



## STEM Study Groups Effectiveness Report Fall 2017

### Introduction

The purpose of this report is to evaluate the effectiveness of Study Groups (SG). What follows are descriptive statistics, success rates, and statistical analyses for each course offered under SG in Fall 2017.

Study Groups are just one activity Citrus College has implemented with the goal of facilitating student learning and ultimately student success. Study Groups provide regularly scheduled out-of-class review sessions for students who may want additional help. All the mathematics classes in this analysis also have Embedded Tutors which provide additional support during class.

In Fall 2017 Study Groups (SG) were offered for five science and five mathematics courses for a total of 1,407 students. There were 341 students that attended at least one SG session, resulting in a 24% overall Study Group participation rate.

**Table 1** Course Enrollment and SG Participation

Courses	# of SG Supported Sections	Enrollment	SG Participants Count	SG Participation Rate
BIOL124	5	115	19	17%
BIOL125	3	69	27	39%
CHEM103	3	71	9	13%
CHEM110	6	141	37	26%
CHEM111	3	73	9	12%
MATH025*	8	282	71	25%
MATH029*	7	206	55	27%
MATH030*	5	208	57	27%
MATH140*	2	77	14	18%
MATH150*	4	165	43	26%
<b>Total</b>	<b>46</b>	<b>1,407</b>	<b>341</b>	<b>24%</b>

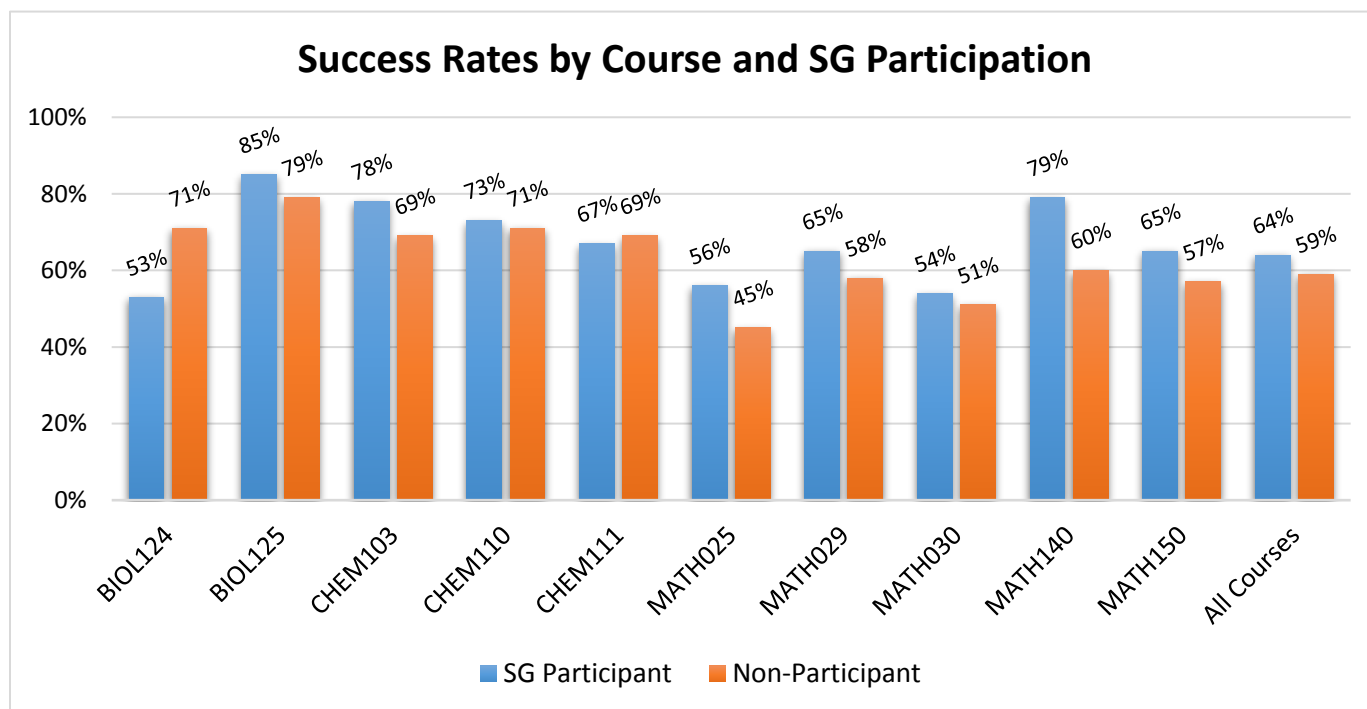
\*These courses included an in-class Embedded Tutor

**Success Rates based on SG Participation**

Chi-square tests were used to examine if students who participated in study group sessions (SG) were more likely to be successful in each course compared to students who did not participate. Success was defined as students earning a final course grade of A, B, or C. Students earning a final course grade of D, F, FW, or W were considered unsuccessful.

