STEM Study Group
Effectiveness Report
Spring 2017

Introduction

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

Study Groups are one just 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.

In Spring 2017, Study Groups (SG) were offered for eight science and mathematics courses – BIOL105, BIOL124, BIOL200, CHEM103, CHEM110, MATH165, MATH190, and PHYS112 – for a total of 1,097 students. There were 215 students that attended at least one SG session and 882 that did not attend at all. Overall this yielded a 20% participation rate in Study Groups.

It is important to note that one MATH190 section, eight BIOL105 sections, and all three BIOL125 supported sections were excluded from the analysis because either the CRNs were not supported the whole semester or student did not attend. To this end, BIOL125 is not included in this report.

Table 1 Course Enrollment and SG Participation

Courses	# of SG Supported Sections	Enrollment	SG Participants Count	SG Participation Rate
BIOL105	20	460	44	10%
BIOL124	5	125	25	20%
BIOL200	4	119	50	42%
CHEM103	1	26	11	42%
CHEM110	6	127	42	33%
MATH165	2	125	22	18%
MATH190	3	94	18	19%
PHYS112	1	21	3	14%
Total	**42**	**1,097**	**215**	**20%**

Success Rates based on SG Participation

Chi-square analyses were conducted to examine if students who participated in study group sessions (SG) were more likely to be successful in the course compared to students who did not participate.

Success was operationalized as a dichotomous variable in which students earning a final course grade of A, B, or C were categorized as successful. Students earning a final course grade of D, F, FW, or W were categorized as unsuccessful.

Success Rates by Course and SG Participation
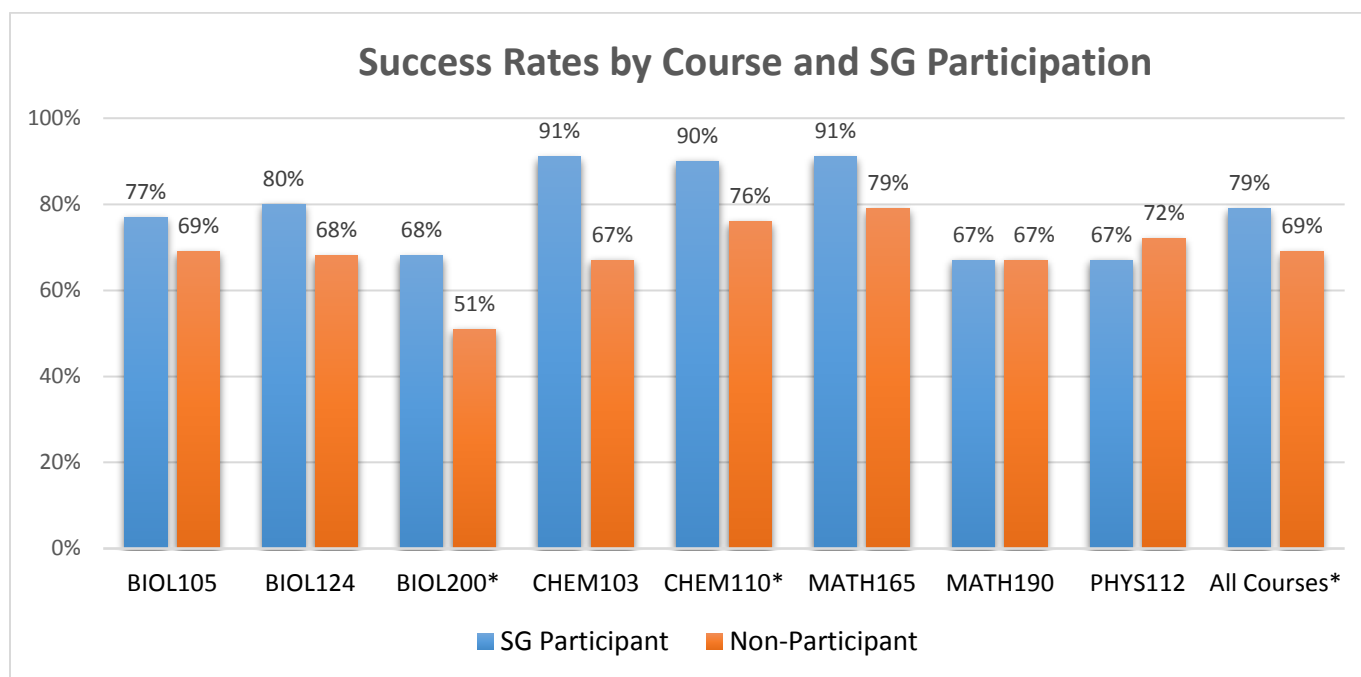
Figure 1
* Indicates statistically significant differences at $p \leq .05$.

With the exception of students in PHYS112 and MATH190, students who attended Supplemental Instruction sessions had higher success rates than students who did not. The results of a chi-square test revealed there was a statistically significant association between SG Participation and success when examining all courses combined. In other words, students who attended Study Groups were more likely to succeed than students who did not attend, $X^2(1, N=1,097) = 8.44, p=.004$.

When disaggregating by course, the association between SG Participation and success was only marginally significant for students in BIOL200, $X^2(1, N=119) = 3.55, p=.059$ and CHEM110, $X^2(1, N=127) = 3.60, p=.058$.

