Supplemental Instruction: Helping Disadvantaged Students Reduce Performance Gap

By Hongtao Yue, Ruby Sangha Rico, Mai Kou Vang, and Tosha Aquino Giuffrida

Abstract: ***This study examined how Supplemental Instruction (SI) visits help traditionally disadvantaged students reduce the performance gap in their courses. A student is defined as holding a "disadvantaged" status when he or she can identify with the following factors: underrepresented minority status, first-generation status, Federal Pell Grant eligible status, and English/mathematics remedial status. This study revealed that students including both disadvantaged and nondisadvantaged would benefit from an increase of SI participation. The more disadvantaged students gained larger performance improvement than less disadvantaged students with more SI visits, indicating the importance of regular SI participation for disadvantaged students to close the performance gap with nondisadvantaged students.***

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At a glance, the educational system within the United States seems to be making strong strides to improve student access, retention, and persistence (Engle & Tinto, 2008). Upon closer examination, however, one sees wide gaps in equality of degree attainment in higher education. Many gaps in degree attainment are among students considered as disadvantaged due to characteristics such as being a first-generation college student, requiring English and math remediation, from a low-income household, and identifying with an underrepresented minority (URM) ethnic group. This particular student population has encountered numerous academic challenges resulting in a much lower performance and achievement rate than their counterparts.

The U.S. Department of Education (2013) has collected graduation rates among various ethnic groups. Data reveals 10% of African-American students and 9% of Hispanic students earned a bachelor's degree, which is only slightly up from the 1999-2000 figures of 9% and 6% respectively. This stands in sharp contrast to the 72.9% of Caucasian students who have earned a four-year degree. In other words, Caucasian students are roughly seven times more likely to graduate with a bachelor's degree than their URM peers. A similar situation is found with respect to socioeconomic status: the gap in achieving a four-year degree between low- and high-income students nearly doubled in the last 35 years (Engle & Tinto, 2008). Generally, then, major and widening gaps exist across ethnic and income lines.

Engle and Tinto (2008) described the path to successful completion of a bachelor's degree for most of the 4.5 million low-income, first-generation students enrolled in postsecondary education as "long, indirect, and uncertain" (p. 2). Across all institution types, low-income, first-generation students were nearly four times more likely to leave higher education after the first year when compared to students who did not have similar risk factors (Engle & Tinto, 2008). Such statistical evidence demonstrates the importance for postsecondary institutions to understand the needs of their disadvantaged student population and to implement successful interventions to reduce the existing performance and achievement gaps.

Literature Review

Underrepresented Students

Disadvantaged students historically have had lower degree attainment than majority students in college. A focus on college completion must include strategies to assist more URM in degree attainment. SI has shown potential to boost retention for many student groups. A traditionally disadvantaged student is known to identify with any one of four characteristics: URM status, first-generation student (FGS) status, Federal Pell Grant eligible status, and English/mathematics remedial status. These students are less likely to accomplish their educational goals due to lack of access, readiness, familial and/or peer support, or feelings of exclusion (Beal & Noel, 1980; Chaney, Muraskin, Cahalan, & Goodwin, 1998; Webb, 1987).

URM students are those designated as "students of color" or who are sometimes referred to as "non-white." Typically, URM students include those who identify as Hispanic or Latino/a, African American or Black, or Native American. Carter (2006) indicated ethnic minority students have a lower rate of completing their educational goals than their peers. They are less likely to be engaged in academic and social experiences, interact with faculty and other students, participate in extracurricular activities, and use social support services. Furthermore, this student population is more likely to live and work off-campus, work full-time, and take classes part-time (Engle & Tinto, 2008).

There are three definitions of a first-generation college student, all related to the parents' educational

background: those whose parents have no college experience (McConnell, 2000; National Center for Educational Statistics [NCES], 1998; Riehl, 1994; Terenzini, Springer, Yaeger, Pascarella, & Nora, 1996), those whose parents have not earned a two-year college degree, and those whose parents have not earned a four-year or bachelor's degree (Supiano, 2014). When compared to their continued-generation peers, first-generation college students typically have a difficult time adjusting to the demands of their academic and personal lives, have lower expectations of themselves, and lack in family support (both financially and emotionally) as they transition to an institution of higher education (Darling & Smith, 2007; Engle & Tinto, 2008; McConnell, 2000; Terenzini et al., 1996).

Students become eligible to receive funding for college through the Pell Grant program from the U.S. Department of Education based on their financial need, which is the difference between cost of attendance and expected family contribution. Prior to and while pursuing college, these students often lack access to the technology used in learning and assessment, especially within competency-based assessment. They may also lack access to learning experiences outside of the traditional classroom, which hold the potential of increasing and deepening the learning of content (Lewis, Eden, Garber, Rudnick Santibanez, & Tsai, 2014).