**Table 2** Success Rates by Course and SG Participation

Course	SG Participant			Non-Participant		
	Success Count	Total	Success Rate	Success Count	Total	Success Rate
BIOL124	10	19	53%	68	96	71%
BIOL125	23	27	85%	33	42	79%
CHEM103	7	9	78%	43	62	69%
CHEM110	27	37	73%	74	104	71%
CHEM111	6	9	67%	44	64	69%
MATH025	40	71	56%	96	211	45%
MATH029	36	55	65%	88	151	58%
MATH140	11	14	79%	38	63	60%
MATH030	31	57	54%	77	151	51%
MATH150	28	43	65%	70	122	57%
Total	219	341	64%	631	1,066	59%



**Figure 1**

\* Indicates statistically significant differences at  $p \leq .05$ . No significance was found.

With the exception of students in BIOL124 and CHEM111, students who attended Study Group sessions had higher success rates than students who did not. However, the results of several chi-square tests revealed there was not a statistically significant association between SG Participation and success when examining all courses combined,  $X^2(1, N=1,407) = 2.73, p = .098$ , or when disaggregating by each course. In other words, the success rate of Study Group participants did not significantly differ from Non-Participants.

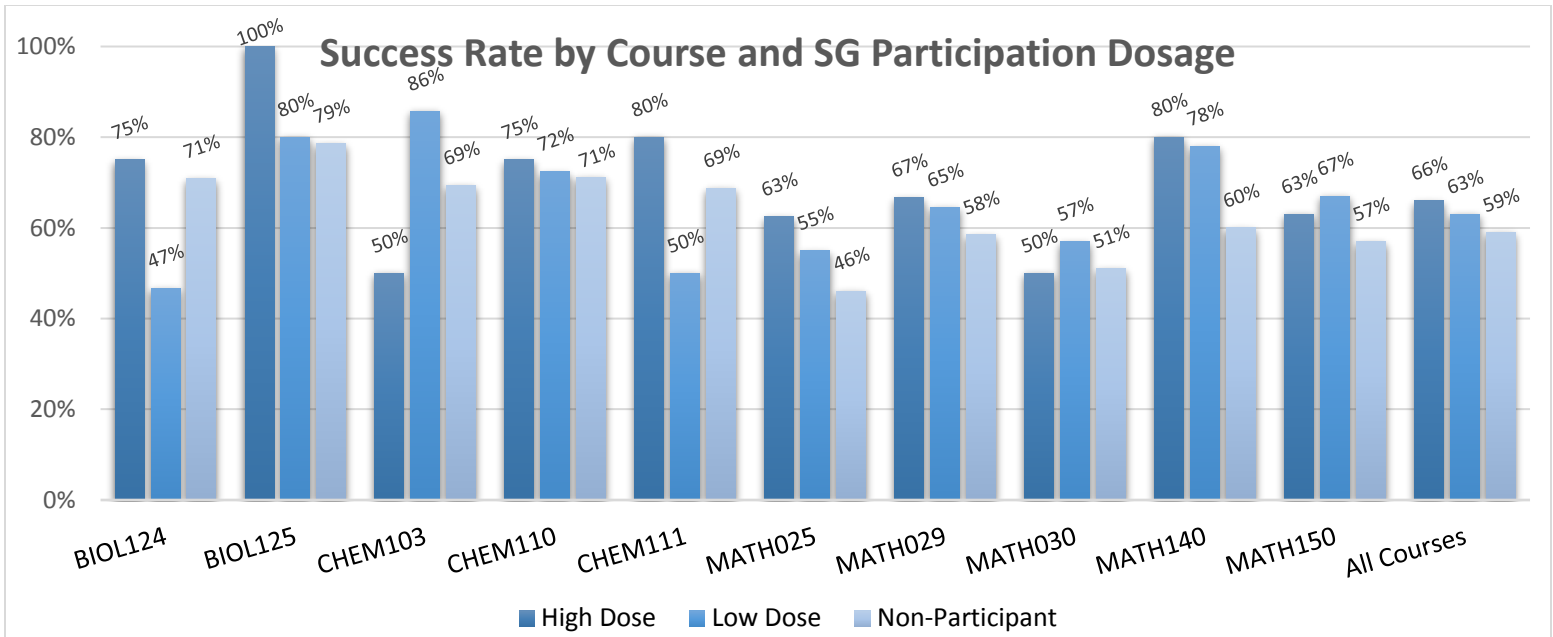
### **Success Rates Disaggregated by Dosage of SG Participation**

To further compare differences among participant groups, Study Group participation was broken down into two categories: Low Dose (i.e. students attending 1 – 4 SG sessions) and High Dose (i.e. students attending 5 or more SG sessions). Students that did not attend any SG sessions were considered Non-SG participants.

Overall, students who attended five or more SG sessions (i.e. High Dose participants) had the highest course success rate (66%), followed by students who attended 1-4 sessions (63%). Students who did not attend any SG session had the lowest final course grades (59%).

