

**TUTORING AND SUPPLEMENTAL INSTRUCTION AS PREDICTORS OF STUDENT SUCCESS:  
STUDENT OUTCOMES IN MATH AND THE SCIENCES  
FALL 2008**

**Bri Hays, Research Analyst  
Matt Wetstein, Dean of Planning, Research and Institutional Effectiveness  
(MARCH 2009)**

---

**BACKGROUND**

The Math/Science Learning Center (MSLC) at San Joaquin Delta College is a one-stop shop for students seeking assistance in math and science. The (MSLC) offers tutoring, supplemental instruction and computer labs to students enrolled in math and science courses. San Joaquin Delta College's Title V grant has funded many of the services offered at the MSLC since fall 2007, and student utilization of Center services has increased steadily since that semester. In the 2007-2008 academic year alone, Delta College students utilized the Center's services for a total of over 52,000 student-hours. In the same year, over 1,600 students utilized MSLC services each semester.

Tutoring and supplemental instruction (SI) services at the MSLC are intended to support student success in the College's most popular and/or difficult math and science courses. With each subsequent semester, tutoring and SI are offered for additional courses and to increasing numbers of students. Supplemental instruction is often confused with tutoring, although the two Delta College programs differ in important ways. Supplemental instruction 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. Tutoring at the College's Math/Science Learning Center typically entails a student requesting tutoring in a specific course and utilizing the assigned tutor's drop-in hours for help with coursework. The aims of the present study were to describe the students who utilize MSLC services, describe Center usage in fall 2008, and examine the impact of tutoring and supplemental instruction on student success. Student outcomes, demographic and academic data were obtained from the College's System 2000 database and were analyzed for students in courses with high tutoring and/or SI participation rates. Tutoring and SI session attendance data were obtained from the MSLC.

In fall 2008, 1810 students utilized the MSLC's services. Of those, the majority (61%) utilized the Center's services for at least one hour during the semester. About one third of the students who used MSLC services received tutoring in science, and 40% received tutoring in math. The remaining students showed interest in but never attended tutoring or simply used the MSLC computer labs. Table 1 provides an overview of MSLC student demographics, academic performance and beginning assessment levels in reading, writing and math for students (1) who received at least one hour of tutoring, and (2) who received less than one hour of tutoring. Figures 1 and 2 illustrate the most popular math and science classes for which students receive tutoring.

Table 1. MSLC Student Demographics, Previous Academic Performance and Assessment Levels