Finally, students needing remediation lack the basic reading, writing, and quantitative reasoning skills required for success in college (Scott-Clayton, Crosta, & Belfield, 2014). Although these students are accepted into college, they may be conditionally admitted until remedial courses are completed or must complete basic skills courses in order to continue collegiate courses. Research has shown as students' average 2.6 courses to complete remediation, their time to degree completion is consequently extended (NCES, 2012).

As students enter their college education, they bring along a variation of characteristics, experiences and commitments to the institutions (Thayer, 2000). These pre-existing variables include those mentioned previously such as academic preparedness, parent educational attainment, socioeconomic levels, and personal aspirations for degree attainment. These variables work in conjunction to impact the level of success or difficulty witnessed by the student. Hamrick and Stage (2004) explored college predisposition at high-minority enrollment, low-income schools.

Many first generation, low income students attend inner-city schools with low levels of funding, crowded classrooms, inadequate course offerings and underprepared teachers. As these students make their transition to college, they take along with them these disadvantaged factors and a lack of readiness for the expectations of performance within an institution of higher education.

Achievement Gap

The achievement gap has been defined in many ways within the scope of student performance. Depending on how it is defined, it can serve as a vital tool for improving our educational system. Shannon and Bylsma (2002) defined the achievement gap as "the difference between how a group performs compared to what is expected of it" (p. 11). Another study referred to the achievement gap as the difference in test scores between various demographic groups (Anderson, Medrich, & Fowler, 2007). Compared to the various definitions, this research focuses on the gap which exists between disadvantaged and nondisadvantaged students and their mean final course grade in an SI-supported course.

According to Shannon and Bylsma (2002) there are two major factors which contribute to the achievement gap: factors outside of the educational environment and factors within the educational environment. In their report they state that outside factors such as socioeconomic status, family background, and student aspiration and personality impact the achievement gap experienced by students before they enter postsecondary education. Educational factors such as limited access to equal education and resources as well as lower-quality teaching are also major influences (Noguera, 2001; Shannon & Bylsma, 2002). Shannon and Bylsma also have reported that learning opportunities such as extended learning time, rigorous curriculum, and participation in enriched and varied programs can help close the gap. Furthermore, learning opportunities increase time on tasks, challenge students' academic abilities, and promote a sense of belonging (Shannon & Bylsma, 2002).

Disadvantaged students are less likely to engage in academic and social experiences.

A Framework of Student Success & SI

Several studies have measured the impact of SI on student success in higher education. It has repeatedly been shown to improve students' academic performance, such as course grade and retention (Bowles & Jones, 2004; Congos & Schoeps, 1993, 1998; Lewis, O'Brien, Rogan, & Shorten, 2005; McGuire, 2006), and even graduation (Bowles, McCoy, & Bates, 2008). The Geometric Model of Student Persistence and Achievement (Swail, 2004) has been used to explain the success of SI by placing the student directly in the center of a triangle while identifying each side with a factor that is believed to impact student success. This particular model allows educators to explore the relationship between cognitive, social, and institutional factors.

As identified by Swail (2004), cognitive factors such as intelligence, knowledge, and academic ability are crucial to student persistence and performance, as they directly impact the student's ability to comprehend and successfully complete the academic demands of a college curriculum. Research has found low-income, first-generation college students are less likely to have access to or participate in a demanding high school curriculum, lack study and time management skills, and, as a consequence, are more likely to take remedial courses (Engle & Tinto, 2008).

On the other hand, disadvantaged students are less likely to engage in academic and social experiences such as studying in groups with peers, interacting with faculty members, participating in extracurricular activities, and using support services, all factors which nurture success in college (Engle & Tinto, 2008). Lehmann (2007) investigated the role played by a detached university culture within the increasing dropout rates among first-generation college students. Key findings suggested that first-generation students were more likely to leave college before accomplishing their educational goals, often despite having good academic standing, due to feeling disconnected with the college life, environment, and culture. This lack in sense of belonging was identified more than any other reason of leaving their college career (Lehmann, 2007).

The third factor identified in Swail's (2004) Geometric Model, is institutional. This refers to the intended or unintended practices, strategies, and culture of the college or university which impact student persistence and achievement. The institutional portion of this model speaks to the abilities of the institution to provide appropriate support to students through their college experience, both academically and socially. When an institution is unable to provide such support, it can interfere with student success. Rendon (1995) has described many educational institutions as "not setup to educate or accommodate for diversity, creating an invalidating environment for students who do not 'fit the mold'" (p. 9), which often speaks to the experience of disadvantaged students within higher education.

When closely examining SI, one will find that the program incorporates the factors identified by the Geometric Model of Student Persistence and Achievement (Swail, 2004). First, it is an institutional service that aims to enhance content knowledge and understanding. Second, SI sessions are embedded within an environment enriched with student engagement and participation. As structured study sessions are facilitated for individual courses, students

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are constantly surrounded by familiar faces. Through this promotion of student-to-student interaction, SI sessions hold the potential of providing students with a sense of belonging and contentedness with the university.

