

**SUPPLEMENTAL INSTRUCTION AND STUDENT SUCCESS:  
A REPORT ON MATH/SCIENCE LEARNING CENTER SI OUTCOMES IN SPRING 2009  
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**BACKGROUND**

The Math/Science Learning Center (MSLC) is one of two distinct learning centers at San Joaquin Delta College. The MSLC is a comprehensive learning center that offers various learning assistance services to students, including:

- Tutoring in math (pre-algebra and above)
- Tutoring in science and science-related courses
- Course materials check-out
- Textbook borrowing
- Computer labs
- Supplemental instruction

The College's Title V grant has funded many of the services offered at the MSLC since fall 2007, including the center's supplemental instruction (SI) program, which has been operating at the center since spring 2008. The goals of supplemental instruction services at the MSLC are to:

- support student success in the College's historically difficult general education math and science courses and gateway math courses, and to
- improve student success, retention and graduation rates.

**► The MSLC Supplemental Instruction Program**

As is true of the College's other SI program (housed in the Reading/Writing Learning Center or RWLC), the MSLC supplemental instruction program is generally based on the University of Missouri, Kansas City model. The program requires the recruitment of a previously successful student to sit in on class sessions and provide structured, scheduled out-of-class learning assistance to students. In the MSLC program one SI leader may facilitate SI sessions for several sections of the same course taught by the same instructor. Faculty participation in SI is voluntary, and availability of SI for a course is based on the funding available for a given semester. Because of this, only a limited number of courses include an SI component; among those that do offer SI, student participation is completely voluntary. In addition, students who participate in SI may also receive individual or group tutoring at the MSLC and may freely participate in other learning assistance or student support programs, such as learning communities.

**► Previous Research on Supplemental Instruction**

Several studies have been conducted to investigate the effectiveness of SI as a learning assistance program since its inception in the 1970s (McCarthy & Smuts, 1997). Previous research has linked student participation in SI with student retention and success in the long- and short-term (Bowles & Jones, 2003-2004; Martin, Arendale & Associates, 1992; Ogden, Thompson, Russell & Simons, 2003; International Center for Supplemental Instruction, 2007) as well as persistence and eventual graduation (Bowles, McCoy & Bates, 2008; Ramirez, 1997). However, few studies of SI effectiveness have taken a multivariate approach and incorporated external factors into student

success models. Instead, many studies have utilized SI attendance cut-off points to code students as “participants” or “non-participants” and compared course grades between the two groups (Martin & Arendale, 1992). While helpful in the preliminary assessment of SI as a learning assistance program, these studies do not take into account external factors related to student success, such as motivation to succeed, previous academic performance, student engagement and student pre-college preparation (McCarthy & Smuts, 1997).

To better assess the unique contribution of SI to student success, some recent studies of SI effectiveness have developed multivariate models of student success, retention and graduation. These models, typically applied to student data from four-year universities, have utilized course grades or GPAs as the outcome of interest and previous academic performance, gender, and college entrance exam scores as covariates with SI session attendance (Bowles & Jones, 2003-2004; Ogden et al, 2003; Congos & Schoeps, 1999-2000).

Building upon this multivariate approach, two studies were conducted on SI effectiveness in math and science courses at the College (in spring 2008 and fall 2008), each revealing positive results for the SI program. The present study sought to replicate the findings of these studies using data from the spring 2009 semester. The goals of the present study were to 1) examine the impact of supplemental instruction on student success in math and science courses, controlling for other factors, and 2) determine if the results of previous studies on the SI program at the College could be replicated with data from spring 2009.