When courses were disaggregated, a similar pattern was found in which High Dose participants had the highest course success rates while Non-participants had the lowest. CHEM103 and MATH030 had the most unexpected patterns in which High Dose participants had the lowest success rates. However it is important to note that there were only 2 students who fell into the high dose group for CHEM103 and 20 students for MATH030.

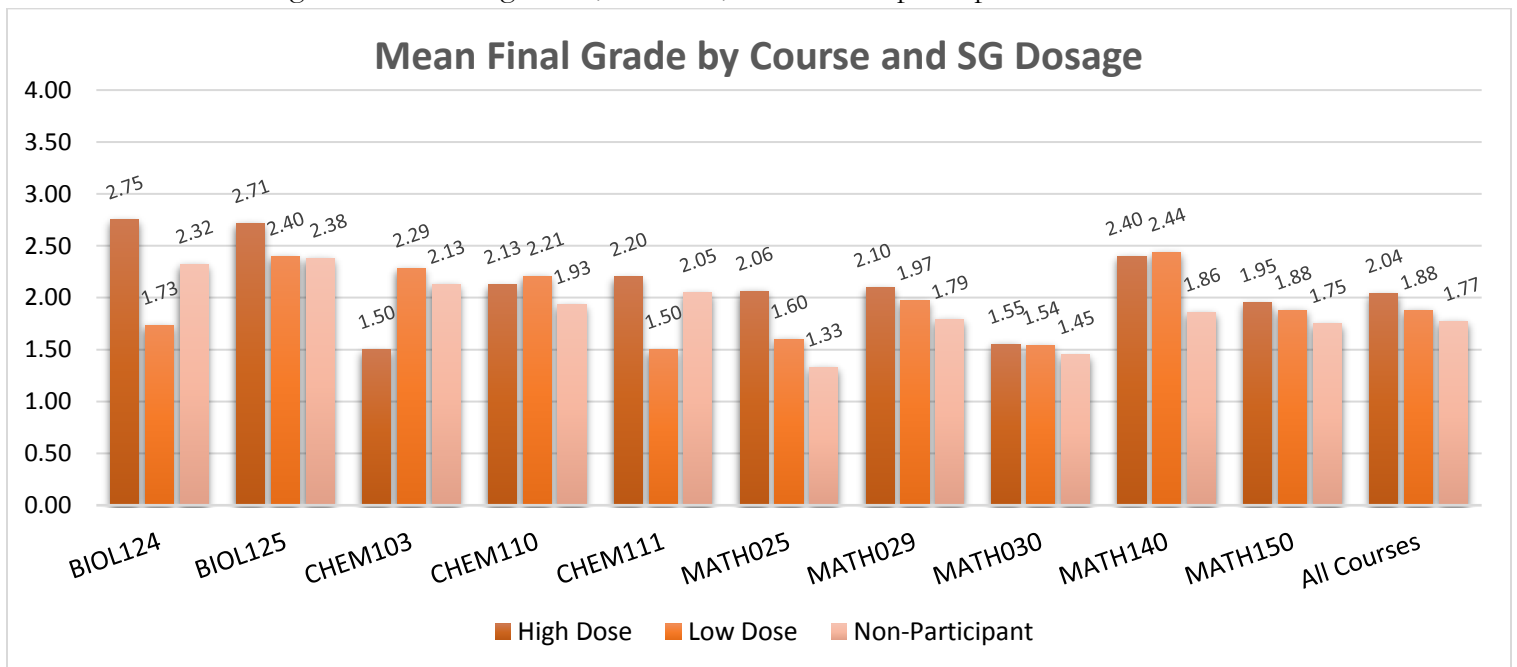
The results of several chi-square analyses (which measured success continuously using students' final course grade) revealed no statistically significant differences between high dose, low dose, and non-SG participants,  $X^2(2, N=1,407) = 3.03, p = .220$ . Even though it may appear that the differences in success rate should be significant (e.g. the difference between success rates for High and Low Dose participants in CHEM103, as shown in Figure 2), the lack of significance may be due to low sample size. In the case of CHEM103 which has 71 students total, only 2 students fell into the high dose group and 7 students in the low dose group.



**Figure 2**

\* Indicates statistically significant differences at  $p \leq .05$ . No significance was found.

One-way ANOVA analyses were conducted to measure success using students' final course grade. Grades were converted into a continuous variable using the following scale: A=4, B=3, C=2, D=1, and F/FW/W=0. Results showed again that there was no statistically significant differences of mean final course grade between high dose, low dose, and non-SG participants.



**Figure 3**

\*Indicates statistically significant differences at  $p \leq .05$ . No significance was found.

**Table 3** Summary of one-way ANOVA Results

Course	<i>df</i>	<i>N</i>	<i>F</i>	<i>p</i>
BIOL124	2	115	1.13	.327
BIOL125	2	69	.980	.389
CHEM103	2	71	.220	.803
CHEM110	2	141	.528	.591
CHEM111	2	73	.393	.667
MATH025	2	282	2.54	.081
MATH029	2	206	.573	.565
MATH030	2	208	.095	.909
MATH140	2	77	.860	.427
MATH150	2	165	.202	.817
All Courses	2	1,407	2.02	.133

\*Indicates significance at  $p \leq .05$ . No significance was found.