Contributions of Current Study on SI

SI is a high-impact practice originally developed by Dr. Deanna Martin at the University of Missouri-Kansas City (UMKC) in 1973 and proven to increase academic performance and retention for students enrolled in traditionally difficult courses (Martin & Arendale, 1994). SI is recognized as an Exemplary Educational Program by the U.S. Department of Education and is unique in that it focuses on high-risk courses (rather than at-risk students) and is driven by a higher level of critical thinking skills (McGuire, 2006). The International Center for SI at UMKC defines SI as a collaborative learning approach program that utilizes peer-assisted study sessions in which a student leader facilitates regularly scheduled sessions to enhance course content, develop study skills, and compare notes.

This study fills a gap in the literature within the existing studies on SI. First, given SI mainly focuses on traditionally high-risk courses rather than at-risk students, there are limited studies on how SI affects the performance of at-risk students. Secondly, there are limited studies which explore how student performance is impacted by an increasing number of SI visits, as there is no consistent operational definition of an SI participant. Many studies refer to students as SI participants after only one visit, but studies that look at visit correlation to student success could not be located.

In this study, we attempt to expand SI research by examining the relationship between the number of SI visits and course performance. Particularly, this study will examine whether and how the number of SI visits impact student course performance in terms of final course grade. The purpose of this study is to answer the following two questions:

- How does the number of SI visits affect students' course performance?
- How do SI visits help traditionally disadvantaged students reduce the performance gap?

Method

Institution Setting

The study was conducted at a large state university in the west designated by the federal government as a Hispanic Serving Institution (HSI) as well as an Asian American Native American Pacific Islander-Serving Institution (AANAPISI). In Fall 2016, the university enrolled more than 24,000 students. Among them, 65.1% were under-represented minority students, 66.6% were first-generation students, 63.2% were eligible for Pell grants, and 50.2% of students who entered as first-time freshmen are required to take English or/and Mathematic courses. Overall, about 88.1% of these students met at least one of four disadvantaged factors.

The university has identified the SI program as one High Impact Program (HIP) on campus and expanded it in recent years. In Fall 2016, SI program offered 44 SI-supported courses including 68 classes supported by SI sessions. In total 42 faculty members and 49 SI leaders were involved in the SI program. During the same period, there were a total of 2670 students who participated in SI sessions; the participation rate was 46%. On average, these students visited SI sessions five times in Fall 2016. SI programs usually have offered 1-hour study sessions three times a week for students enrolled in historically difficult classes. During SI sessions, students have been encouraged to work with their peers from class and their SI Leader to develop successful study strategies, exchange creative ideas, gain a better understanding of the course material, and improve their overall grade.

SI sessions hold the potential of providing students with a sense of belonging and contentedness with the university.

Demographics

This study included 16,297 undergraduate students enrolled in 22 courses supported by SI sessions (referred to hereafter as "SI supported courses") in six semesters from Fall 2011 to Spring 2014, drawn from a large state university in California. Among the 22 SI-supported courses, 18 were STEM courses across the five disciplines of biology (N = 7,866), chemistry (N = 581), mathematics (N = 3,713), engineering (N = 172), and physics (N = 1,109); and 4 were non-STEM courses offered in criminology (N = 105), economics (N = 361), and political science (N = 2,390). Nineteen courses were lower division courses (N = 16,184), and three were upper division (N = 113); 10 were GE courses (N = 12,296), and 12 were non-GE courses (N = 4,001).

Among the 16,297 undergraduate students enrolled in courses supported by SI, 56.6% were female, and 66.2% were URM students including African Americans (4.2%), American Indians (0.3%), Pacific Islanders (0.3%), Hispanics (41.9%), and Asians (19.5%). Asian students are considered URM in our data because half of the Asian students at this institution identified as Hmong, an educationally underrepresented ethnic group. Most other Asian students reported as members of other Southeast Asian communities bearing similar characteristics to Hmong students. About 66.8% of the students were first-generation college students, 60.6% were Pell Grant eligible, and 51.5% needed remediation in math and/or English at entry. The majority of these students were lower division students (38.7% freshmen, 26.8% sophomores, 17.9% juniors, and 16.6% seniors), 93.7% were full-time students, and 44.0% were in STEM majors.

In sum, our sampled data well represented the diverse student population within the university, as well as the breadth of courses offered. The exception was that few upper division courses provided SI; this reflects the fact that on this campus SI is offered in support of high-risk, lower division courses.

Variables

The dependent variable in the study was SI target course grades. All categorical course grades were converted to grade points (A = 4, B = 3, C = 2, D = 1 and F/WU = 0). Independent variables of interest included both total number of SI visits (SI sessions and office hours attended) and students' disadvantaged status. Student disadvantaged status may include one or more of the four factors: URM (URM vs. Non-URM), FGS (FGS vs. Non-FGS), Pell eligibility (Pell eligible vs. Non-eligible), and Remedial status (Rem vs. Non-Rem). In this paper, the terms remedial and developmental are used interchangeably.