## **METHODOLOGY**

Student success, demographic and academic data were obtained from the College’s System 2000 database and were analyzed for students in all courses and sections with SI components. Tutoring and SI session attendance data were obtained from the College’s System 2000 database and MSLC internal databases. In spring 2009, a total of 10 courses (27 sections) offered supplemental instruction to enrolled students. Specific SI courses included the following:

- Core Biology (Biology 1)
- Introduction to Medical Microbiology (Biology 22)
- Human Anatomy (Biology 31)
- Human Physiology (Biology 32)
- General Chemistry (Chemistry 1A)
- Administration of Medication (Health Science 3)
- Review of Arithmetic (Math 76)
- Pre-Algebra (Math 78)
- Introduction to Probability and Statistics (Math 12)

A total of 756 students enrolled in the above courses and sections, equaling 780 enrollments—24 students were enrolled in two SI-participating courses. Of the 756 unique students enrolled in these courses, 267 (36%) utilized the MSLC’s supplemental instruction services. Among those who participated in SI, the majority (80%) attended two or more one-hour SI sessions during the spring semester. Table 1 provides an overview of spring 2009 SI participation rates by course. As the table shows, SI participation rates varied greatly from course to course, ranging from 4% in Pre-Algebra (Math 78) to 62% in Physiology (Biology 32).

Table 1. MSLC Student SI Participation by Course

Course	Enrolled	Attended at Least 1 SI Session	
	Number	Number	Percentage
Biology 1 (Core Biology)	47	7	14.9%
Biology 22 (Medical Microbiology)	67	18	26.9%
Biology 31 (Human Anatomy)	201	71	35.3%
Biology 32 (Human Physiology)	188	117	62.2%
Chemistry 1A (General Chemistry)	89	42	47.2%
Health Science 3 (Administration of Medication)	57	9	15.8%
Math 76 (Review of Arithmetic)	28	5	17.9%
Math 78 (Pre-Algebra)	53	2	3.8%
Math 12 (Probability and Statistics)	50	6	12.0%
<i>Overall/Total</i>	<i>780</i>	<i>277</i>	<i>35.5%</i>

Note: Table illustrates duplicated data; 24 students were enrolled in two SI-participating courses

### ► SI Participants versus Non-Participants

To determine if SI participants differed significantly from their non-participating peers, demographic and academic data were obtained for SI participants and non-participants enrolled in SI courses. SI participants were similar to non-participants in terms of ethnicity, but the two groups differed in terms of gender and age. SI participants were significantly more likely to be female and were, on average, about three years older than non-participants. Table 2a illustrates participant and non-participant demographics.

Table 2a. SI-Participating Course Student Demographics by SI Status

	Non-Participants N=503		SI Participants N=277	
	N	%	N	%
<b>Ethnicity</b>				
African American	31	6.2%	21	7.6%
American Indian/Alaskan Native	3	0.5%	3	1.1%
Asian/Pacific Islander	190	37.8%	107	38.6%
Hispanic	128	25.4%	67	24.2%
White	113	22.5%	58	20.9%
Other/Unknown	38	7.6%	21	7.6%
<b>Gender**</b>	N	%	N	%
Female	329	65.4%	209	75.5%
Male	174	34.6%	68	24.5%
Unknown	0	0.0%	0	0.0%
<b>Age**</b>	M	SD	M	SD
	23.26	6.72	26.61	9.03

\*\*Significant at the 99% confidence level

Academic goal, previous performance and initial assessment data were also obtained for SI participants and non-participants. Table 2b presents academic data (previous GPA, units attempted), placement data (initial math, writing and reading assessment levels) and special program participation for SI participants and non-participants.

Table 2b. Student Academic Characteristics and Special Program Participation by SI Status

Academic Measures	Non-Participants N=503		SI Participants N=277	
	M	SD	M	SD
Previous Cumulative GPA**	2.88	.75	3.18	.53
Units Attempted (Spring 2009)**	11.19	4.32	10.26	4.11
Counseling Appointments 2008-09*	1.60	2.30	2.16	2.47
RWLC Tutoring Hours**	3.41	13.37	26.19	45.63
Initial Math Assessment Level*	N	%	N	%
Level 1	95	20.6%	70	28.8%
Level 2	139	30.2%	62	25.5%
Level 3	227	49.2%	111	45.7%
Initial Writing Assessment level+	N	%	N	%
Level 1	183	40.7%	79	34.3%
Level 2	143	31.8%	93	40.4%
Level 3	124	27.6%	58	25.2%
Initial Reading Assessment level	N	%	N	%
Level 1	137	29.8%	67	28.0%
Level 2	224	48.8%	131	54.8%
Level 3	98	21.4%	41	17.2%
BOGG Fee Waiver Status	N	%	N	%
Did Not Receive BOG Fee Waiver	293	58.3%	150	54.2%
Received BOG Fee Waiver	210	41.7%	127	45.8%
EOPS Participation	N	%	N	%
Not an EOPS student	427	84.9%	229	82.7%
EOPS student	76	15.1%	48	17.3%
DSPS Participation	N	%	N	%
Not an DSPS student	487	96.8%	269	97.1%
DSPS student	16	3.2%	8	2.9%
Educational Goal	N	%	N	%
No Transfer	206	41.0%	119	43.1%
Transfer	296	59.0%	157	56.9%
Tutoring Participation**	N	%	N	%
Did not receive tutoring	370	73.6%	73	26.4%
Received tutoring	133	26.4%	204	73.6%