### SG Participation and Success Rates by Gender

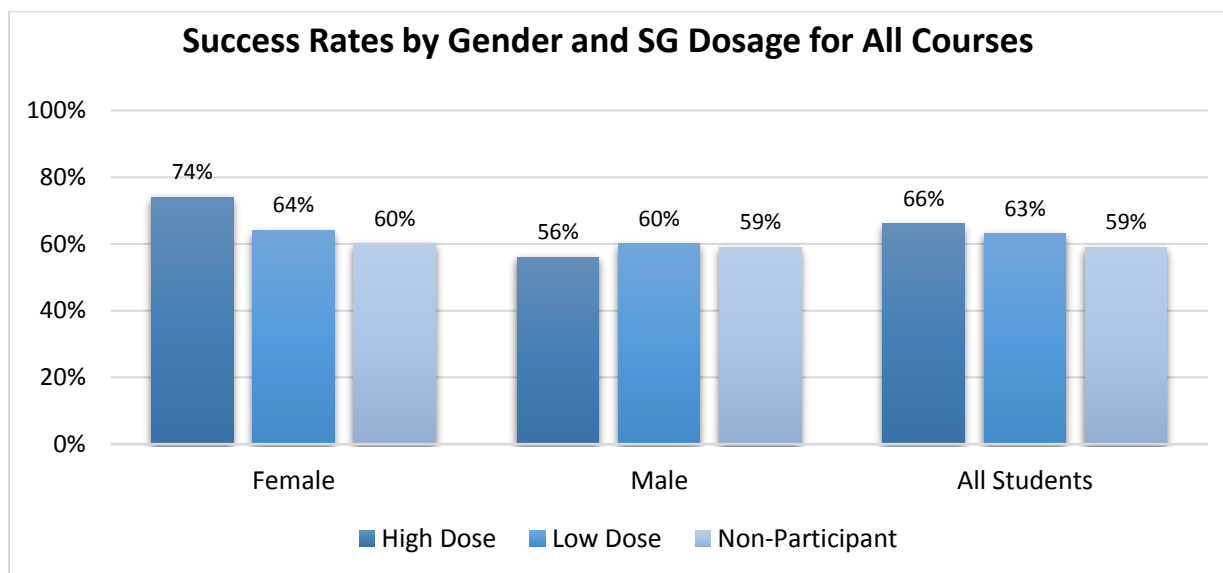
The tables and figures below show the breakdown of Study Group participation and success rates by gender. As shown in Table 4 and Table 5, female students participated in Study Groups at a higher rate than male students overall.

**Table 4** Female Study Group Participation Rates

Course	SG Female Participants	Total Females	Female SG Participation Rate
BIOL105	11	67	16%
BIOL124	18	43	42%
CHEM103	7	46	15%
CHEM110	19	68	28%
CHEM111	7	36	19%
MATH025	50	169	30%
MATH029	33	102	32%
MATH030	24	100	24%
MATH140	8	42	19%
MATH150	22	86	26%
Total	199	759	26%

**Table 5** Male Study Group Participation Rates

Course	SG Male Participants	Total Males	Male SG Participation Rate
BIOL105	8	44	18%
BIOL124	9	26	35%
CHEM103	2	24	8%
CHEM110	17	70	24%
CHEM111	2	37	5%
MATH025	21	112	19%
MATH029	20	97	21%
MATH030	31	102	30%
MATH140	6	33	18%
MATH150	21	78	27%
<b>Total</b>	<b>137</b>	<b>623</b>	<b>22%</b>



**Figure 4**

\*Indicates statistically significant differences at  $p \leq .05$ . No significance was found.

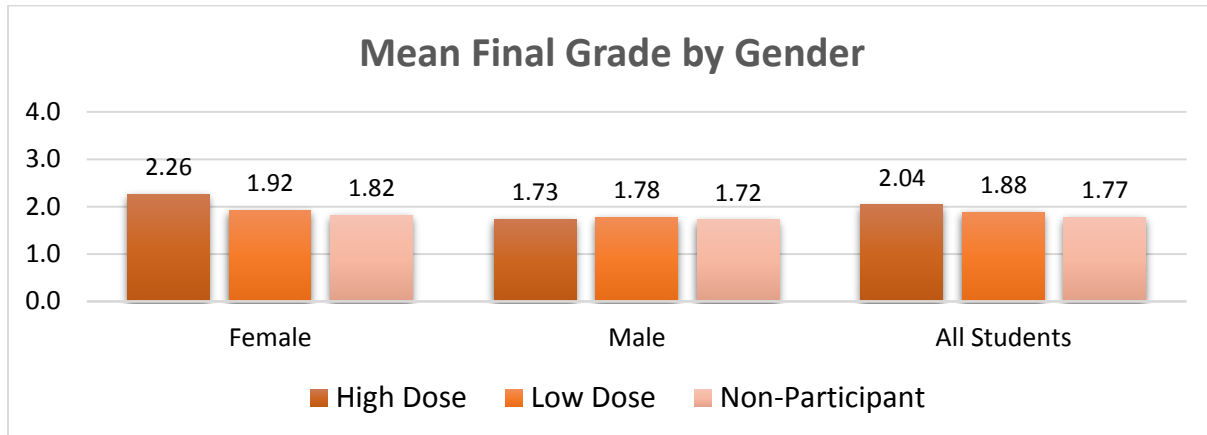
Overall, females who attended five or more Study Group sessions had higher success rates than females who attended fewer or did not attend at all. Interestingly, the success rates for males that attended 1-4 sessions was the highest. As evident by a chi-square analysis, the differences in these success rates for females,  $X^2(2, N=759) = 5.09, p = .079$  and males,  $X^2(2, N=623) = .231, p = .891$  were not significant.