Eight additional independent variables considered as controlling variables included five student characteristics (prior SI course performance, gender, student class level, full-time status, and major of college) and three course characteristics discipline category (STEM vs. non-STEM), course level (LD vs. UD), and course type (GE vs. non-GE). Prior performance was defined as the cumulative GPA at the beginning of the term in which a student took an SI-supported course. For new freshmen (N = 1,566) and transfer students (N = 422) without a university cumulative GPA, high school GPA and transfer GPA have been used instead.

Analysis

This study employed multiple research approaches including both data visualization and statistical modeling. First, data was displayed in scatter plots with the best fitted trend lines used to describe the relationship between SI visits and course performance and how the performance gap between disadvantaged and nondisadvantaged students is affected by number of SI visits. Second, the General Linear Model (GLM) was utilized to determine the significant effects of SI visits on course performance after controlling for other student and course characteristics.

GLM is a flexible statistical model which allows us to model the value of a quantitative dependent

variable (such as course grades) based on its relationship to a set of independent variables (Horton, 1978; Leech, Barrett, & Morgan, 2014). It can estimate the dependent variable with categorical independent variables as factors (such as disadvantaged status) or continuous independent variables as covariates (such as SI visits). Additionally, it allows one to specify factor-covariate interactions (such as the interaction of disadvantaged status and SI visits) to see if the relationship between a covariate and the dependent variable changes for different levels of factors.

We also conducted a follow-up survey on the 32 SI Leaders who were employed by the program within the academic year 2014-15. The survey asked them what they considered "regular," "less than regular," and "occasional" SI attendance. The survey design gave them a range of categories (strongly agree, agree, neutral, disagree, and strongly disagree) to select from when categorizing student visits.

Findings

Describing SI Visits, Disadvantaged Status, and Performance Gap

There were significant performance gaps between disadvantaged and nondisadvantaged students prior to taking the target courses as well as in SI-supported courses (see Table 1). Disadvantaged students had entered these high-risk courses with lower GPAs than their counterparts, for all four disadvantaged factors. The pre-SI course performance gap was about 0.2 to 0.3 in terms of cumulative GPA when the term began. Because these target courses are usually high-risk courses, final course grades manifested a wider gap of 0.3 to 0.5.

However, the performance gap decreased with the increase in number of SI visits. In other words, the more often disadvantaged students attended SI sessions, the smaller the performance gap became. Figure 1 plots the relationship between SI visits and student course performance by URM status: the horizontal axis represents the number of SI sessions that students attended during a semester and the vertical axis represents the average course grade at each point of SI visits. The figure shows only the data for 0 to 24 SI visits since few students had more than 24 visits. Two lines are the best-fitted trend lines based on a polynomial trend model of degree of 2. The solid line is for URM students and the dash line is for Non-URM students. The trend line model for course grade has R-Squared = 0.695 and P-value < 0.0001. There are two vertical reference lines on the graph representing numbers of SI visits at 8 and 16. Figure 1 clearly shows that for all students, including URM and Non-URM students, the more frequent the SI session attendance, the better the course performance, even though the relationship was not linear. The most important finding was the dynamic change in course performance gap corresponding with SI visits. The largest gap occurred for students who did not attend any SI session (SI visit = 0), but the gap decreased with the increasing number of SI visits. At eight SI visits, the performance gap was reduced by about 50%. When SI visits approached 16, the gap almost disappeared. The dynamic patterns of other three disadvantaged factors (FGS, Pell eligible and remedial status) are similar to that of URM status.

Based on two cut-off points of 8 and 16 SI visits identified previously, we further classified all students into four, SI-visit groups (0 visits, 1-7 visits, 8-15 visits, and 16 or more visits) to see how the course performance gap changed within each SI-visit group (see Table 1).

The right panel of Table 1 shows the course performance gaps within each of four SI-visit groups. There were no statistically significant differences between disadvantaged and nondisadvantaged

Table 1

Performance Gap Between Disadvantaged and Nondisadvantaged Students

	All students			SI-Visit Group							
		Prior to SI courses	In SI courses	Enrolled HC				Avg. SI Course grade			
	Enrolled HC	Avg. Cumulative GPA in the beginning of term	Avg. Course grade	0	1-7	8-15	16+	0	1-7	8-15	16+
Grand Total	16,297	2.94	2.14	10,438	4,500	903	456	1.98	2.31	2.66	2.93
URM status											
Non-URM	5,505	3.12	2.36	3,547	1,540	289	129	2.22	2.55	2.81	3.00
URM	10,792	2.85	2.02	6,891	2,960	614	327	1.85	2.19	2.59	2.91
Gap (URM - Non-URM)		-0.26***	-0.34***					-0.37***	-0.36***	-0.22**	-0.09
FGS status											
Non-FGS	5,414	3.08	2.33	3,405	1,572	298	139	2.17	2.52	2.87	2.96
FGS	10,883	2.87	2.04	7,033	2,928	605	317	1.88	2.21	2.55	2.92
Gap (FGS - Non-FGS)		-0.20***	-0.29***					-0.29***	-0.31***	-0.32***	-0.03
Pell eligibility status											
Not eligible	6,423	3.08	2.33	4,060	1,874	329	160	2.18	2.51	2.80	3.00
Eligible	9,874	2.85	2.01	6,378	2,626	574	296	1.85	2.17	2.58	2.90
Gap (Eligible - Not eligible)		-0.23***	-0.32***					-0.33***	-0.34***	-0.22**	-0.10
Eng/Math remedial status											
Non-Remedial	7,896	3.10	2.37	5,089	2,182	407	218	2.24	2.56	2.74	2.99
Remedial	8,401	2.79	1.91	5,349	2,318	496	238	1.73	2.08	2.59	2.88
Gap (Remedial - Non-Remedial)		-0.31***	-0.46***					-0.51***	-0.47***	-0.15*	-0.11