Source: SJDC System 2000 Database

Note: 90% of all students enrolled in SI-participating courses completed the math assessment; 87% completed the writing assessment, and 90% completed the math assessment.

+Significant at the 90% confidence level

\*Significant at the 95% confidence level

\*\*Significant at the 99% confidence level

There were some notable academic differences between SI students and non-participants entering the spring 2009 semester. As the table shows, SI participants were significantly better academic performers than non-participating students prior to the spring 2009 semester. In terms of initial placement, SI students were similar to non-participants in reading but were more likely to assess at Level 1 in math and Level 2 in writing than non-participants. SI participants were rather similar to non-participants in terms of family income, special program participation and educational goals. However, SI students differed markedly from non-participants in two important areas: SI participants were significantly more likely than non-participants to receive tutoring in the MSLC during the spring 2009 term and scheduled a higher number of counseling appointments during the 2008-2009 academic year. The data suggest a degree of self-selection bias for students who take part in SI activities. SI participants tend to be better students with a better academic track record in terms of grades and higher levels of engagement with the College. As such, the need for statistical controls in a multivariate model is paramount.

The present study was undertaken to assess the effectiveness of SI in increasing short-term student success in historically difficult courses controlling for competing factors. Several statistical tests were conducted, including chi-square, t-tests and logistic regression analysis. The results of the study are provided below.

## RESULTS

Overall, 59% of students enrolled in SI-participating sections passed the course. Success rates varied greatly from course to course, ranging from 76% for Introduction to Probability and Statistics to 14% for Review of Arithmetic. Table 3 presents overall success rates for each SI-participating course.

*Table 3. Student Success Rate by Course*

Course	Enrolled Number	Successful	
		Number	Percentage
Biology 1 (Core Biology)	47	26	55.3%
Biology 22 (Medical Microbiology)	67	41	61.2%
Biology 31 (Human Anatomy)	201	121	60.2%
Biology 32 (Human Physiology)	188	117	62.2%
Chemistry 1A (General Chemistry)	89	48	53.9%
Health Science 3 (Administration of Medication)	57	29	50.3%
Math 76 (Review of Arithmetic)	28	4	14.3%
Math 78 (Pre-Algebra)	53	33	62.3%
Math 12 (Probability and Statistics)	50	38	76.0%
<i>Overall/ Total</i>	<i>780</i>	<i>457</i>	<i>58.6%</i>

For a preliminary examination of student outcomes by SI participation, a chi-square analysis was conducted with course success, defined as course completion with a grade of C or better, and course retention as the outcomes of interest. As Table 4a illustrates, students who participated in SI were

significantly more likely than non-participating students to pass the course (72% versus 51%) and to be retained at the end of the semester (87% versus 71%).

*Table 4a. Student Success and Retention by SI Participation*

	Enrolled	Successful**		Retained**	
	N	N	%	N	%
Did not participate in SI	503	258	51.3%	355	70.6%
Participated in SI	277	199	71.8%	241	87.0%
<i>Total</i>	<i>780</i>	<i>457</i>	<i>58.6%</i>	<i>593</i>	<i>76.4%</i>

\*\*Significant at the 99% confidence level

The results of the initial chi-square analysis revealed that SI participants were more likely to pass and be retained in all SI-participating math and science courses combined. When examined at the course level, the results revealed higher rates of success for SI participants in all but one course. SI participants were significantly more likely to pass Core Biology, Medical Terminology, Human Anatomy, Human Physiology, and General Chemistry courses.