To investigate these findings further, one-way ANOVAs and post hoc analyses were conducted to determine whether mean final grade differences between high, low, and non-participating female and male students were significant overall, and at the course level. Refer to Figure 5 and Table 6 for a summary of the overall results.

When measuring success continuously using students’ final course grade, the one-way ANOVA analysis revealed the mean final grade difference when all courses were combined was marginally statistically significant for females,  $F(2, 759)=2.84, p=.059$ , but not statically significant for males,  $F(2, 623)=.085, p=.918$ . Specifically, post hoc analyses showed that High Dose female students ( $M=2.26, SD=1.39$ ) succeeded at a significantly higher rate than their non-participating counterparts ( $M=1.82, SD=1.46$ );  $p=.050$ .

At the course level, the one-way ANOVA analysis revealed the mean final grade difference was only statistically significant for **female students in BIOL124**,  $F(2, 67) = 3.31, p = .043$ . Surprisingly, post hoc analyses revealed that Low Dose female students ( $M=1.00, SD=1.73$ ) succeeded at a significantly lower rate than Non-participant female students ( $M=2.36, SD=1.51$ );  $p=0.034$ . However it is important to note that there were only 9 students who fell into the low dose female group for BIOL124 so any conclusions should be made cautiously considering the low sample size.

All other group differences at the course level were not significant.



**Figure 5**

\*Indicates statistically significant differences at  $p \leq .05$ . No significance was found at the .05 level.

**Table 6** Summary of one-way ANOVA Gender Results

Gender	<i>df</i>	<i>N</i>	<i>F</i>	<i>p</i>
Females	2	759	2.84	.059
Males	2	623	.085	.918
All Courses	2	1,407	2.02	.133

\*Indicates significance at  $p \leq .05$ . No significance was found at the .05 level.

### SG Participation and Success Rates by Ethnicity

The tables and figures below show the breakdown of Study Group participation and success rates by ethnicity. As shown in Tables 7 - 10, students of Other Ethnicity participated in Study Groups at the highest rate followed by White students, Hispanic students, and Asian students.

**Table 7** Hispanic Students Study Group Participation Rates

Course	SG Hispanic Participants	Total Hispanic Students	Participation Rate
BIOL105	11	71	15%
BIOL124	17	39	44%
CHEM103	7	51	14%
CHEM110	21	87	24%
CHEM111	5	35	14%
MATH025	49	208	24%
MATH029	38	151	25%
MATH030	40	158	25%
MATH140	8	53	15%
MATH150	30	121	25%
<b>Total</b>	<b>226</b>	<b>974</b>	<b>23%</b>

**Table 8** White Students Study Group Participation Rates

Course	SG White Participants	Total White Students	Participation Rate
BIOL105	2	14	14%
BIOL124	5	14	36%
CHEM103	1	10	10%
CHEM110	10	26	38%
CHEM111	1	12	8%
MATH025	7	35	20%
MATH029	7	26	27%
MATH030	9	24	38%
MATH140	5	17	29%
MATH150	9	22	41%
<b>Total</b>	<b>56</b>	<b>200</b>	<b>28%</b>