** P < 0.05; ** P < 0.01; *** P < 0.001* One-way ANOVA for cumulative GPA and course grade.

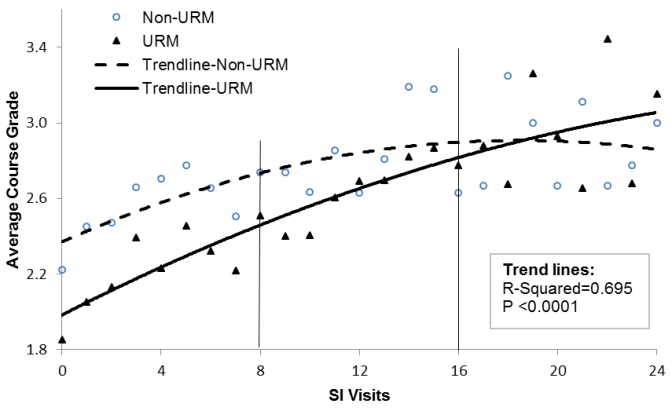

***Figure 1*. Number of SI Visits and Course Performance**

students across all four disadvantaged factors in the SI-visit group of 16 or more. In the other three SI-visit groups (0, 1-7, and 8-15), disadvantaged students still had significantly lower average course grade than their counterparts across four disadvantaged factors.

Measuring the Degree of Disadvantage

Up to this point in the analyses, all findings have been bivariate, without considering interactions between the factors. To more accurately measure the degree of disadvantage of students and to avoid high inter-correlations among four disadvantaged factors when modeling the effects of SI visits, we combined the four factors and developed a composite scale called the disadvantage index. The four disadvantaged factors in Table 1 were coded 1 or 0, with 1 indicating disadvantaged status (lower academic performance), so that the disadvantage index is the sum of the four disadvantage factors, with a range of 0 to 4 with 5 units at equal intervals of 1. The higher the values on the index, the higher the disadvantage; 0 means that students did not have any disadvantage factors, and 4 means students have all four disadvantage factors.

Table 2 displays the statistics by the disadvantage index. Only 10.6% of students had no disadvantage factors, 17.0% had one, and 18.6% had two. The majority, 53.9%, had at least three factors. Table 2 also shows that the higher the disadvantage index, the lower the academic performance in both circumstances, prior to attempting the SI target course and within the target course itself. Also, the gap increases proportionally with the extent of disadvantage. For example, students with all four disadvantage factors had a lower cumulative GPA at the beginning of term by 0.54 and lower SI target course grade by 0.82.

Modeling Course Grade

The results of the tests of between-subjects effects from the GLM model with course grade as the dependent variable are shown in Table 3 (page 25). The model accounts for of 25.4% of the total variance in course grade. The disadvantage index, SI visits, and their interaction are the statistically significant factors affecting course grade. All eight controlling variables except course level were statistically significant. The most important factor (in terms of Partial Eta Squared) was the cumulative GPA in the beginning of term, followed by SI visits, course type, and course discipline.

Based on the estimated parameters from the model, the disadvantage index had a significantly negative effect on course grade, whereas SI visits had a significantly positive effect on it. All other significant factors had expected effects on course grades. The following students had significantly higher course grades than their counterparts: those who had higher cumulative GPA in the beginning of term, were female, were in a higher class level, were full-time, were enrolled in non-STEM courses, and were enrolled in GE courses.

Evaluating the Effects of SI Visits on Course Performance Gap

There was a significant interaction effect of disadvantage index and SI visits on course grade. To clearly display how SI visits impacted the performance gap between disadvantaged and nondisadvantaged students, we plotted the means of predicted course grades by disadvantage index and SI-visit groups (see Figure 2, page 25).

