0.116)
Non-Traditional Student[p]	-0.050
	(0.157)
Sophomore Status or Higher[m]	0.186**
	(0.094)
Minority[w]	-0.467***
	(0.140)
Credits Enrolled	0.045***
	(0.015)
ACT Score	0.071***
	(0.014)
No ACT Score Submitted[c]	0.310
	(0.196)
Previous Cumulative GPA	0.582***
	(0.087)
New Freshman Status[f]	-0.006
	(0.127)
Previously Attended SI[g]	0.041
	(0.171)
Required Course[h]	-0.094
	(0.094)
Expected Grade Point in Course	0.183**
	(0.073)
No Survey Submitted[q]	-0.034
	(0.161)
Course-Level Characteristics	
Class Size	0.004
	(0.006)
Female Professor[j]	0.095
	(0.171)
Female SI Leader[g]	0.123
	(0.130)
Average SI Size	-0.028
	(0.066)
SI Same Day as Class[k]	-0.164*
	(0.092)
Class Average GPA	0.009
	(0.141)
Constant	-2.498***
	(0.520)
Fit Statistics	
N	710
F-Statistic (P-Value)	10.85 (0.00)
R-Squared	0.235

The number in the parenthesis is the heteroskedastic-robust standard error
[t] the reference group is male student
[p] the reference group is students younger than 25
[m] the reference group is freshman
[w] the reference group is white
[c] the reference group is submitted ACT score (imputation dummy)
[f] the reference group is second semester freshman or sophomore student
[g] the reference group is not previously been offered SI
[h] the reference group is non-required course for intended major
[q] the reference group is no submitted survey (imputation dummy)
[j] the reference group is male professor
[g] the reference group is male SI leader
[k] the reference group is SI on non-class days
*** Signifies the coefficient is significantly different from zero with a 1% chance or less of a type 1 error for OLS estimate
** Signifies the coefficient is significantly different from zero with between a 1% and 5% chance or less of a type 1 error for OLS estimate
* Signifies the coefficient is significantly different from zero with between a 5% and 10% chance or less of a type 1 error for OLS estimate

In Table 5, columns 1 and 2 are results of the first and second stage of another 2SLS model with student likeliness to attend as an instrument but also the logged number of miles a student lives from school as another. In the first stage, likeliness is again a strong instrument but logged miles are not. The Angrist-Pischke Multivariate F-Test results a 10.14 on their strengths as instruments. This indicates that they fit the characteristics of being correlated with SI attendance. In the second stage, however, again we could find no evidence that attending SI had an impact on final grades.

6. Conclusion

Although SI is a program meant to increase grades and decrease withdrawal rates, studies of its effects are still scarce and face many challenges with accounting for student motivation. The issue of endogeneity makes it hard to examine and pinpoint which direction the resulting bias is. It is unclear as to the type of student that is attending SI and how much of an impact their motivation is having on their final grade. Using a baseline value-added education production function, attending SI is significant and does increase final grades in a course. Previous performance of a student is also very significant as higher previous performers are still achieving higher grades. This value-added does not eliminate the bias created, although these results alone reflect a positive impact due to SI attendance.

To account for the motivational bias, the two-stage least squares model found SI to be insignificant in the second stage. The model added outside variation to control for motivation and the endogenous variable of attendance. Once the self-selection bias was accounted for, attending SI had no impact on final grades but those students who were

Table 5: The Effect of SI Attendance on Final Grade Using Student Likeliness and Distance as Instruments