**Table 9** Asian Students Study Group Participation Rates

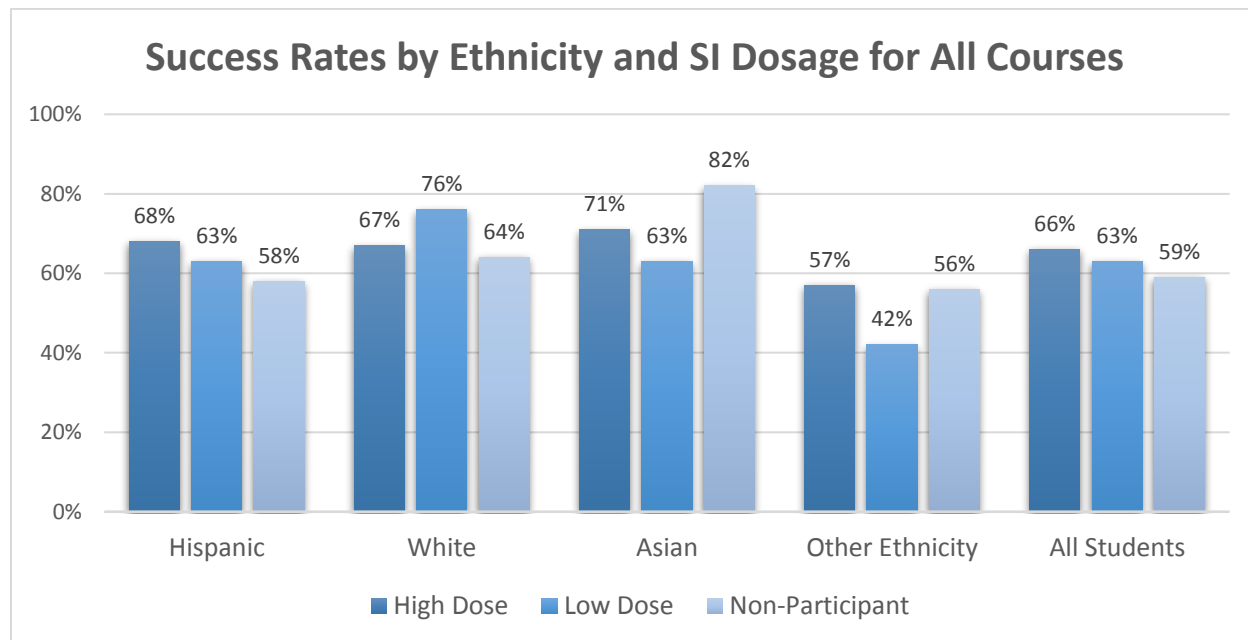
Course	SG Asian Participants	Total Asian Students	Participation Rate
BIOL105	4	19	21%
BIOL124	4	13	31%
CHEM103	1	7	14%
CHEM110	6	21	29%
CHEM111	2	17	12%
MATH025	1	8	13%
MATH029	2	9	22%
MATH030	3	11	27%
MATH140	0	4	0%
MATH150	3	12	25%
<b>Total</b>	<b>26</b>	<b>121</b>	<b>21%</b>

**Table 10** Other Ethnicity Students Study Group Participation Rates

Course	SG Other Ethnicity Participants	Total Other Ethnicity Students	Participation Rate
BIOL105	2	11	18%
BIOL124	1	3	33%
CHEM103	0	3	0%
CHEM110	0	7	0%
CHEM111	1	9	11%
MATH025	14	31	45%
MATH029	8	20	40%
MATH030	5	15	33%
MATH140	1	3	33%
MATH150	1	10	10%
<b>Total</b>	<b>33</b>	<b>112</b>	<b>29%</b>

When examining success rates across all courses by ethnicity, students who attended five or more Study Group sessions had higher success rates overall than those who attended fewer or did not attend at all. This pattern was only similar for Hispanic students.

The results of several chi-square tests revealed that the association between SG Participation Dosage and success was marginally statistically significant for Hispanic students,  $\chi^2(2, N=974) = 5.51$ ,  $p=.063$ .



**Figure 6**

\*Indicates statistically significant differences at  $p \leq .05$ . No significance was found at the .05 level.

When the data was disaggregated by course, no statistically significant differences were found between high dose, low dose, and non-participants. This is due in large part because the sample size for some of the groups were too small to run ANOVA or Post hoc analyses. The decision was made to collapse high and low dose participants into one category and use chi-square tests to examine whether the differences in success rates were significant between SG participants and Non-SG participants.

As evident by a chi-square analysis, Asian students in BIOL124 who participated in study groups had a significantly lower success rate than those who did not attend,  $\chi^2(1, N = 19) = 4.42$ ,  $p= .035$ . This result is counter to expectation but it is important to note that there were only 4 students in the SG-participant group. Similarly, White SG-participants in CHEM111 had a significantly lower success rate than White Non-SG participants,  $\chi^2(1, N=12) = 5.46$ ,  $p=.020$ . However, it is important to note there was only 1 student in the SG-participant group.

Lastly, Hispanic SG-participants in MATH140 had a significantly higher success rate than Hispanic Non-SG participants,  $\chi^2(1, N=53) = 6.18, p = .013$ . No other ethnicity differences at the course level were found.