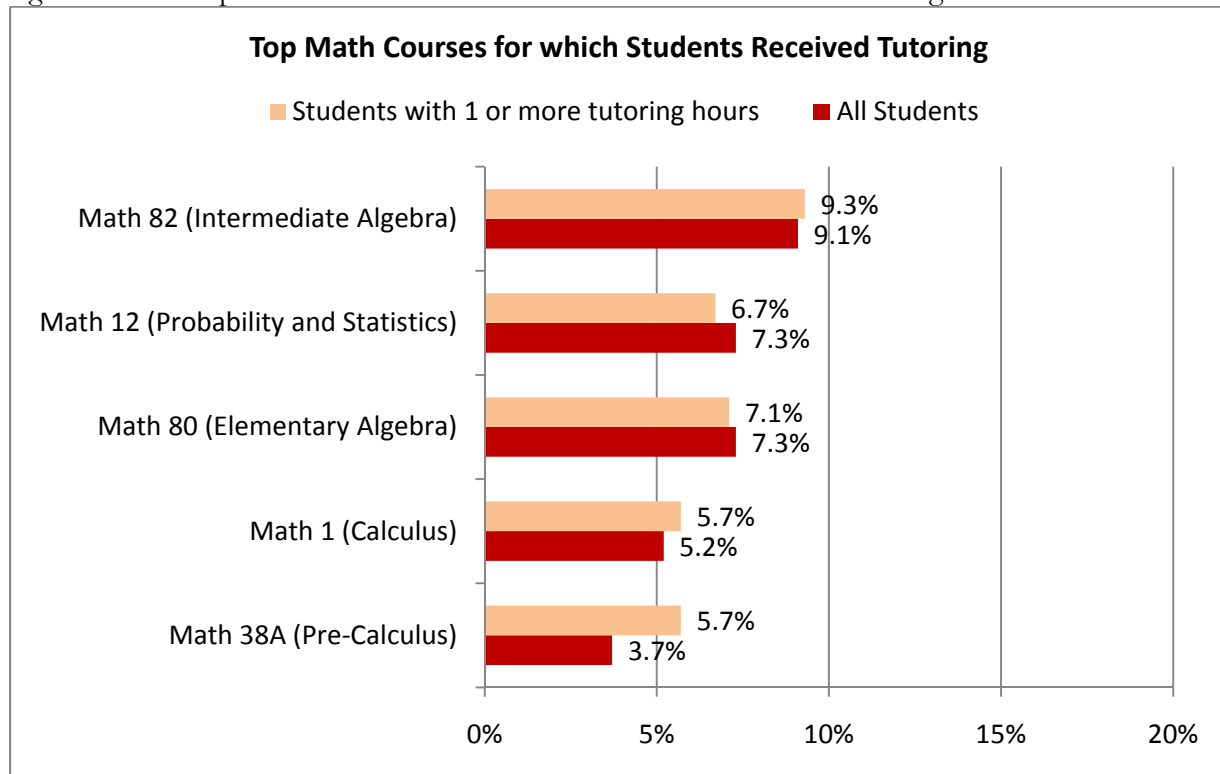
	Students Receiving One Hour of Tutoring or More		Students Who Received Less than One Hour of Tutoring	
	N	%	N	%
<b>Gender</b>				
Female	674	61.4%	450	63.1%
Male	405	36.9%	254	35.6%
Unknown	18	1.6%	9	1.3%
<i>Total</i>	<i>1,097</i>	<i>100.0%</i>	<i>713</i>	<i>100.0%</i>
<b>Ethnicity</b>	<b>N</b>	<b>%</b>	<b>N</b>	<b>%</b>
African American	112	10.2%	70	9.8%
American Indian/Alaskan Native	12	1.1%	9	1.3%
Asian	235	21.4%	120	16.8%
Hispanic	305	27.8%	196	27.5%
Other non-white	17	1.5%	6	0.8%
Pacific Islander	105	9.6%	77	10.8%
White, not Hispanic	231	21.1%	186	26.1%
Unknown	80	7.3%	49	6.9%
<i>Total</i>	<i>1,097</i>	<i>100.0%</i>	<i>713</i>	<i>100.0%</i>
<b>Age</b>	<b>M</b>	<b>SD</b>	<b>M</b>	<b>SD</b>
Average age	25.5 years	9.4	24.1 years	8.4
<b>Low-Income Status</b>	<b>N</b>	<b>%</b>	<b>N</b>	<b>%</b>
Received BOG fee waiver	511	46.6%	296	41.5%
Did not receive BOG fee waiver	586	53.4%	417	58.5%
<i>Total</i>	<i>1,097</i>	<i>100.0%</i>	<i>713</i>	<i>100.0%</i>
<b>Special Program Status</b>	<b>N</b>	<b>%</b>	<b>N</b>	<b>%</b>
Participant in EOPS program	55	5.0%	38	5.3%
Participant in DSPS program	63	5.7%	37	5.2%
<b>Guidance and Counseling Services</b>	<b>N</b>	<b>%</b>	<b>N</b>	<b>%</b>
Completed Guidance 11 course	310	28.3%	149	20.9%
Completed at least one Student Ed Plan	253	23.1%	176	24.7%
<b>Initial Math Assessment Level</b>	<b>N</b>	<b>%</b>	<b>N</b>	<b>%</b>
Level 1	266	24.2%	163	22.9%
Level 2	293	26.7%	193	27.1%
Level 3	435	39.7%	290	40.7%
No score data available	103	9.4%	67	9.4%
<i>Total</i>	<i>1,097</i>	<i>100.0%</i>	<i>713</i>	<i>100.0%</i>
<b>Initial Reading Assessment Level</b>	<b>N</b>	<b>%</b>	<b>N</b>	<b>%</b>
Level 1	287	26.2%	170	23.8%
Level 2	506	46.1%	360	50.5%
Level 3	183	16.7%	109	15.3%
No score data available	121	11.0%	74	10.4%
<i>Total</i>	<i>1,097</i>	<i>100.0%</i>	<i>713</i>	<i>100.0%</i>

Table 1, continued

<b>Initial Writing Assessment Level</b>	<b>N</b>	<b>%</b>	<b>N</b>	<b>%</b>
Level 1	393	35.8%	222	31.1%
Level 2	357	32.5%	267	37.4%
Level 3	229	20.9%	152	21.3%
No score data available	118	10.8%	72	10.1%
<i>Total</i>	<i>1,097</i>	<i>100.0%</i>	<i>713</i>	<i>100.0%</i>
<b>Academic Progress Measures</b>	<b>M</b>	<b>SD</b>	<b>M</b>	<b>SD</b>
Cumulative GPA prior to Fall 2008	3.02	.64	2.79	.79
Unit load in Fall 2008	11.67	4.35	10.94	4.55
Total tutoring hours for Fall 2008	20.59	31.78	.10	.22