Success Rates Disaggregated by Dosage of SG Participation

To further compare differences among participant groups, SG 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-Participants. The success rates for all courses broken down by SG dosage are shown in the figure below.

Generally, students who attended fiver or more SG sessions (i.e. High Dose participants) had the highest course success rate, followed by students who attended 1-4 sessions. MATH190 and PHYS112 were exceptions to this pattern as Low Dose participants had the lowest success rate.

The results of a chi-square test revealed there was a statistically significant association between SG Dosage and success when examining all courses combined. It appears that in general, attending 5 or more sessions is related to higher course success, X^2(2, N=1,097) =13.20, p=.001. However, no significant differences were found when disaggregating at the course level.
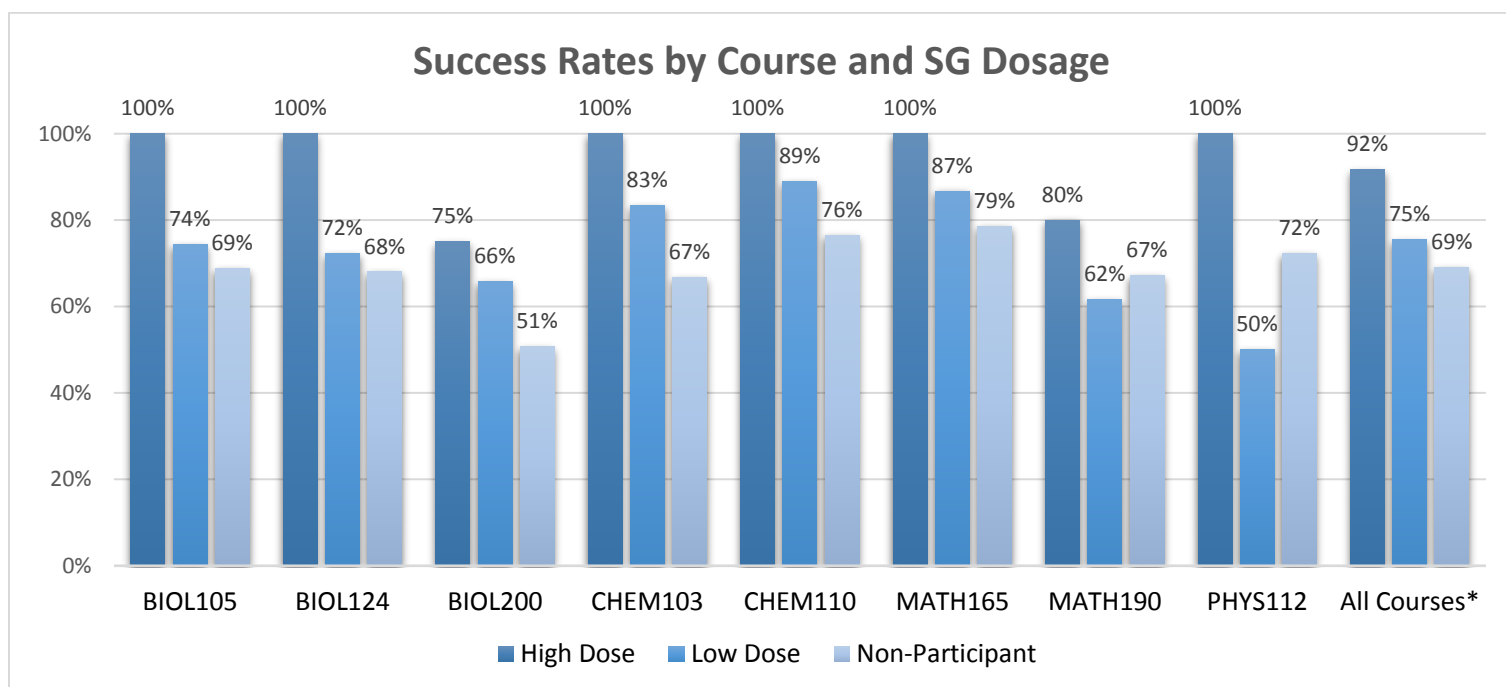
Figure 2
* Indicates statistically significant differences at $p \leq$.05.

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 there was a statistically significant difference between mean final grade for students in BIOL200, MATH165, and all courses combined.

Specifically, for **BIOL200** the only group difference that was significant was between High Dose students (*M*=2.67, *SD*=1.67) and Non-participants (*M*=1.54, *SD*=1.49).

For **MATH165**, the mean final grade differences were statistically significant between the High Dose group (M=3.71, SD=0.49) and Low Dose group (M=2.33, SD=1.11), as well as between the High Dose and Non-participants (M=2.27, SD=1.32).