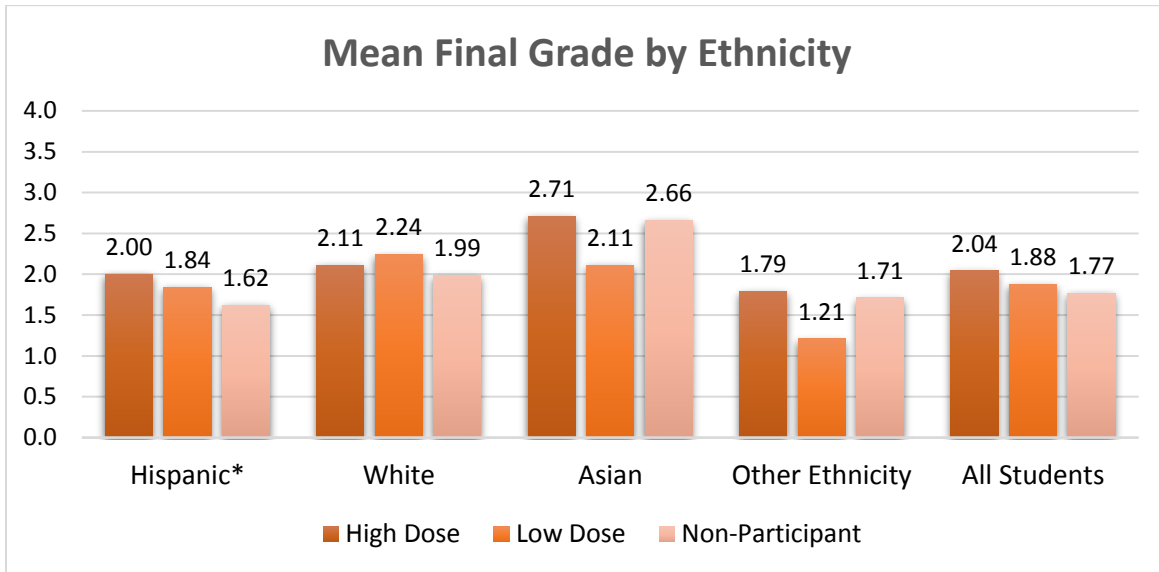


Figure 7

\*Indicates statistically significant differences at  $p \leq .05$

The results of several one-way ANOVA analyses (which measured success continuously using students' final course grade) revealed that the differences in mean final course grades shown above were only statistically significant for Hispanic students,  $F(2, N=974) = 3.56, p = .029$ .

Table 11 Summary of one-way ANOVA Ethnicity Results

Ethnicity	<i>df</i>	<i>N</i>	<i>F</i>	<i>p</i>
Hispanic*	2	974	3.56	.029
White	2	200	.461	.632
Asian	2	121	.825	.460
Other Ethnicity	2	112	1.60	.218
All Students	2	1,407	2.02	.133

\*Indicates significance at  $p \leq .05$

### SG's Influence on Course Success: Logistic Regression Analyses

To gain a better understanding of how Study Groups related to student success even when taking into account other extraneous variables not controlled for, a hierarchical logistic regression analysis was conducted. This analysis examined whether SG participation predicted higher course grades above and beyond other influential factors such as students' pre-existing GPA, gender, and ethnicity.

When looking at all courses, the analysis revealed that pre-existing GPA was a significant predictor. In particular, the odds ratio revealed that as students' GPA increased by a unit, the odds of success in the course increased by a factor of 2.7; in other words, students were more likely to be successful if their preexisting, overall GPA was high, regardless of their participation in Study Groups. This suggests that the greatest predictive variable of an individual student's success in a math and science course may be their preexisting GPA (i.e. students' cumulative GPA prior to taking the course).

**Table 12** Hierarchical Logistic Regression Examining Predictors of Overall Course Success

Variables	B	S.E.	Wald	p-value	Odds Ratio
<b>Step 1</b>					
<b>Pre-GPA*</b>	1.01	0.11	86.34	<b>0.000</b>	2.74
Gender (Female)	-0.04	0.15	0.07	0.793	0.96
Ethnicity (White)	0.02	0.20	0.01	0.924	1.02
Ethnicity (Asian)	0.47	0.26	3.33	0.068	1.60
Ethnicity (Other)	-0.14	0.27	0.28	0.597	0.87
<b>Step 2</b>					
SG (Low Dose)	0.07	0.20	0.13	0.717	1.07
SG (High Dose)	0.45	0.28	2.50	0.114	1.56

\*Indicates significance at  $p \leq .05$

Logistic regression analyses were also conducted for each course. The results are summarized below.

For **BIOL124** the analysis revealed that GPA was a significant predictor. In particular, the odds ratio revealed that as students GPA increased by a unit, the odds of success increase by a factor of 7.9.

Surprisingly, non-participation in Study Groups was also a significant predictor, above and beyond the effects of students' gender, ethnicity and GPA. Based on the results of the odds ratio, students that did not attend Study Groups were over 4 times more likely to succeed in BIOL124 compared to students who attended at least one session. However it is important to note that there were only 3 students who fell into the high dose group for BIOL124 so any implications should be made with caution considering the low sample size.