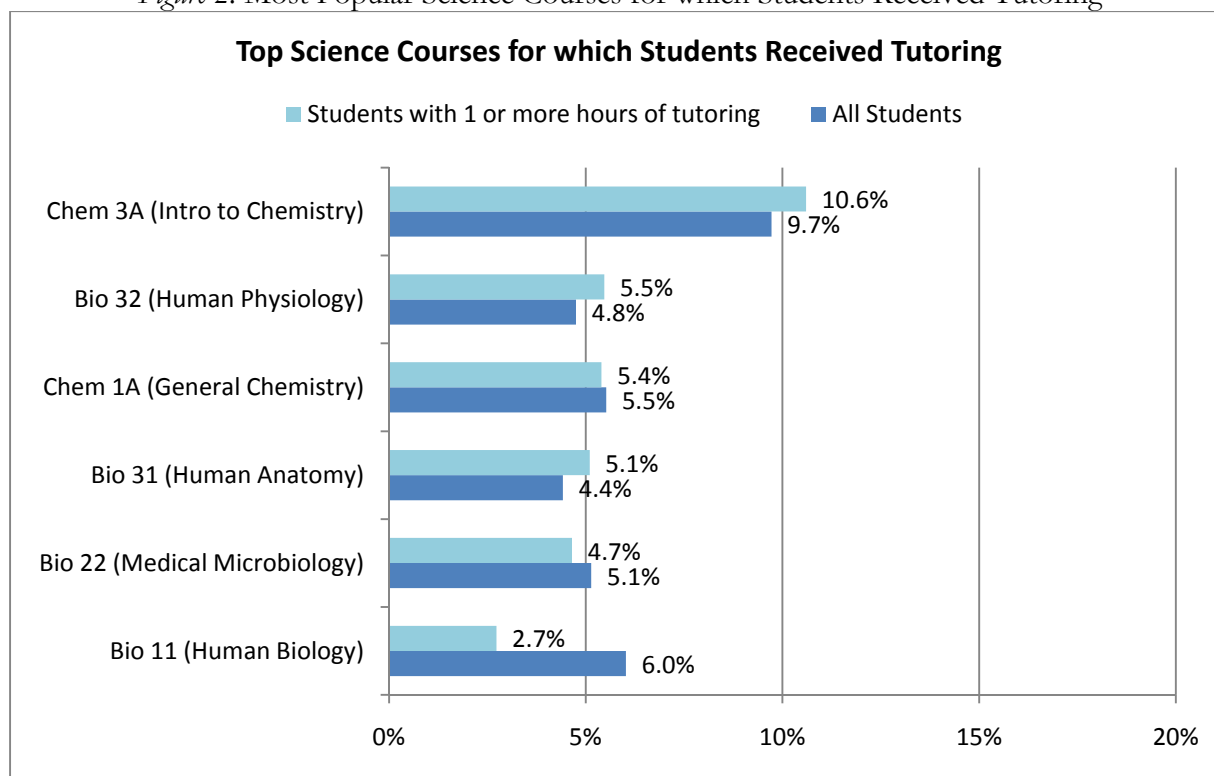
Source: SJDC System 2000 Database, March 13, 2009

Figure 1. Most Popular Math Courses for which Students Received Tutoring



Source: MSLC Tutoring Database, Fall 2008

Figure 2. Most Popular Science Courses for which Students Received Tutoring



Source: MSLC Tutoring Database, Fall 2008

## METHODOLOGY

One of the goals of the present study was to examine the impact of student learning assistance programs (tutoring and supplemental instruction) provided in the Math/Science Learning Center in fall 2008. Data were obtained for students participating in either or both SI and tutoring, and student outcomes were analyzed for each course. Supplemental instruction (SI) was available for five courses in fall 2008: Anatomy (Biology 31), Physiology (Biology 32), Core Biology (Biology 11), Statistics (Math 12) and Algebra Math 80). Only sections for which SI was offered were included in the SI analysis.

Tutoring was provided to students in numerous math and science courses; however, sample sizes for many courses were too small to be included in course-level analysis. Five of the most popular math and science courses were selected for inclusion in the tutoring analysis based on the large proportion of students who received tutoring services. These courses included Probability and Statistics, Elementary Algebra, Intermediate Algebra, General Chemistry and Introduction to Chemistry. All students enrolled in each of these courses in fall 2008 were included in the study.

Student success is the goal of both SI and tutoring, and a number of factors have been linked to course success in previous studies at Delta College, such as student assessment levels, special program participation, completion of a Student Education Plan (SEP), completion of an orientation (Guidance 11) course, and semester unit load. To determine if student participation in tutoring and/or SI was a significant predictor of student success after controlling for these and other academic and demographic factors, logistic regression analysis was conducted. Student success

(grade of C or better in a course) served as the dichotomous outcome variable of interest. Results of the analysis are provided below for each learning assistance program.

## RESULTS

### Supplemental Instruction Outcomes

First, SI sessions attended served as the predictor of interest, and tutoring was included in the study to examine the unique contributions of each learning assistance program; students who did not participate in tutoring were coded as having zero tutoring hours for the semester, and students who did not participate in SI were coded as attending zero SI sessions. Only course sections with SI components were selected for inclusion in this part of the study.

The final SI regression model is outlined below:

$$\text{Predicted probability of success} = a + b_1 (\text{gender}) + b_2 (\text{ethnicity}) + b_3 (\text{age}) + b_4 (\text{low-income status}) + b_5 (\text{SEP status}) + b_6 (\text{Guidance 11 status}) + b_7 (\text{previous cumulative GPA}) + b_8 (\text{initial math assessment level}) + b_9 (\text{initial reading assessment level}) + b_{10} (\text{semester unit load}) + b_{11} (\text{total tutoring hours}) + b_{12} (\text{total SI sessions attended}) + \text{error term (unexplained variance)}$$

All course sections for which SI was available were included in the study and aggregated so that the overall impact of SI on student success in math and science courses could be examined. Course discipline was included as a variable to determine if outcomes differed between math and science courses. A total of 369 students were included in the analysis. Descriptive statistics for all variables included in the model are provided in Table 2a.