A similar pattern was found for **all courses combined** in which the differences between the High Dose group (M=2.96, SD=1.11) and Low Dose group (M=2.27, SD=1.35), as well as between the High Dose and Non-participants (M=2.05, SD=1.41) were significant. No significant differences between high dose, low dose, and non-SG participants were found for students enrolled in the other six courses.
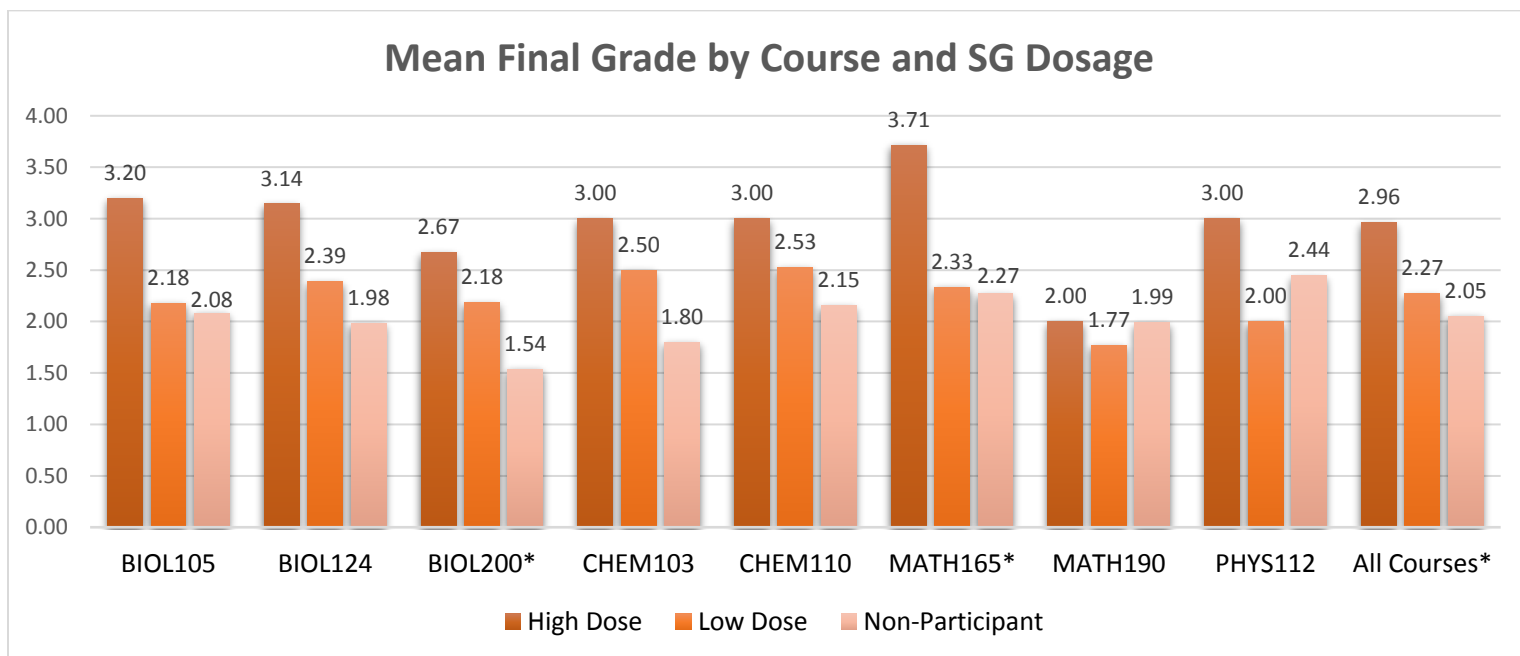

Figure 3
*Indicates statistically significant differences at $p \leq .05$

Table 2 Summary of one-way ANOVA Results

Course	df	N	F	p
BIOL105	2	460	1.66	.191
BIOL124	2	125	2.79	.066
BIOL200*	2	119	3.87	**.024**
CHEM103	2	26	1.86	.178
CHEM110	2	127	2.37	.098
MATH165*	2	125	4.22	**.017**
MATH190	2	94	.130	.878
PHYS112	2	21	.108	.899
All Courses*	2	1,097	15.48	**<.001**

*Indicates significance at $p \leq .05$

SG Participation and Success Rates by Gender

The tables and figures below show the breakdown of Study Group participation and success rates by gender and ethnicity. As shown in Table 3 and Table 4, female students participated in Study Groups at a higher rate than Male students overall.

Table 3 Female Study Group Participation Rates

Course	SG Female Participants	Total Females	Female SG Participation Rate
BIOL105	31	265	12%
BIOL124	16	77	21%
BIOL200	35	78	45%
CHEM103	9	18	50%
CHEM110	20	68	29%
MATH165	15	76	20%
MATH190	6	31	19%
PHYS112	2	13	15%
Total	134	626	21%

Table 4 Male Study Group Participation Rates

Course	SG Male Participants	Total Males	Male SG Participation Rate
BIOL105	13	184	7%
BIOL124	8	46	17%
BIOL200	15	38	39%
CHEM103	2	8	25%
CHEM110	19	55	35%
MATH165	7	49	14%
MATH190	12	62	19%
PHYS112	1	8	13%
Total	77	450	17%