Table 2

Enrollment, Performance, and SI Participation by Disadvantage Index

		Disadvantage index					Grand Total
		0	1	2	3	4	
Enrollment							
Enrolled Headcount		1,724	2,763	3,031	3,991	4,788	16,297
Enrolled %		10.6%	17.0%	18.6%	24.5%	29.4%	100.0%
Course performance							
Avg. Cumulative GPA in the beginning of term		3.27	3.11	3.01	2.89	2.73	2.94
Avg. Course grade		2.68	2.35	2.18	2.06	1.86	2.14
Performance Gap (compared to students whose disadvantage index = 0)							
Avg. Cumulative GPA in the beginning of term		0.00	-0.16	-0.26	-0.37	-0.54	
Avg. Course grade		0.00	-0.33	-0.50	-0.62	-0.82	
SI Participation							
Enrolled Headcount	0	1,073	1,790	1,912	2,615	3,048	10,438
	1-7	521	759	871	1,065	1,284	4,500
	8-15	84	154	157	211	297	903
	16+	46	60	91	100	159	456
	Total	1,724	2,763	3,031	3,991	4,788	16,297
% of Column	0	62.2%	64.8%	63.1%	65.5%	63.7%	64.0%
	1-7	30.2%	27.5%	28.7%	26.7%	26.8%	27.6%
	8-15	4.9%	5.6%	5.2%	5.3%	6.2%	5.5%
	16+	2.7%	2.2%	3.0%	2.5%	3.3%	2.8%
	Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
SI visits (Participated students only)	Enrolled Headcount	651	973	1,119	1,376	1,740	5,859
	Mean	5.3	5.3	5.3	5.4	5.9	5.5
	Median	3.0	3.0	3.0	3.0	3.0	3.0
	SE	6.8	6.2	6.1	6.5	6.7	6.5

Table 3

Modeling Course Grade: Tests of Between-Subjects Effects

Source	Type III Sum of Squares	*df*	Mean Square	*F*	Sig.	Partial Eta Squared
Corrected Model	7638.416a	26	293.785	208.764	0.000	0.254
Intercept	138.305	1	138.305	98.280	0.000	0.006
Disadvantage index	203.605	4	50.901	36.170	0.000	0.009
SI Visits	362.164	1	362.164	257.354	0.000	0.016
Disadvantage index/ SI Visits	19.366	4	4.841	3.440	0.008	0.001
Gender	13.783	1	13.783	9.795	0.002	0.001
Student level	113.832	3	37.944	26.963	0.000	0.005
Major of college	283.181	8	35.398	25.154	0.000	0.012
Full-Time status	20.417	1	20.417	14.508	0.000	0.001
Course disciplines	309.253	1	309.253	219.756	0.000	0.014
Course level	1.086	1	1.086	.772	0.380	0.000
Course type	329.029	1	329.029	233.808	0.000	0.014
Cumulative GPA in the beginning of term	4738.619	1	4738.619	3367.272	0.000	0.174
Error	22480.940	15975	1.407			
Total	103076.000	16002				
Corrected Total	30119.356	16001				

Note. "a" R Squared = .254 (Adjusted R Squared = .252)

Figure 2 shows that an increase in SI visits reduced the performance gap in SI supported courses. The course grades converged; the gap disappeared for the SI visit group of 16+ because more disadvantaged students gained larger improvement with increased SI visits than less disadvantaged students, which is particularly true for students who have three or four disadvantage factors. For example, when comparing students with 16+ visits to students with no SI visits, those who didn't have any disadvantage factors improved by 0.63 (= 3.21 in 16+ group – 2.58 in 0 group). On the other hand, students who had one, two, three, and four disadvantage factors improved their average grade by 0.96 (= 3.20-2.24), 0.83 (= 2.91-2.08), 1.08 (= 3.04-1.96), and 1.37 (= 3.07-1.70), respectively. Students who had three or four factors and attended SI 16 or more times gained the largest improvement (more than one point). The performance gap thus narrowed and even closed for the SI visit group of 16+. In the SI visit group of 0, the performance gaps were: -0.34 (= 2.24-2.58), 0.50 (= 2.08-2.58), -0.62 (= 1.96-2.58), and -0.88 (= 1.70-2.58) for students who have one, two, three, and four factors, compared to students who didn't have any of the four factors. Also, in the SI visit group of 16+, the corresponding gaps were -0.01 (= 3.20-3.21), -0.29 (= 2.91-3.21), -0.17 (= 3.04-3.21), and -0.13 (= 3.07-3.21).

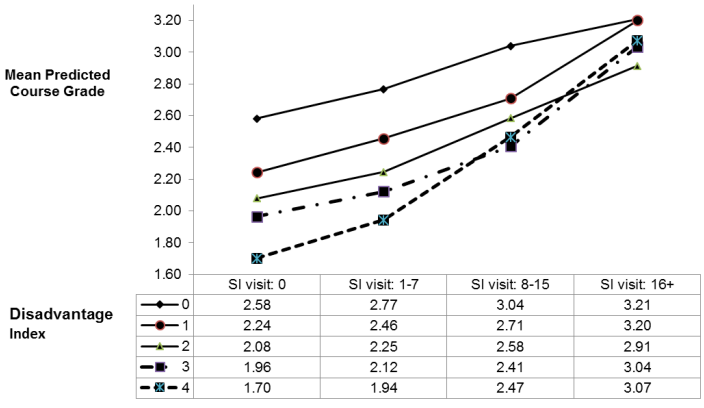

Figure 2. **Mean predicted course grade by disadvantage index and SI visit group**

Even after controlling for the influences of the cumulative GPA in the beginning of term and other student and course characteristics in the model, the more often students attended SI sessions, the higher their grades in high-risk courses were. Furthermore, the greatest beneficiaries were those entering with the greatest disadvantage who completed more SI visits. Their performance gap narrowed with the increase of SI visits and finally closed when SI visits reached 16.