*Table 2a. Descriptive Statistics for Variables in the SI Logistic Regression Model*

Group	Range of Scores/Coding Scheme	Mean	SD
Gender	0=Female; 1=Male	.26	.44
Ethnicity	0=White; 1=Non-white	.73	.44
Age	17 to 56	23.65	6.95
Low-income status	0=No fee waiver; 1=Fee waiver	.38	.49
SEP completion	0=No SEP on file; 1=SEP on file	.16	.36
Guidance 11 completion	0=Did not complete Guidance 11 1=Completed Guidance 11	.27	.45
Initial math assessment level	1 to 3	2.27	.80
Initial reading assessment level	1 to 3	1.98	.67
Semester unit load	4.0 to 23.0	11.13	3.98
Previous cumulative GPA	0.00 to 4.00	2.96	.69
Discipline	0=Math course; 1=Science course	.82	.39
Tutoring hours	0.00 to 140.53	4.52	14.18
SI sessions attended	0 to 48	1.60	4.24
Success	0=Not successful; 1=Successful	.58	.49

Results of the statistical analysis revealed just three statistically significant predictors of success in math and science courses: initial reading assessment level, previous cumulative GPA and number of SI sessions attended. Table 2b presents coefficients and odds ratios for each predictor in the model.

Table 2b. Logistic Regression for Success in Chemistry 1A

Predictor	B	Standard Error	Odds Ratio
Constant	-3.654	.967	.026
Gender	.318	.277	1.480
Ethnicity	.392	.282	1.480
Age	-.018	.020	.982
Low-income status	-.150	.255	.861
SEP completion	-.062	.337	.940
Guidance 11 completion	.219	.278	1.244
Initial math assessment level	.184	.170	1.202
Initial reading assessment level <sup>+</sup>	.409	.214	1.505
Semester unit load	-.007	.033	.993
Previous cumulative GPA**	.984	.202	2.675
Discipline	-.279	.347	.757
Tutoring hours	.020	.013	1.021
SI sessions attended**	.152	.057	1.164

+Significant at the 90% confidence level

\*Significant at the 95% confidence level

\*\*Significant at the 99% confidence level

Negative 2 Log Likelihood Ratio 429.690

Model Chi Square 71.723

Percent of Cases Correctly Predicted 71.0%

Proportional Reduction in Error 30.46%

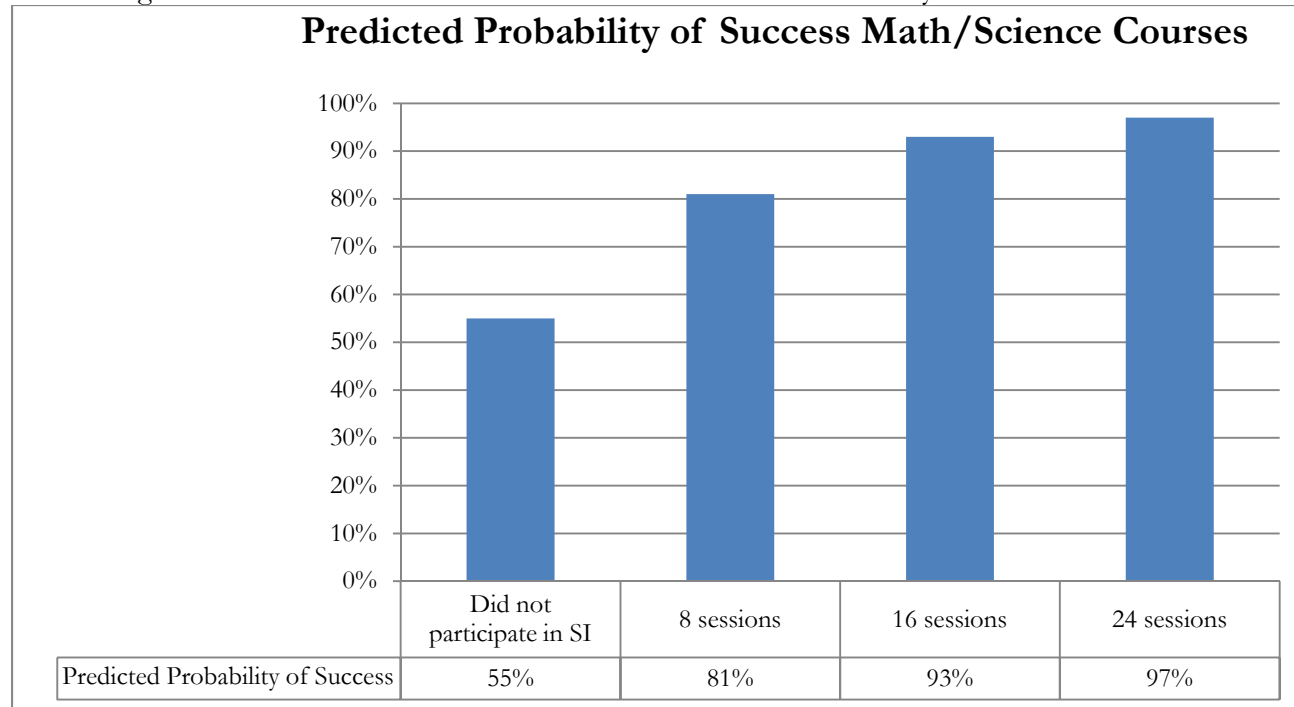
Nagelkerke R<sup>2</sup> .238

The full regression model resulted in a proportional reduction in error of 30%. Previous cumulative GPA, initial reading level, and number of SI sessions attended were statistically significant predictors of success across all math and science courses. Table 2c 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 81%. Students who did not participate in SI had a predicted success rate of just 55%. 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 97%. Figure 3 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 success in a math and science course if they attend one session roughly every other week. Student chance of success increases with additional sessions attended; however, the increase in predicted success rate is considerably smaller after about 16 sessions.