Generally, both males and females who attended five or more Study Group sessions had higher success rates than those who attended fewer or did not attend at all. However, the results of chi-square tests revealed that there was a statistically significant association between SG Participation Dosage and success but only for females, $X^2 (2, N=626) = 10.87, p=.004$. It appears that for female students overall, attending 5 or more sessions is related to higher course success.
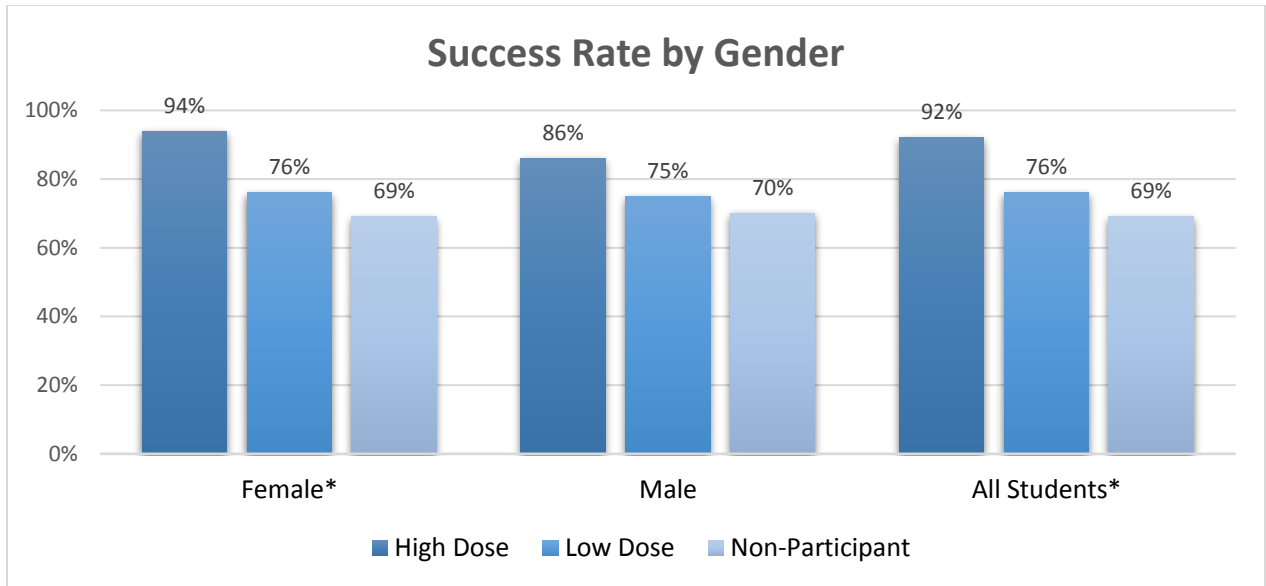
Figure 4
* Indicates statistically significant differences at $p \leq .05$.

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. Refer to Figure 5 and Table 3 on the next page for a summary of the results.

When measuring success continuously using students' final course grade, the one-way ANOVA analysis revealed the mean final grade difference was only statistically significant for females, $F(2, 626)=16.58$, $p<.001$. Particularly, post hoc analyses indicated that females who attended 5 or more Study Group sessions ($M=3.09$, $SD=1.01$) had a significantly higher mean final grade than female students who attended 1-4 sessions ($M=2.41$, $SD=1.35$) and those that did not attend at all ($M=2.05$, $SD=1.41$). Likewise, female students who attended 1-4 sessions had a significantly higher group mean final grades than females that did not attend.
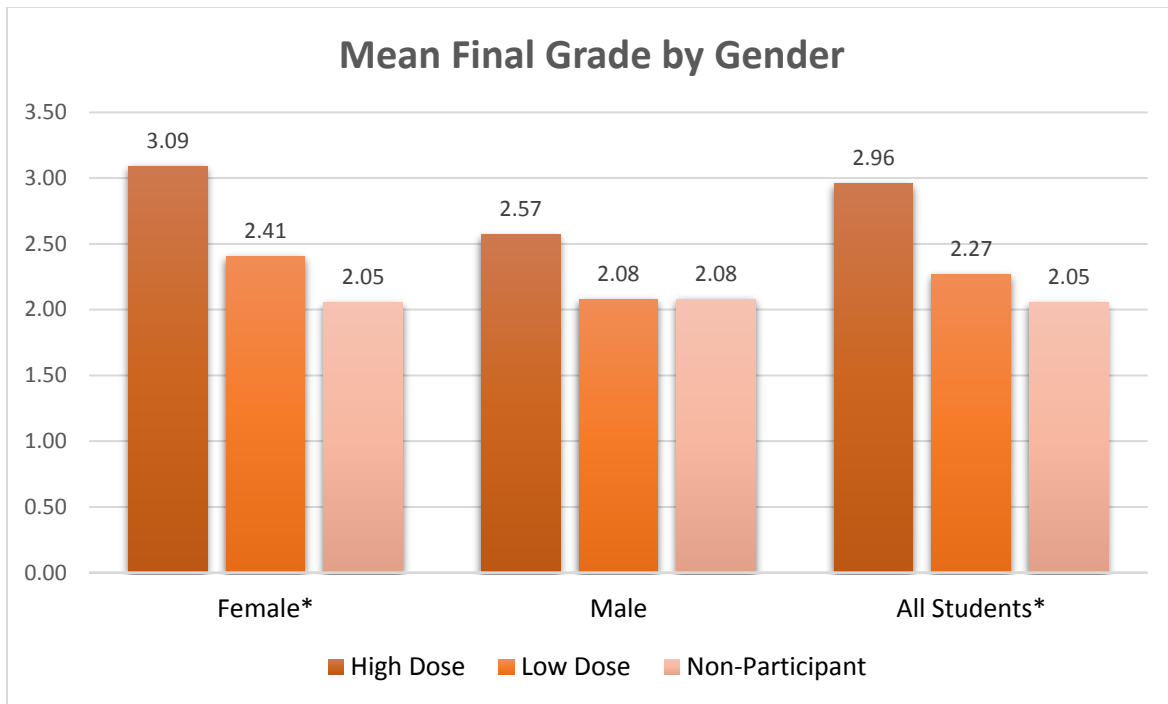
Mean Final Grade by Gender

Figure 5
* Indicates statistically significant differences at $p \leq .05$.