*Table 4b. Student Success by SI Participation and Course*

Course	Enrolled	Successful	
	Number	Number	Percentage
Biology 1 (Core Biology)+			
Non-participants	40	20	50.0%
SI Participants	7	6	85.7%
Biology 22 (Medical Microbiology)*			
Non-participants	49	26	53.1%
SI Participants	18	15	83.3%
Biology 31 (Human Anatomy)**			
Non-participants	130	64	49.2%
SI Participants	71	57	80.3%
Biology 32 (Human Physiology)**			
Non-participants	71	35	49.3%
SI Participants	117	82	70.1%
Chemistry 1A (General Chemistry)+			
Non-participants	47	21	44.7%
SI Participants	42	27	64.3%
Health Science 3 (Administration of Medication)			
Non-participants	48	23	47.9%
SI Participants	9	6	66.7%

*Table continues*

Table 4b, continued

Course	Enrolled	Successful	
		Number	Percentage
Math 76 (Review of Arithmetic)	Number	Number	Percentage
Non-participants	23	3	13.0%
SI Participants	5	1	20.0%
Math 78 (Pre-Algebra)	Number	Number	Percentage
Non-participants	51	31	60.8%
SI Participants	2	2	100.0%
Math 12 (Probability and Statistics)	Number	Number	Percentage
Non-participants	44	35	79.5%
SI Participants	6	3	50.0%

+Significant at the 90% confidence level

\*Significant at the 95% confidence level

\*\*Significant at the 99% confidence level

The crosstab/chi-square analyses were intended to serve as preliminary measures of SI student outcomes. The results observed, while positive, do not take into account other factors related to student success. In addition, although a substantial portion of the literature on the effectiveness of SI has relied on simple descriptive or basic inferential statistics like those illustrated in Tables 4a and 4b (Martin & Arendale, 1992; Hensen & Shelley, 2003), these analyses do not take into account level of treatment required for students to achieve specific rates of success. To control for these factors and examine likelihood of success at various levels of treatment intensity, a logistic regression model was applied to student data from the spring 2009 semester. Student success, defined as passing a course with a grade of C or better, served as the outcome of interest (success=1; unsuccessful completion=0).

A total of 680 students (87% of all cases) were included in the logistic regression model. Because sample sizes at the course level were rather small, all math and science SI courses were included in the same regression model, and a dichotomous variable was added to distinguish science courses from math courses.

Previous studies of learning assistance programs have linked several factors to student success, including demographic factors, unit load, participation in other services and programs, such as EOPS, and student utilization of counseling and tutoring services. These factors as well as other academic factors were included in preliminary analysis for the current study. However, just six variables emerged as significant predictors of student success, including:

- Previous cumulative GPA
- Initial writing placement
- Low-income status
- Unit load
- Course type (science or not)
- Number of SI sessions attended

Contrary to expectation, total hours of tutoring received was not a significant predictor of success when controlling for SI sessions attended and other factors related to student success. Hours of tutoring received were strongly correlated with the number of SI sessions attended ( $r=.518, p<.01$ ) and were thus included in the model to control for any impact tutoring may have had on student success. Descriptive statistics and coding schemes for each variable in the final regression model are provided in Table 5a.

Table 5a. Descriptive Statistics for Variables in the SI Logistic Regression Model

Variable	Range of Scores/Coding Scheme	Mean	SD
Initial writing placement	1 to 3	1.88	.80
Previous cumulative GPA	0.00 to 4.00	2.97	.69
Low-income status (BOG fee waiver)	Not low income=0 Low income=1	.44	.50
Unit load	3 to 25	11.06	4.24
Science course status	0=Not a science course 1=Science course	.82	.38
MSLC tutoring hours	0.00 to 357.05	11.41	31.45
SI sessions attended	0 to 33	2.30	5.01
Success	0=Not successful; 1=Successful	.59	.49

Table 5b presents coefficients, standard errors and odds ratios for each predictor in the regression model.