	2SLS (Stage 1)	2SLS (Stage 2)
Student-Level Characteristics		
Ln (SI Attendance)		0.355
		(0.333)
Student Likeliness to Attend SI	0.122***	
	(0.027)	
Ln (Miles)	0.008	
	(0.024)	
Female[t]	0.196***	-0.091
	(0.062)	(0.116)
Non-Traditional Student[p]	0.171	-0.056
	(0.109)	(0.157)
Sophomore Status or Higher[m]	-0.043	0.187**
	(0.065)	(0.094)
Minority[w]	0.039	-0.468***
	(0.107)	(0.139)
Credits Enrolled	0.008	0.046***
	(0.010)	(0.015)
ACT Score	-0.014	0.071***
	(0.009)	(0.014)
No ACT Score Submitted[c]	0.263**	0.302
	(0.110)	(0.196)
Previous Cumulative GPA	0.143***	0.577***
	(0.055)	(0.087)
New Freshman Status[f]	-0.073	-0.003
	(0.077)	(0.127)
Previously Attended SI[g]	0.206	0.034
	(0.127)	(0.171)
Required Course[h]	-0.050	0.095
	(0.066)	(0.094)
Expected Grade Point in Course	-0.008	0.183**
	(0.050)	(0.073)
No Survey Submitted[q]	-0.382***	-0.024
	(0.083)	(0.162)
Course-Level Characteristics		
Class Size	-0.005	0.004
	(0.005)	(0.006)
Female Professor[j]	-0.195*	0.103
	(0.113)	(0.171)
Female SI Leader[g]	0.095	0.122
	(0.093)	(0.130)
Average SI Size	0.124***	-0.032
	(0.035)	(0.066)
SI Same Day as Class[k]	0.004	-0.164*
	(0.067)	(0.092)
Class Average GPA	-0.018	0.009
	(0.106)	(0.141)
Constant	-0.374	-2.496***
	(0.414)	(0.520)
Fit Statistics		
N	710	710
F-Statistic (P-Value)	10.38 (0.00)	14.87 (0.00)
R-Squared	0.235	0.256
Angrist-Pischke Multivariate F-Test	10.14	

The number in the parenthesis is the heteroskedastic-robust standard error
[t] the reference group is male student
[p] the reference group is students younger than 25
[m] the reference group is freshman
[w] the reference group is white
[c] the reference group is submitted ACT score (imputation dummy)
[f] the reference group is second semester freshman or sophomore student
[g] the reference group is not previously been offered SI
[h] the reference group is non-required course for intended major
[q] the reference group is no submitted survey (imputation dummy)
[j] the reference group is male professor
[g] the reference group is male SI leader
[k] the reference group is SI on non-class days
*** Signifies the coefficient is significantly different from zero with a 1% chance or less of a type 1 error for OLS estimate
** Signifies the coefficient is significantly different from zero with between a 1% and 5% chance or less of a type 1 error for OLS estimate
* Signifies the coefficient is significantly different from zero with between a 5% and 10% chance or less of a type 1 error for OLS estimate

already high performing did receive higher grades in the course. SI was also found to have no impact in the long run. These results contradict those without a control for motivation.

Using a more empirical approach to control for student motivation and the endogenous variable of attending SI, results follow a different route as other empirical studies done previously. If SI continues to be offered, SI would not be impactful for all students who attend UW-Rock County. Although the exact grade point difference for those who attend SI is unknown, other colleges and universities that offer the program do find the number of Ds, Fs, and withdrawals in these difficult courses to decrease and final grades to increase.

Should SI proven to be ineffective in helping students at the UW Rock County, then it may be a program worth removing from the institution all together. As mentioned previously from Table 1 results, the average number of sessions attended was almost two, which is few over the course of the semester.

Since the program is still new to UW-Rock County and has been limited in its offerings, perhaps it needs more time to reach more students and have a larger course offering. From the results found however, SI in its current state at this two-year campus is not benefiting students as intended in regard to their final grade in the course. The program takes a lot of time to prepare and setup from not only the SI Coordinator standpoint, but also from the SI Leader and faculty. There was also no evidence that SI attendance a this two-year campus has a significant impact on future grades and is

therefore not meeting another one of their objectives of, improving grades in future courses.

This study saw a few limitations in that this data is only across three year's worth of time with a relatively small sample compared to that of a possible four-year institution. It is possible then, that results may be different for a four-year institution that has a wider range of SI offerings over a longer time frame with a larger sample. There is also slight heterogeneity in SI Leaders and the quality of their sessions as well as the students attending overall.

As mentioned previously above, however, SI may be benefiting students in a sense that they are feeling more involved in the class as well as building better relationships with their classmates and faculty. Regardless if a student may not be achieving a higher grade in the course, they are overall being introduced to better studying habits as well interacting in groups between their fellow classmates. The feedback between an SI Leader and the faculty member could also be crucial in helping a professor adapt to their students. An institution such as UW-Rock County or any other two-year commuter school should take this into consideration if they chose to potentially remove or offer the program at the institution.

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