Table 5 Summary of one-way ANOVA Gender Results

Gender	df	N	F	p
Females*	2	626	16.58	**<.001**
Males	2	450	0.868	.421
All Students*	2	1,097	15.48	**<.001**

*Indicates significance at $p \leq .05$

SG Participation and Success Rates by Ethnicity

The tables and figures below show the breakdown of Study Group participation and success rates by gender and ethnicity. As shown in Tables 6-9, White students participated in Study Groups at the highest rate followed by Hispanic students, students of Other Ethnicity, and Asian students.

Table 6 Hispanic Students Study Group Participation Rates

Course	SG Hispanic Participants	Total Hispanic Students	Participation Rate
BIOL105	33	299	11%
BIOL124	16	77	21%
BIOL200	27	73	37%
CHEM103	7	15	47%
CHEM110	28	84	33%
MATH165	14	80	18%
MATH190	12	57	21%
PHYS112	3	9	33%
Total	**140**	**694**	**20%**

Table 7 White Students Study Group Participation Rates

Course	SG White Participants	Total White Students	Participation Rate
BIOL105	7	84	8%
BIOL124	6	19	32%
BIOL200	10	21	48%
CHEM103	2	6	33%
CHEM110	9	21	43%
MATH165	2	21	10%
MATH190	3	12	25%
PHYS112	0	3	0%
Total	**39**	**187**	**21%**

Table 8 Asian Students Study Group Participation Rates

Course	SG Asian Participants	Total Asian Students	Participation Rate
BIOL105	1	43	2%
BIOL124	3	23	13%
BIOL200	11	19	58%
CHEM103	1	3	33%
CHEM110	2	13	15%
MATH165	3	12	25%
MATH190	2	20	10%
PHYS112	0	7	0%
Total	23	140	16%

Table 9 Other Ethnicity Students Study Group Participation Rates

Course	SG Other Ethnicity Participants	Total Other Ethnicity Students	Participation Rate
BIOL105	3	34	9%
BIOL124	0	6	0%
BIOL200	2	6	33%
CHEM103	1	2	50%
CHEM110	3	9	33%
MATH165	3	12	25%
MATH190	1	5	20%
PHYS112	0	2	0%
Total	13	76	17%

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. Similarly, the success rates for High Dose Hispanic, White and Asian students were higher than their Low Dose and non-participating counterparts.

The results of several chi-square tests revealed that the association between SG Participation Dosage and success was only statistically significant for Hispanic students, $X^2(2, N=694) =10.76, p=.005$. It appears that for Hispanic students overall, attending 5 or more sessions is related to higher course success.

Success Rates by Ethnicity

Ethnicity	High Dose	Low Dose	Non-Participant
Hispanic*	91%	75%	66%
White	86%	81%	72%
Asian	100%	78%	76%
Other Ethnicity	100%	60%	71%
All Students*	92%	76%	69%
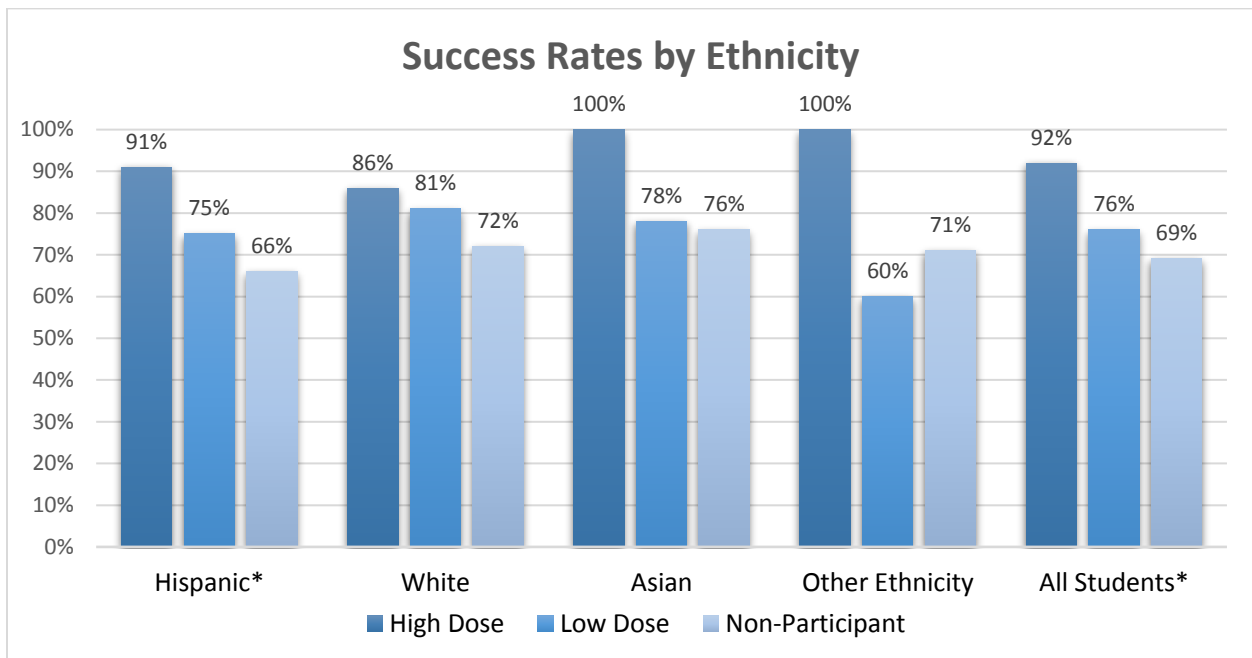
Figure 6
* Indicates statistically significant differences at $p \leq .05$.