Table 2c. Predicted Probability of Success in Math or Science Course by Number of SI Sessions Attended

Intercept	Mean Gender	Mean Ethnicity	Mean Age	Mean Low-Income Status	Mean SEP Status	Mean GUID 11	Mean Cumulative GPA	Mean Math Assessment	Mean Reading Assessment	Mean Unit Load	Hours of Tutoring Received	SI Sessions Attended	Probability of Success
-3.654	.26	.73	23.65	.38	.16	.27	2.96	2.27	1.98	11.13	4.52	0	.55
-3.654	.26	.73	23.65	.38	.16	.27	2.96	2.27	1.98	11.13	4.52	8	.81
-3.654	.26	.73	23.65	.38	.16	.27	2.96	2.27	1.98	11.13	4.52	16	.93
-3.654	.26	.73	23.65	.38	.16	.27	2.96	2.27	1.98	11.13	4.52	24	.97

Figure 3. Predicted Success Rates for Math and Science Courses by SI Sessions Attended



## Tutoring Outcomes

In order to determine if tutoring participation predicted success across different courses, the top two science and top three math courses for which students received tutoring were examined. All students enrolled in the following courses were included in the analysis: Math 12 (Probability and Statistics), Math 82 (Intermediate Algebra), Math 80 (Elementary Algebra), Chemistry 1A (General Chemistry) and Chemistry 3A (Introduction to Chemistry). Students who participated in tutoring for the specific course were included in the study, and students who participated in tutoring for other courses were included in the analysis but were coded as having zero tutoring hours.

### ► Science Courses

Two chemistry classes were among the most popular courses for which students received tutoring: Chemistry 1A and Chemistry 3A. Although SI was available for one section of Chemistry 3A, the number of students in that section of SI represented a rather small proportion of the overall enrolled student population. Thus, SI was not included in the analysis for Chemistry 1A or any other course.

The same regression model used in the SI analysis, with the exception of SI participation, was employed for the tutoring study. The final tutoring regression model is outlined below:

$$\text{Predicted probability of success} = a + b_1 (\text{gender}) + b_2 (\text{ethnicity}) + b_3 (\text{age}) + b_4 (\text{low-income status}) + b_5 (\text{SEP status}) + b_6 (\text{Guidance 11 status}) + b_7 (\text{previous cumulative GPA}) + b_8 (\text{initial math assessment level}) + b_9 (\text{initial reading assessment level}) + b_{10} (\text{semester unit load}) + b_{11} (\text{total tutoring hours}) + \text{error term (unexplained variance)}$$

A total of 151 cases were included in the Chemistry 1A analysis. Descriptive statistics for each predictor in the model are provided in Table 3a.

*Table 3a.* Descriptive Statistics for Variables in the Chemistry 1A Logistic Regression Model

Group	Range of Scores/Coding Scheme	Mean	SD
Gender	0=Female; 1=Male	.55	.50
Ethnicity	0=White; 1=Non-white	.77	.42
Age	15 to 46	20.60	4.58
Low-income status	0=No fee waiver; 1=Fee waiver	.37	.49
SEP completion	0=No SEP on file; 1=SEP on file	.11	.32
Guidance 11 completion	0=Did not complete Guidance 11 1=Completed Guidance 11	.28	.45
Initial math assessment level	1 to 3	2.56	.73
Initial reading assessment level	1 to 3	2.15	.60
Semester unit load	5.0 to 25.0	14.26	3.46
Previous cumulative GPA	1.74 to 4.00	3.06	.53
Tutoring hours	0.00 to 234.39	14.26	33.63
Success	0=Not successful; 1=Successful	.46	.50

Results of the statistical analysis revealed four statistically significant predictors of success in Chemistry 1A: initial reading assessment level, previous cumulative GPA, semester unit load and number of hours of tutoring received. Table 3b presents coefficients and odds ratios for each predictor in the model.

Table 3b. Logistic Regression for Success in Chemistry 1A

Predictor	B	Standard Error	Odds Ratio
Constant	-5.918	2.186	.003
Gender	2.42	.409	1.274
Ethnicity	-.131	.495	.878
Age	-.018	.045	.982
Low-income status	185	.423	1.203
SEP completion	-.141	.696	.869
Guidance 11 completion	.151	.465	1.163
Initial math assessment level	.371	.320	1.449
Initial reading assessment level <sup>+</sup>	.764	.391	2.147
Semester unit load*	-.140	.063	.870
Previous cumulative GPA**	1.669	.430	5.307
Tutoring hours*	.016	.008	1.016