Table 5b. Logistic Regression for Success in SI-Participating Courses

Predictor	B	Standard Error	Odds Ratio
Constant	-3.016	.538	.049
Initial writing placement**	.432	.120	1.540
Previous cumulative GPA**	1.264	.164	3.541
Low-income status*	-.417	.185	.659
Unit load*	-.047	.022	.954
Science course**	-.968	.251	.380
Tutoring hours	.000	.004	1.000
SI sessions attended**	.155	.033	1.167

\*Significant at the 95% confidence level

\*\*Significant at the 99% confidence level

Negative 2 Log Likelihood Ratio	751.286
Model Chi Square	15.337
Percent of Cases Correctly Predicted	72.5%
Proportional Reduction in Error	33.5%
Nagelkerke R <sup>2</sup>	.307

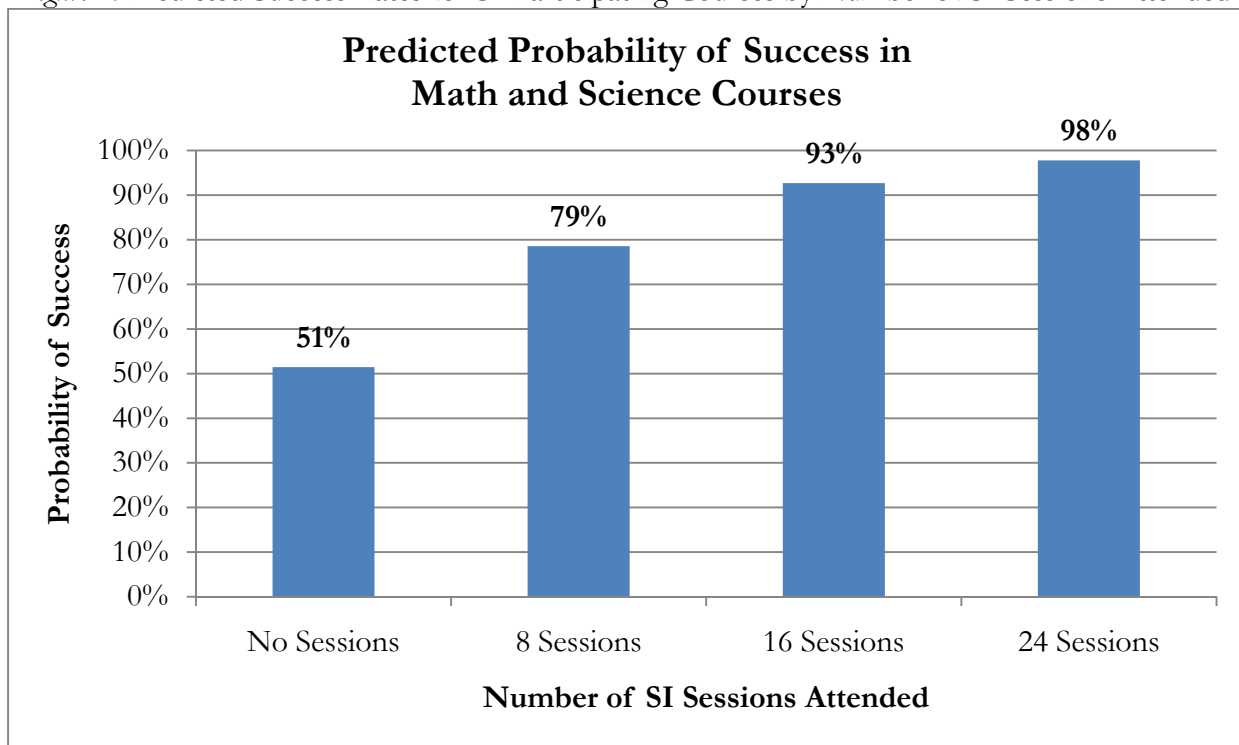
The final regression model resulted in a proportional reduction in error of 34% and an effect size of .31, meaning the variables included in the model explained nearly one third of the variance in student success. Table 5c presents the predicted probability of success for a student in a math or science course based on the number of SI sessions attended. Controlling for all other variables included in the model, students who attended a total of 8 SI sessions had a predicted success rate of 79%, a substantial increase over the predicted success rate of 51% for students who did not participate in SI. Students who attended 16 sessions (about one per week) had a predicted success rate of 93%, and students who attended 24 sessions had a predicted success rate of 98%.