**Table 13** Hierarchical Logistic Regression Examining Predictors of BIOL124 Course Success

Variables	B	S.E.	Wald	p-value	Odds Ratio
<b>Step 1</b>					
<b>Pre-GPA*</b>	2.075	0.575	13.047	<b>0.000</b>	7.97
Gender (Female)	-0.008	0.511	0	0.987	0.99
Ethnicity (White)	19.986	11447.048	0	0.999	4.78E+08
Ethnicity (Asian)	-0.722	0.727	0.986	0.321	0.49
Ethnicity (Other)	-0.905	0.833	1.181	0.277	0.40
<b>Step 2</b>					
SG (High Dose)	2.173	1.785	1.482	0.224	8.79
<b>SG (Non-Participant)*</b>	1.538	0.771	3.977	<b>0.046</b>	4.65

\*Indicates significance at  $p \leq .05$

Additional logistic regression analyses revealed that preexisting GPA was a significant predictors of course success for all courses except BIOL125, CHEM111, and MATH030. In other words, students were more likely to be successful if their preexisting, overall GPA was high, regardless of whether they participated in Study Groups or not. Neither gender, ethnicity, nor SG participation were found to be significant predictors for any course.

### Interaction between SG Dose and GPA: Two-Way ANOVA

Is a student's final course grades influenced by the interaction between Study Group participation and pre-GPA (i.e. a student's cumulative GPA prior to taking the course)? For example, there could be a difference in course success for a B-student who participates in SG versus a C-student who participates in SG. There was interest in examining this question because perhaps for instance, Study Groups are more helpful for B-students than they are for C-students.

#### ***Two-Way ANOVA Results***

In an effort to see if certain students – “A” students vs “B” students vs “C” students, etc. – benefitted from Study Groups more than other students, a Two-Way ANOVA was conducted using final course grade (continuous) as the dependent variable and both Pre-GPA (categorical) and SG Dose (categorical) as independent variables. Students were categorized as “A”, “B”, “C”, “D”, or “F” students using their pre-GPA (i.e. their cumulative GPA prior to Fall 2017). Pre-GPA was converted into a categorical variable using the following scale: “A-student”=4.0-3.5, “B-student”=3.4-2.5, “C-student”=2.4-1.5, “D-student”=1.4-1.0, and “F-student”=0.9-0.0.

**Table 14** Summary of the original Two-Way ANOVA results

Variable	df	F	Sig.	Partial Eta Squared
Corrected Model	13	13.65	0.000	0.156
Pre-GPA*	4	18.69	<b>0.000</b>	0.072
SG Dose	2	0.61	0.542	0.001
Pre-GPA x SG Dose	7	0.28	0.961	0.002

\* Indicates statistically significant differences at  $p \leq .05$ .

The results of the Two-Way ANOVA yielded a significant main effect for Pre-GPA,  $F(4,973)=18.69$ ,  $p<.001$ , as the mean final course grade was significantly higher for “A-students” ( $M=2.66$ ) compared to “B-students” ( $M=2.09$ ), “C-students” ( $M=1.20$ ), “D-students” ( $M=1.50$ ), and “F-students” ( $M=0.36$ ).

In addition, the main effect for SG Dose was not significant,  $F(2,973)=0.61$ ,  $p=.542$ , indicating that we failed to reject the null hypothesis that the mean final course grade between High Dose, Low Dose, and non-Study Group participants are the same.

However, upon further insight, it appeared there were no “F-students” who fell into the High Dose category. Similarly, there was only two “D-student” who was in the High Dose group. Therefore, the decision was made to exclude the “D-students” and “F-students” and rerun the Two-Way ANOVA analysis.

**Table 15** Summary of the revised Two-Way ANOVA results

Variable	df	F	Sig.	Partial Eta Squared
Corrected Model	8	17.88	0.000	0.135
Pre-GPA*	2	28.41	<b>0.000</b>	0.058
SG Dose	2	0.95	0.386	0.002
Pre-GPA x SG Dose	4	0.13	0.974	0.001

\* Indicates statistically significant differences at  $p \leq .05$ .

The revised analysis once again showed that there was a significant main effect of Pre-GPA,  $F(2,928)=28.41, p<.001$ . However the main effect for SG Dose was still not significant,  $F(2, 928)=0.95, p=.386$ . Similarly, in both analyses, the results showed that the interaction between Pre-GPA and SG Dose was not significant,  $F(4, 928)=0.13, p=.974$ . The partial eta squared – a measure of effect size – in both analyses showed that Pre-GPA has a bigger effect on final course grade than students' participation in Study Groups.

### Conclusion

Students who attended Study Group sessions had higher success rates than students who did not, with the exception of students in BIOL124 and CHEM111. However, the results of several chi-square tests revealed there was not a statistically significant association between SG Participation and success when examining all courses combined or when disaggregating by each course. Similarly, the results of the one-way ANOVAs did not show support that students who attended Study Group sessions had significantly higher final course grades and were more likely to be successful than students who did not attend at all. A primary limitation of this data were the low group sizes, particularly for the High Dose and Low Dose categories.

The findings of the Logistic Regression and the Two-Way ANOVA examined whether Study Groups participation predicted student success even when taking into account other extraneous variables like students' gender, ethnicity, or cumulative GPA prior to the course (i.e. Pre-GPA). Results revealed the number of Study Group sessions attended did not significantly predict final course grade when controlling for other contributing factors. However, results indicated that a students' pre-existing GPA was a significant predictor of how well a student performed for all courses observed except BIOL125, CHEM111, and MATH030.