+Significant at the 90% confidence level

\*Significant at the 95% confidence level

\*\*Significant at the 99% confidence level

Negative 2 Log Likelihood Ratio 164.543

Model Chi Square 43.666

Percent of Cases Correctly Predicted 75.5%

Proportional Reduction in Error 46.39%

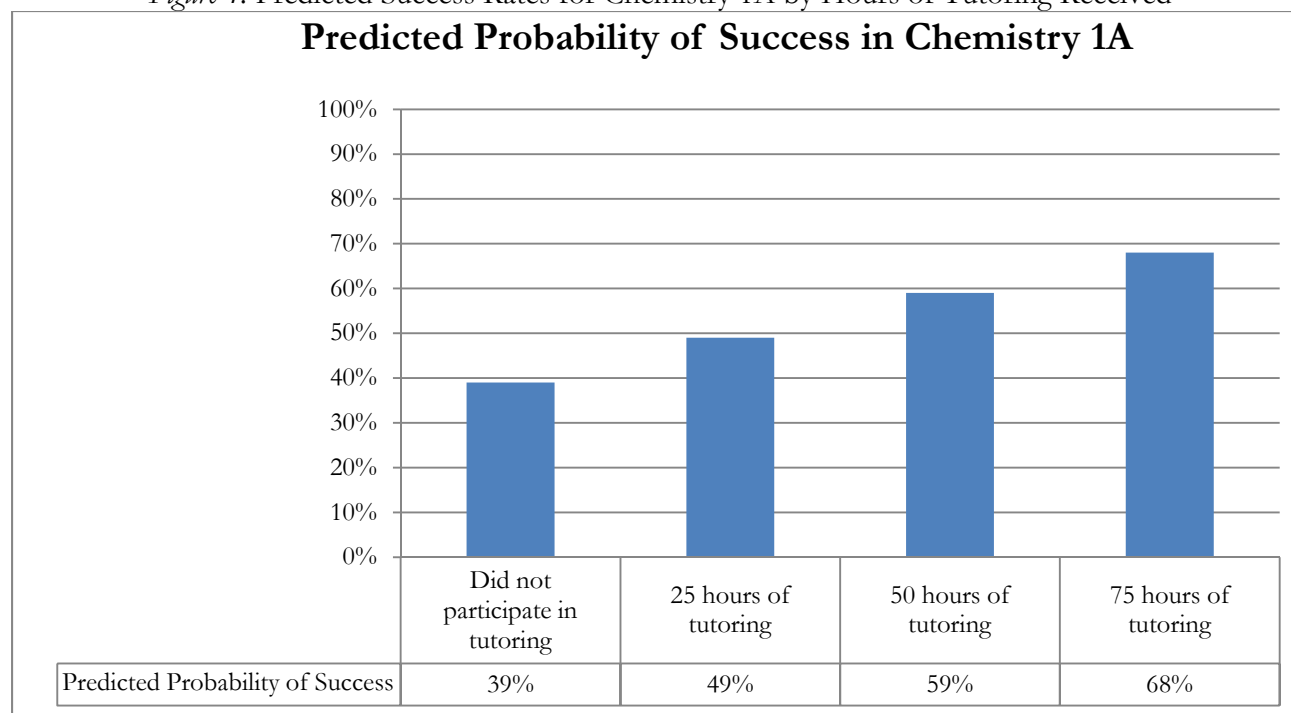
Nagelkerke R<sup>2</sup> .336

The full regression model resulted in a proportional reduction in error of 46%. Previous cumulative GPA, initial reading level, semester unit load and number of hours of tutoring were statistically significant predictors of success in Chemistry 1A. Table 3c presents the predicted probability of success for a student in a Chemistry 1A course based on the number of hours of tutoring received. Controlling for all other variables included in the model, students who received a total of 25 hours of tutoring had a predicted success rate of 49%. Students who did not participate in tutoring had a predicted success rate of just 39%. Students who received 50 hours of tutoring had a predicted success rate of 59%, and students who received 100 hours of tutoring (roughly 6 hours per week) had a predicted success rate of 75%. Figure 4 illustrates the predicted probability of success based on the number of hours of tutoring received.

Table 3c. Predicted Probability of Success in Chemistry 1A by Number of Hours of Tutoring Received

Intercept	Mean Gender	Mean Ethnicity	Mean Age	Mean Low-Income Status	Mean SEP Status	Mean GUID 11	Mean Cumulative GPA	Mean Math Assessment	Mean Reading Assessment	Mean Unit Load	Hours of Tutoring Received	Probability of Success
-5.918	.55	.77	20.60	.37	.11	.28	3.06	2.56	2.15	14.26	0	.39
-5.918	.55	.77	20.60	.37	.11	.28	3.06	2.56	2.15	14.26	25	.49
-5.918	.55	.77	20.60	.37	.11	.28	3.06	2.56	2.15	14.26	50	.59
-5.918	.55	.77	20.60	.37	.11	.28	3.06	2.56	2.15	14.26	75	.68

Figure 4. Predicted Success Rates for Chemistry 1A by Hours of Tutoring Received



Results were less conclusive for Introduction to Chemistry (Chemistry 3A). Only age, previous cumulative GPA and initial math assessment level were significant predictors of success. Overall tutoring results appear somewhat mixed for chemistry courses. Additional research is required to gain a better understanding of tutoring’s impact on student success in this subject area.

► **Math Courses**

Results were similarly mixed for math courses. The same regression model was used to predict success in Elementary Algebra (Math 80), Intermediate Algebra (Math 82) and Probability and Statistics (Math 12), but tutoring was a significant predictor of success in just one course. For Math 80, previous cumulative GPA was the only statistically significant predictor of success. In Math 82, gender, age and previous cumulative GPA were the only significant predictors of success.

More promising results emerged for tutoring in Math 12 (Probability and Statistics). A total of 698 cases were included in the analysis for this course. Descriptive statistics for all variables in the model are provided in Table 4a.