Although we have found that the performance gap between disadvantaged and non-disadvantaged students narrowed and even closed at the point of 16 SI visits, we do not believe that there are substantial differences among SI visits of 15, 16 or 17. Instead, we believe that this finding may relate to a certain regularity of SI attendance during a semester. At the university under study, SI sessions are offered two to three times per week in a semester, usually over 4 months or 16 weeks.

Thus, students in the SI-visit group of 16 or more are more likely to have attended SI sessions regularly, perhaps at least once per week. Even though we do not have exact dates of attendance to verify this argument, the results from the follow-up survey support this reasoning. Of the 32 surveyed SI Leaders, 91.9% agreed or strongly agreed that a student who attends 16 or more SI sessions throughout the course of the semester is considered a "regular" attendee. When asked if a student who attends 8-15 SI sessions is considered a "less than regular" attendee, 51.3% of SI Leaders agreed or strongly agreed. Lastly, when asked what defines an "occasional" SI attendee, 86.5% of SI leaders agreed or strongly agreed that attending 1-7 SI sessions would place a student within this attendance bracket.

Discussion

When exploring the importance of regular student attendance to a support service such as SI, it is crucial to understand the needs of a disadvantaged student population and examine how SI as a program is structured to address these specific needs. Disadvantaged students encounter severe challenges due to two major factors: lack of necessary academic skills required for college success and lack of engagement with the campus community which often leads to a decreased sense of belonging. SI addresses these very needs as it utilizes peers to foster a collaborative learning environment which integrates content based on study skills with social interactions. Through strategies such as student-to-student interaction, think-pair-share, and redirecting of questions, social interaction and college-level study skills are promoted in all sessions. Furthermore, this study has found that students have the opportunity to develop or reshape their learning habits through

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regular SI attendance and constant exposure to designed SI features.

This study added two new perspectives to the current research base when examining the effects of SI participation on students' learning outcomes: the total number of SI sessions attended and the disadvantage index. Most SI studies compared SI participants with nonparticipants based on a single cut-off point of SI sessions attended (such as 1, 3, 5, or even 12 sessions). There was no consistent operational definition of an SI participant. Furthermore, assessing SI programs based on the dichotomous participation status may overlook the more complicated effects of SI participation because students may participate in SI to various degrees (a student may attend between 1 and 24 sessions or even more). This study defined SI participation by number of SI visits (the total number of SI sessions a student attended during a semester), which accurately reflects the degree of SI participation a student had. By looking at the total number of SI sessions, this study has provided a broader picture about how SI participation affects students' course performance. Findings reflected the positive but nonlinear relationship between SI participation and course performance for all students as well as the differential effects of SI participation on course performance for different student groups.

The study also expanded the research base by examining student performance based on their disadvantage index. Considering the possible overlap among four disadvantage factors, this study combined the four disadvantage factors and developed the disadvantage index, which is a comprehensive and more accurate measure of the extent of disadvantage a student has. This not only made the estimation of the effects of SI participation more reliable but also provided new insights on how SI participation affects students differently, depending on their disadvantage index (see Figure 2).

From both new perspectives—the degree of SI participation (the total number of SI sessions attended) and the extent of disadvantage status of students (the disadvantage index)—this study discovered differential effects of SI participation on students' learning outcomes, depending on both factors, which further made a unique contribution to the current research. That is, with an increased number of SI visits the more disadvantaged students realized larger performance improvement than less disadvantaged students. As a result, the performance gap in SI-supported courses narrowed and finally closed for students who attended 16 or more SI sessions. This study also examined the total number of SI sessions attended to the underlying regular pattern of SI participation during a semester and proposed that students in the SI-visit group of 16 or more are more likely to have regularly attended SI sessions or participate in SI sessions on the weekly basis, which is supported by the responses from a follow-up survey of SI leaders. Thus, the findings from this study indicate how SI participation can help disadvantaged students to close their performance gap with nondisadvantaged students: Attending SI sessions on a regular or weekly basis is critical.