*Table 5c. Predicted Probability of Success in Course by Number of SI Sessions Attended*

Constant	Mean Writing Placement	Mean Cumulative GPA	Mean Low-income	Mean Unit Load	Mean Science	Mean Tutoring Hours	SI Sessions Attended	Probability of Success
-3.016	1.88	2.97	.44	11.06	.82	11.41	0	.51
-3.016	1.88	2.97	.44	11.06	.82	11.41	8	.79
-3.016	1.88	2.97	.44	11.06	.82	11.41	16	.93
-3.016	1.88	2.97	.44	11.06	.82	11.41	24	.98

Figure 1 illustrates the predicted probability of success based on the number of SI sessions attended. As the figure shows, students have a substantially higher chance of passing the course if they attend one SI session roughly every other week than if they do not attend at all. Students' chances of success continue to increase with each additional session attended, but the increase in predicted success rate is considerably smaller after about 16 sessions.

*Figure 1. Predicted Success Rates for SI-Participating Courses by Number of SI Sessions Attended*



## CONCLUSIONS

The primary goal of the present study was to assess the impact of supplemental instruction on student outcomes in math and science courses for which SI was offered in spring 2009. Specifically, the study examined the relationship between of SI participation and student success in Core Biology, Introduction to Medical Microbiology, Human Anatomy, Human Physiology, General Chemistry, Administration of Medication, Review of Arithmetic, Pre-Algebra and Introduction to Probability and Statistics during the spring 2009 term. Overall, the results of the study provide evidence that student participation in SI is indeed related to student success.

The results of the present study build upon those of previous studies conducted on SI at Delta College. Two previously-conducted studies revealed positive results for the SI program in math and science courses from spring 2008 to fall 2008. Each of these studies has consistently shown positive results for the SI program, indicating students who attend one SI session every other week have a roughly three in four chance of passing a math or science course.

In the present study, students who attended SI sessions on a regular basis (once per week or once every other week) greatly increased their chances of success in math and science courses. Students who did not participate in SI had just a 51% chance of success, but students who attended one SI session every other week increased their chances of success by nearly half, to 79%. Students who participated in one SI session per week increased their chances of success even more (93%). It should be noted that although predicted success rate increased with each additional SI session attended, increases in success began to level off after 16 SI sessions.

In the present study, student low-income status, unit load, initial writing placement, course discipline (science versus math), hours of tutoring received and SI sessions attended were included as predictors in the final regression model. Each variable included in the model emerged as a significant predictor of student success, with one exception: tutoring was not a significant predictor of success. Although hours of tutoring were highly correlated with SI sessions attended, when both variables were included in the model, SI was the stronger predictor of student success.

The results of the present study also build upon the findings of studies previously conducted at other institutions (Bowles & Jones, 2003-2004; Hensen & Shelley, 2003; Martin & Arendale, 1992; Ogden et al, 2003; International Center for Supplemental Instruction, 2007) and at Delta College, which showed that students who participated in SI were more likely to succeed than students who did not participate in SI. The findings of the study imply that, when SI is available, students who regularly participate in SI are more likely to succeed than students who do not participate. Based on the results of the present study as well as those of previous studies, SI appears to be a valuable learning assistance program that provides participating students with a substantially greater chance of successfully passing a course.

As with any study, there were a number of limitations to the present study. The results of the present study reveal that SI-participants differ markedly from their non-participating peers both demographically and in terms of College service utilization. For example, SI-participating students tend to be older, female, better academic achievers and, with respect to utilization of campus resources, more engaged than their non-participating peers. In addition, although tutoring was included in the student success model, it did not emerge as a significant predictor of success. Tutoring participation was highly correlated with SI participation, revealing a possible latent variable

of help-seeking behavior or academic engagement. This factor, as well as a measure of student motivation, should be incorporated into future studies of the SI program.

Additional research on SI program effectiveness with different students and skill levels is needed, and a future studies should examine factors that influence student participation in SI. Research should be conducted to determine which students are best served by SI and which courses or subject areas are most appropriate for SI. Finally, research should also be conducted to assess the long-term impact of SI on student learning-related behaviors, term-to-term persistence and graduation among different student populations.

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