A one-way ANOVA and post hoc analysis was conducted to determine whether mean final grade differences between high, low, and non-participating students were significant. Refer to Figure 7 and Table 4 on the next page for a summary of the results.

When measuring success continuously using students' final course grade, a one-way ANOVA analysis revealed the mean final grade difference was statistically significant for Hispanic students, $F(2, 694)=8.67, p<.001$ and students of Other Ethnicity, $F(2, 76)=3.86, p=.026$.

Particularly, post hoc analyses indicated that High Dose Hispanic ($M=2.82, SD=1.13$) had a significantly higher mean final grade than Low Dose Hispanic students ($M=2.15, SD=1.28$) and those that did not attend at all ($M=1.89, SD=1.35$).

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For students of Other Ethnicity, post hoc analyses indicated that those in the High Dose group (*M*=3.67, *SD*=0.58) had a significantly higher mean final grade than those in the Low Dose group (*M*=1.30, *SD*=0.95).
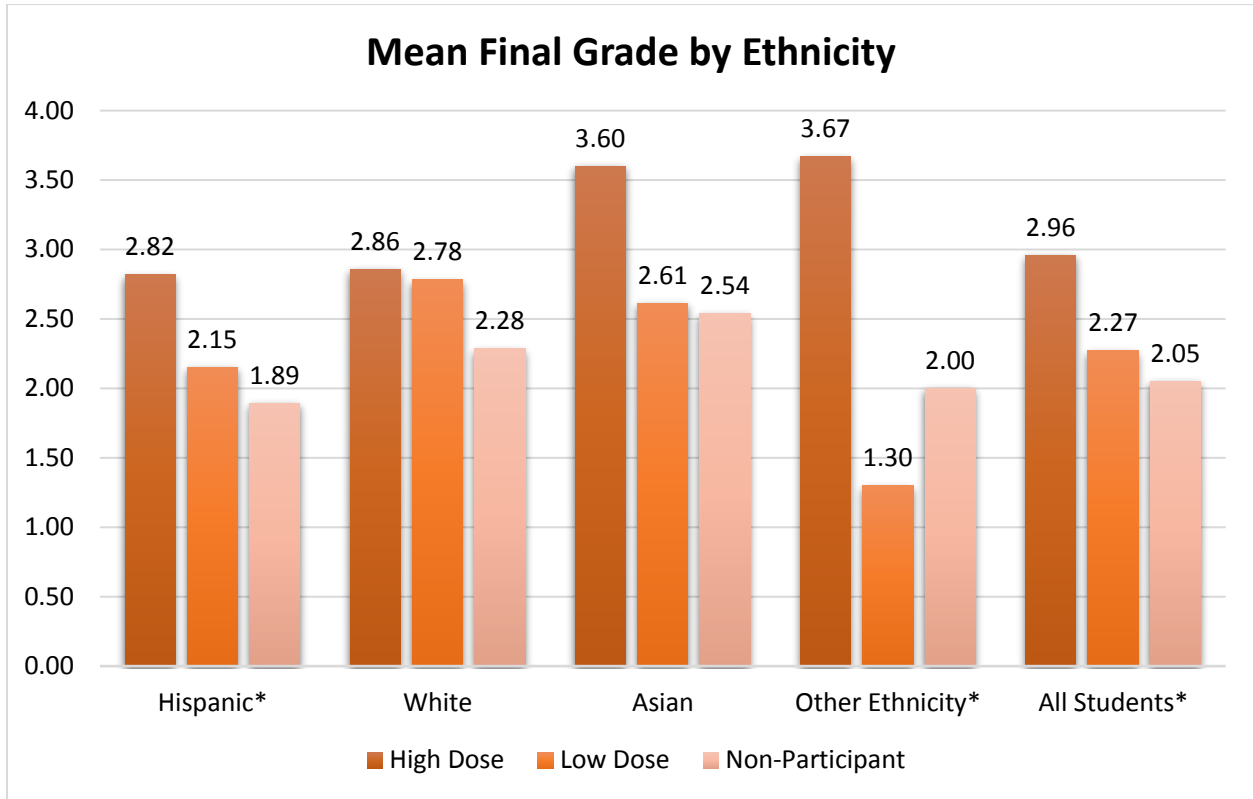
Mean Final Grade by Ethnicity

Figure 7
* Indicates statistically significant differences at *p* ≤.05.