Limitations

As this study was conducted at one large public university in which the majority of students are in some degree of disadvantaged status, the results may not be transferable to other institutions. Also, this study did not consider the amount of time attending SI rather, the number of total visits. There were only a few upper division courses supported by SI sessions in this study. Therefore, the findings cannot be generalized to upper division courses. Furthermore, this study did not control for self-selection; SI participation was voluntary. When modeling course grade and evaluating the effects of SI visits on course performance, this study included the cumulative GPA at the beginning of the term and seven other student and course characteristics as controlling variables in an attempt to reduce the self-selection bias. However, none of them can be assumed to be a definitive proxy for self-selection or motivation. Thus, without accounting for this factor, an estimate of the effects of SI participation on course grade would be biased. Finally, this study proposed that students in the SI-visit group of 16 or more are more likely to have regularly attended SI sessions or participate in SI sessions on the weekly basis, which needs to be further verified based on the exact timing of SI attendance.

Institutions might also develop their own disadvantage index.

Implications for Practice and Research

The implications of this study are not only relevant within the realm of SI, but also beyond this academic support service, as various programs implemented on any given college or university campus can re-examine their service outcomes based on the two new perspectives employed by this study. As found by previous research, this study confirms positive student course performance as a result of SI participation. In addition to this, the study demonstrates the importance of attending SI sessions on a weekly basis for disadvantaged students to close the performance gap with non-disadvantaged peers.

An implication of this finding is to encourage more students, disadvantaged students in particular, to utilize the provided support services. Institutions might consider improving existing programs or developing new interventions which allow or motivate students to participate on a regular basis, even require them to participate in such intervention programs. Institutions can implement the following techniques to encourage weekly attendance in order to witness the greatest benefits: provide extra credit points for weekly participation; offer services beyond regular business hours such as weekend and evening; diversify the methods in which services are delivered, such as online, to reach various student groups; and consider the possibility of using the Co-Requisite approach and Service Learning models with the support services.

Support services might consider re-examining program participation through frequency (the number of visits made) and regularity (the underlying regular pattern) beyond the dichotomous participation status. Program participation frequency and regularity or regular pattern may play an important role in reducing the performance gap for some special student groups, such as disadvantaged students as the case in SI. Support services might consider using applications such as GradesFirst and TutorTrac to accurately track the number of visits and scheduling of visits for helpful insights beyond dichotomous status. Such information can be used as a marketing tool with campus community.

Institutions might also develop their own disadvantage index, similar to the one employed by this study, to target students who are in need of institutional support. By combining all relevant factors and evaluating these factors simultaneously, the developed index would more accurately measure the status of need for students and allow institutions to intentionally embed resources to support students in the most need. Such an index can be utilized in a proactive manner, rather than a reactive approach, in supporting students who identify with characteristics most often associated with academic struggle. Early alert programs and advising services can use such an index to guide their services as they aim to connect with students prior to experiencing personal or academic stress. Through the usage of such an index, cross-functional campus-wide relationships can be formed to promote a dialogue between various programs on supporting the students who are most likely to encounter challenges within their academic journey.

In reviewing the literature regarding practices with high impact on student learning outcomes to determine whether there was a differential outcome for participants in underserved student groups, Brownell and Swaner (2009) found that "there is little research that looks at learning outcomes for specific populations of students, and particularly underrepresented minority, low-income, and first-generation students" (p. 27-28). By combining two new perspectives of program participation frequency/regularity and the disadvantage index

to assess the programs, this study provided a new direction for researchers to identify the differential program effects on learning outcomes for specific student populations.

Conclusion

Very little to no information is present within literature which examines the relationship between the volume of SI visits with student course performance. For this reason, the study reported herein aimed to answer the following questions: Does SI participation affect students' course performance, and particularly, would SI visits help traditionally disadvantaged students to narrow the performance gap in SI-supported courses? This study not only confirmed previous findings in literature which demonstrate SI participation as a positive impact on students' learning outcomes but also further identified the differential effects of SI participation on disadvantaged students, depending on both factors of the degree of SI participation and the extent of students' disadvantage status.

All students, disadvantaged and nondisadvantaged, were found to gain a higher average course grade as the number of attended SI sessions increased. More SI attendance was found to be more important for disadvantaged students. That is, to increase gains in closing the performance gap, disadvantaged students should attend SI sessions regularly or on the weekly basis. This is a valuable implication for SI programs to help all student populations witness larger academic performance improvements.

Findings from this study can also be applied beyond SI programs. As diversity within the U.S. higher education student population increase, the large achievement gap in bachelor degree attainment in higher education between traditionally disadvantaged and nondisadvantaged students has been receiving more and more attention. Given that the process of moving towards degree completion is not continuous but partitioned in academic terms (Bahr, 2009), the achievement gap is the cumulative result from the course performance gaps over terms. Thus, seeking an effective intervention to help disadvantaged students close the gaps in courses is a challenging task faced by higher educational institutions. This study provided enriched implications for institutions to effectively fulfil such a task. There are various student support programs implemented on campuses. Institutions should review these programs by identifying the differential effects of these programs on student learning outcomes from the new perspective of the participation frequency and regularity (or the underlying regular patterns) for disadvantaged students. Finding such patterns can help to increase the success of their student population.

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