*Table 4a. Descriptive Statistics for Variables in the Math 12 Logistic Regression Model*

<b>Group</b>	<b>Range of Scores/Coding Scheme</b>	<b>Mean</b>	<b>SD</b>
Gender	0=Female; 1=Male	.38	.49
Ethnicity	0=White; 1=Non-white	.69	.46
Age	15 to 60	22.99	6.92
Low-income status	0=No fee waiver; 1=Fee waiver	.31	.46
SEP completion	0=No SEP on file; 1=SEP on file	.20	.40
Guidance 11 completion	0=Did not complete Guidance 11 1=Completed Guidance 11	.20	.40
Initial math assessment level	1 to 3	2.32	.80
Initial reading assessment level	1 to 3	2.08	.66
Semester unit load	4.0 to 24.0	11.49	4.43
Previous cumulative GPA	0.00 to 4.00	2.84	.66
Tutoring hours	0.00 to 140.53	1.89	10.96
Success	0=Not successful; 1=Successful	.63	.48

Previous cumulative GPA, age and total hours of tutoring received were significant predictors of success in Probability and Statistics. Initial reading assessment level was also a statistically significant predictor of success, but not in the direction that was expected: initial reading assessment level was inversely related to success. Table 4b presents coefficients and odds ratios for each predictor in the model.

Table 4b. Logistic Regression for Success in Math 12

Predictor	B	Standard Error	Odds Ratio
Constant	-3.013	.698	.049
Gender	.277	.179	1.320
Ethnicity	-.303	.190	.739
Age <sup>+</sup>	.025	.015	1.025
Low-income status	.089	.190	1.093
SEP completion	-.155	.225	.856
Guidance 11 completion	.253	.226	1.288
Initial math assessment level	.100	.115	1.105
Initial reading assessment level <sup>+</sup>	-.251	.145	.778
Semester unit load	.029	.021	1.030
Previous cumulative GPA**	1.054	.151	2.870
Tutoring hours <sup>+</sup>	.023	.014	1.024

+Significant at the 90% confidence level

\*Significant at the 95% confidence level

\*\*Significant at the 99% confidence level

Negative 2 Log Likelihood Ratio 825.375

Model Chi Square 80.889

Percent of Cases Correctly Predicted 68.9%

Proportional Reduction in Error 18.9%

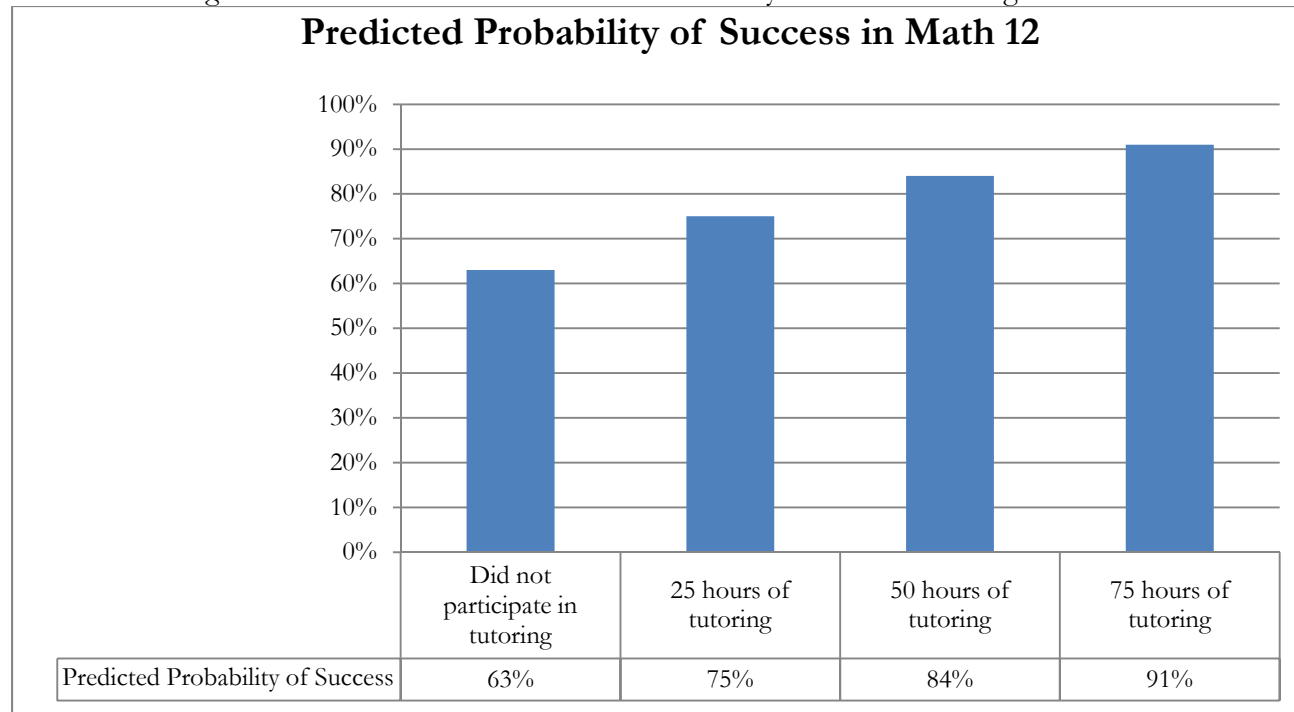
Nagelkerke R<sup>2</sup> .152

The full regression model resulted in a proportional reduction in error of 19%. Previous cumulative GPA, initial reading level, age and number of hours of tutoring were statistically significant predictors of success in Probability and Statistics (Math 12). Table 4c presents the predicted probability of success for a student in a Math 12 course by number of hours of tutoring received. Controlling for other variables, students who received a total of 25 hours of tutoring had a predicted success rate of 75%, whereas students who did not participate in tutoring had a predicted success rate of just 63%. Students who received 50 hours of tutoring had a predicted success rate of 84%, and students who received 75 hours of tutoring (roughly 4.5 hours per week) had a predicted success rate of 91%. Figure 5 illustrates the predicted probability of success in Math 12 based on total number of hours of tutoring received.