Table 10 Summary of one-way ANOVA Ethnicity Results

Ethnicity	*df*	*N*	*F*	*p*
Hispanic*	2	694	8.67	**<.001**
White	2	187	1.92	.150
Asian	2	140	1.26	.287
Other Ethnicity*	2	76	3.86	**.026**
All Students*	2	1,097	15.48	**<.001**

*Indicates significance at p ≤.05

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Study Groups 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 employed. This analysis examines 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 4.7; 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 preexisting GPA may be a strong predictive variable of a student's success in a math or science course.

Most importantly, increased visits to Study Groups positively predicted student success, even when taking into account the effects of pre-existing GPA, gender, and ethnicity. The odds ratio showed that high dose students that attended 5 or more SG sessions were over 3 times (3.08) more likely to succeed in their given math or science course compared to students who did not attend SG at all.

Table 11 Hierarchical Logistic Regression Examining Predictors of Overall Course Success

Variables	B	S.E.	Wald	p-value	Odds Ratio
Step 1					
Pre-GPA*	1.547	0.131	140.271	**<0.001**	4.70
Gender (Female)	0.139	0.155	0.803	0.370	1.15
Ethnicity (White)	-0.105	0.213	0.243	0.622	0.90
Ethnicity (Asian)	0.106	0.249	0.181	0.670	1.11
Ethnicity (Other)	0.214	0.299	0.513	0.474	1.24
Step 2					
SG (Low Dose)	0.056	0.214	0.07	0.792	1.06
SG (High Dose)*	1.124	0.549	4.197	**0.041**	3.08

*Indicates significance at p ≤.05

At the course level, pre-existing GPA was found to be a significant predictor of success for all courses except CHEM103 and PHYS112. The lack of any significance found in these two courses may partly be explained by the low sample size of these courses. The rule of thumb in terms of suggested sample sizes for logistic regressions have ranged as low as a minimum of 10 observations for every predictor in the model[1] to as high as 30 observations for every predictor[2]. In this case that would mean a sample size of at least 40-120 students in each course. The total sample size count for CHEM103 and PHYS112 were 26 and 21 students respectively, falling below the suggest sample size range. This could possibly explain the lack of any significant predictors.

Even though SG participation was found to be significant when examining all courses together, it was not a significant predictor of success when disaggregating at the course level.

Exam Review Study Group Participants

Overall, 118 out of the 215 students who attended Study Groups participated in at least one exam review session, yielding a 55% exam review participation rate. The percentage of SG participants attending at least one SG session varied widely across the nine science and math courses. The lowest exam review participation rate was 23% for BIOL105; the highest was 91% for MATH165. Course success rates for students who attended exam review sessions are shown in the figure below.

Table 12 Exam Review Participation Rate

Course	Exam Review Participants	SG Participants	Exam Review Participation Rate
BIOL105	10	44	23%
BIOL124	22	25	88%
BIOL200	14	50	28%
CHEM103	8	11	73%
CHEM110	29	42	69%
MATH165	20	22	91%
MATH190	13	18	72%
PHYS112	2	3	67%
Total	118	215	55%
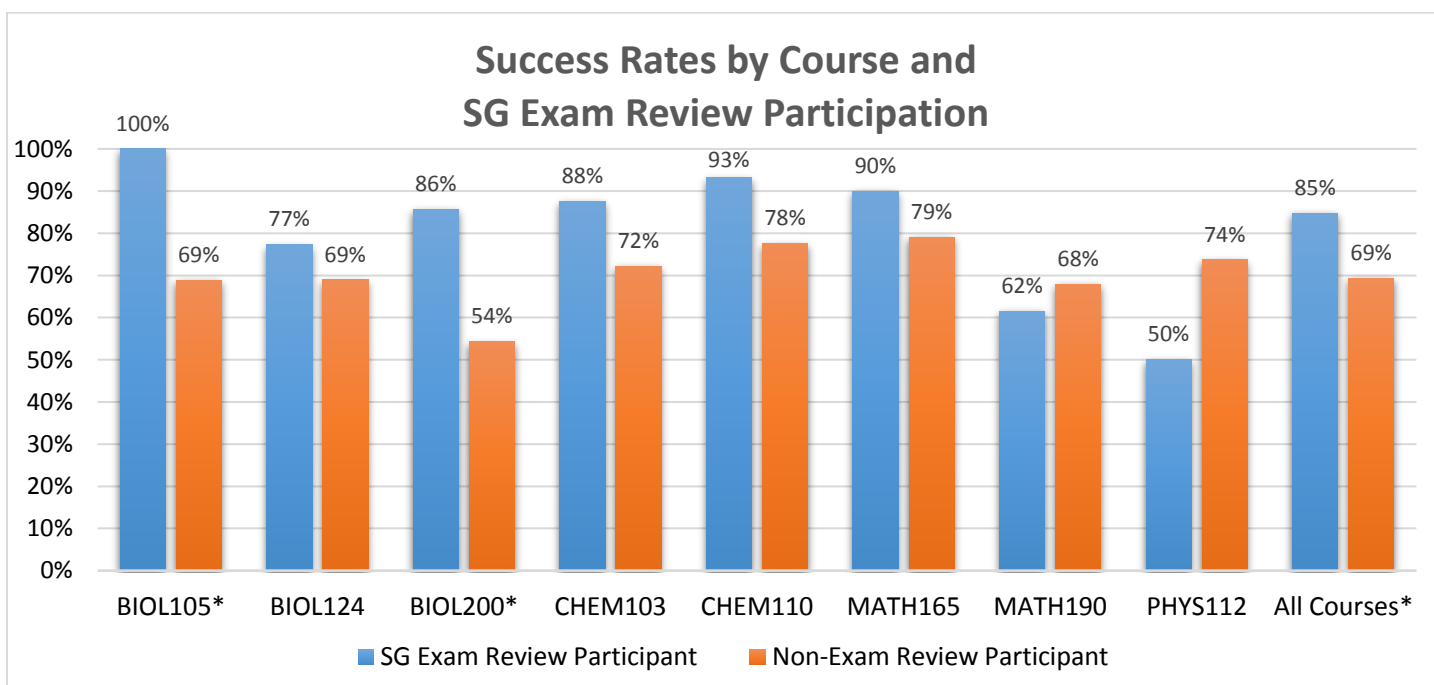
Figure 8
* Indicates statistically significant differences at $p \leq .05$.

With the exception of students in MATH190 and PHYS112, students who attended Study Group sessions had higher success rates than students who did not. The results of chi-square tests revealed the association between exam review participation and success was statistically significant when all courses were combined, $X^2(1, N=1,097) =12.12, p=.001$. In other words, students who attended Study Group sessions for Exam Review were more likely to succeed in the course than students who did not attend an Exam Review session.

At the course level, the association between Exam Review Participation and success was significant only for students in BIOL105 $X^2(1, N=460) =4.47, p=.034$ and students in BIOL200 $X^2(1,N=119)=5.01, p=.025$.

Given that there were only a total of three students who attended 5 or more Exam Review sessions, the decision was made not to analyze Exam Review Participation in terms of dosage (i.e. High Dose, Low Dose, Non-Participants).

Additional Analyses

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, additional analyses were conducted. Students were categorized as "A", "B", "C", "D", or "F" students using their pre-GPA (i.e. their cumulative GPA prior to Spring 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.

Two-Way ANOVA Analysis

Is a student's final course grades influenced by the interaction between SG participation and pre-GPA? For example, there could be a difference in course success for a B-student who participates in SI versus a C-student who participates in SG. We were interested examining this question because perhaps for instance, Study Groups are more helpful for B-students than they are for C-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.

Table 13 Summary of the original Two-Way ANOVA results

Variable	df	F	Sig.	Partial Eta Squared
Corrected Model	12	41.49	0.000	0.315
Intercept	1	138.58	0.000	0.113
Pre-GPA Grouped*	4	33.78	0.000	0.111
SG Dose	2	1.99	0.138	0.004
Pre-GPA Grouped * SG Dose	6	0.50	0.808	0.003

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

The results of the Two-Way ANOVA yielded a significant main effect for Pre-GPA Grouped, $F(4,1096)=33.78$, $p<.001$, as the mean final course grade was significantly higher for "A"-students ($M=3.53$) compared to "B"-students ($M=2.37$), "C"-students ($M=1.42$), "D"-students ($M=0.64$), and "F"-students ($M=0.06$).

In addition, the main effect for SG Dose was not significant, $F(2,1096)=1.99$, $p=.138$, 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 "D" or "F" students who fell into the High Dose category. Therefore, the decision was made to exclude the "D" and "F" students and rerun the Two-Way ANOVA analysis.

Table 14 Summary of the revised Two-Way ANOVA results

Variable	df	F	Sig.	Partial Eta Squared
Corrected Model	8	48.82	0.000	0.273
Intercept	1	960.86	0.000	0.480
Pre-GPA Grouped*	2	52.61	**0.000**	0.092
SG Dose	2	2.97	0.052	0.006
Pre-GPA Grouped * SG Dose	4	0.70	0.590	0.003

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

The revised analysis once again showed that there was a significant main effect of Pre-GPA Grouped, $F(2,1096)=52.61$, $p<.001$. There was also a marginally significant main effect of SG Dose, $F(2,1096)=2.97$, $p=.052$, as students in the High Dose group ($M=2.72$) had higher means than their Low Dose ($M=2.36$) and non-participant ($M=2.24$) counterparts. However in both analyses, the results showed that the interaction between Pre-GPA and SG Dose was not significant, $F(4,1096)=0.70$, $p=.590$.

Even though both the main effect of Pre-GPA Grouped and SG Dose were significant, the partial eta squared – which is 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

The findings of the Logistic Regression and the Two-Way ANOVA reveal the importance of examining several factors simultaneously rather than individually. The results of the chi-square and one-way ANOVAs showed support that students who attended Study Groups had significantly higher final course grades and were more likely to be successful than students who did not attend at

all. Looking at these analyses alone, one might conclude that SG Participation is driving course success. However, when examining SG participation and other possible contributing factors like students' gender, ethnicity, or cumulative GPA prior to the course (i.e. Pre-GPA), it appeared that in this dataset, Pre-GPA was the strongest contributor to course success.

References

[1]Hosmer, D., Lemeshow, S., & Sturdivant, R. (2013). Applied logistic regression (3rd ed). Hoboken, NJ: John Wiley & Sons.

[2]LeBlanc, M. & Fitzgerald, S. (2000). Research design and methodology section: Logistic regression for school psychologists. School Psychology Quarterly, 15(3), 344-358.