Table 4c. Predicted Probability of Success in Math 12 by Hours of Tutoring Received

Intercept	Mean Gender	Mean Ethnicity	Mean Age	Mean Low-Income Status	Mean SEP Status	Mean GUID 11	Mean Cumulative GPA	Mean Math Assessment	Mean Reading Assessment	Mean Unit Load	Hours of Tutoring Received	Probability of Success
-3.013	.38	.69	22.99	.31	.20	.20	2.84	2.32	2.08	11.49	0	.63
-3.013	.38	.69	22.99	.31	.20	.20	2.84	2.32	2.08	11.49	25	.75
-3.013	.38	.69	22.99	.31	.20	.20	2.84	2.32	2.08	11.49	50	.84
-3.013	.38	.69	22.99	.31	.20	.20	2.84	2.32	2.08	11.49	75	.91

Figure 5. Predicted Success Rates for Math 12 by Hours of Tutoring Received



The results of the present study reveal mixed results about the impact of tutoring on student success. In one math course and one science course, tutoring was a significant and positive predictor of success; however, in two other math courses and one other science course, tutoring was not a statistically significant predictor of success, at least when controlling for other predictors of success.

## CONCLUSIONS

The aim of the present study was to examine the impact of supplemental instruction and tutoring on student outcomes in math and science courses. Specifically, the present study investigated the impact of SI on student success in Human Anatomy, Human Physiology, Core Biology, Introduction to Chemistry, Elementary Algebra, and Probability and Statistics course sections offering SI in the fall 2008 semester. In addition, the study aimed to investigate the impact of tutoring on student success in key math and science courses: General Chemistry, Introduction to Chemistry, Algebra, Intermediate Algebra and Statistics. Overall, the results of the present study provide some support for the value of SI as a learning assistance program in math and the sciences. Results for tutoring were somewhat less positive.

Previous studies on student outcomes and learning assistance program participation showed that students who participated in both tutoring and SI in spring 2008 were most likely to succeed in science courses. Individual course sample sizes were too small to conduct course-level analysis, but when courses were combined and grouped by discipline area, SI emerged as a significant predictor of success. Across both disciplines, students who participated in SI had a substantially higher chance of success than those who did not participate. Other predictors of success were initial reading assessment level and previous cumulative GPA. Interestingly, when SI was included in the analysis, tutoring did not emerge as a significant predictor of success in any of the courses or discipline-areas.

When tutoring outcomes were examined for specific math and science courses, results were less positive than those in previous studies, such as one conducted with spring 2008 data. The present study investigated the impact of tutoring on student outcomes in General Chemistry (Chemistry 1A), Introduction to Chemistry (Chemistry 3A), Elementary Algebra (Math 80), Intermediate Algebra (Math 82) and Probability and Statistics (Math 12). Previous studies revealed a significant positive relationship between tutoring and student success; however, the findings of the present study are less definitive. Across all courses, previous cumulative GPA was a significant predictor of success. Initial reading assessment level, semester unit load and demographic variables also emerged as predictors of success in different courses. Tutoring, however, was a significant predictor of success only in Probability and Statistics and General Chemistry. These findings show some promise for tutoring in college-level math and science courses, but additional research should be conducted on tutoring outcomes in these and other courses over different semesters to provide additional evidence of tutoring's impact on student success in math and science.

These results build upon the findings of previous studies, which showed that students who participated in both SI and tutoring were more likely to succeed than students who participated in just SI, just tutoring or neither program. The findings of the present study suggest that, when SI is available, students who participate are more likely to succeed than students who do not participate. Based on the current findings, hours of tutoring received is not a significant predictor of success in course sections that offer SI to students; but in course sections without SI, tutoring may increase students' chances of success. Additional research on the impact of tutoring in combination with SI

is required to obtain a more comprehensive understanding of the unique and combined contributions of these two learning assistance programs.

In light of the findings of this and previous studies, SI appears to be a valuable learning assistance program, one that gives participating students a substantially greater chance of successfully completing a course. Tutoring also appears to give students a better chance of success in some courses. Additional research is required to determine which students are best served by each learning assistance program and which programs are most effective in specific courses or subject areas. There are, as with any study, limitations to the current findings. The data in the current study represent only a small selection of courses, and participation in SI and/or tutoring is completely voluntary. This introduces the possibility of a participant self-selection bias and may limit the generalizability of the results. Controlling for GPA in prior courses attempts to counteract this factor, but it may be the case that students who are predisposed to seek assistance are more motivated to succeed than others. Students included in the SI study generally appeared to be high achievers before they participated in SI. Students included in the tutoring study were somewhat lower achievers than those included in the SI study. Additional research on program effectiveness with different students and skill levels is needed. SI and tutoring may or may not be similarly effective with students who enter a course at different skill and achievement levels. Future studies should be conducted to examine the impact of SI over a number of semesters, with different student populations and in additional courses.