

BIOLOGY STUDENT PARTICIPATION AND REVIEW SESSIONS: IMPROVING SUCCESS IN FRESHMAN BIOLOGY

Neal R. Adam, Grand Canyon University
Galyna Kufryk, Grand Canyon University
Joyita P. Mekondo, Shift 4 Payments LLC*

ABSTRACT

This two-year investigation examined the relationship between class attendance, participation, and final class grade (Final GPA) in an Introductory Biology course for prehealth majors. We also examined the effect of students' attendance at voluntary review sessions on final GPA. Student participation and attendance, as well as DFW rates (percent of students earning D or F or withdrawing), for the four semesters were analyzed as indicators of student dedication. An analysis of DFW rates and attendance indicated that Fall semester students had greater participation in review sessions than Spring semester students. In addition, a significant correlation was found between the number of review sessions attended and the student's final grade. Student data were divided into four groups based on their success in the first exam and their attendance at review sessions to assess the effect of review sessions. The results showed that review sessions were beneficial for students who did well on their first exam as well as for students who did not do well on their first exam. We interpret these data as a positive effect of self-motivated student engagement outside the classroom on academic performance in freshman Biology.

Keywords: Biology; extracurricular; participation; engagement; student success strategy

INTRODUCTION

The transition from high school to college can be difficult for some students. Their past characteristics and behaviors that were once successful in high school might prove less fruitful on the collegiate level (Jensen & Moore, 2008; Moore, 2007a). This is especially true for students with majors in science, technology, engineering, and mathematics (STEM) fields that are known for their traditionally low graduation rates (Schneider et al., 2015). Introductory science courses, specifically, often have high failure rates (Congoset al., 1997; Freeman et al., 2007; Jensen & Moore, 2008b; Moore & LeDee, 2006). This reality often comes as a shock to students who believe, overconfidently, that they will earn higher grades and pass their

course (Jensen & Moore, 2008b). Instructors often attempt to overcome these preconceptions and motivate students to carry out behaviors that will ensure their success in class. These behaviors include class attendance and participation, as well as taking advantage of extra assistance provided by the instructor.

Extra assistance offered by instructors may include extra credit work or extracurricular review sessions to ensure that students master concepts, remain engaged, and ultimately pass their courses. However, students' subsequent behaviors towards these tactics are often puzzling to instructors (Jensen & Moore, 2008b). Students who most need the extra help seem less likely to take advantage of the assistance. Understanding student motivation

*Authors listed alphabetically by last name as each author contributed equally to this manuscript

and participation patterns and their relationship to review session attendance is important so that instructors can plan class strategies. Therefore, the purpose of this research was to:

- Assess the motivation and dedication of students using class attendance/participation and review session attendance as indicators,
- Analyze the type of student who attends review sessions, and
- Examine the benefit of the review sessions.

Student Engagement and Motivation

Before students consider review sessions, they need to be motivated or engaged enough in the classroom or subject matter to attend their classes. Numerous articles have addressed the importance of classroom attendance, engagement, and motivation on academic performance (see Chen & Lin, 2008; Freeman et al., 2007; Golding, 2011; Lysne et al., 2013; Moore, 2007a, 2007b, Partin et al., 2011; Reeve & Lee, 2014; Schneider et al., 2015; Soto & Anand, 2009; Sturm-Beiss, 2013; Taylor III, 2012; Westerman et al., 2011). Various approaches have been used. For example, Lysne et al. (2013) used semistructured student interviews to examine strategies to explore how to increase student engagement in an introductory biology course. The authors defined engagement as the energy, time, and resources needed for learning. A qualitative case study methodology for the research showed that learners engaged in their biology courses when labs or experiments were the standard modes of instructional delivery. Students also felt that traditional classrooms were too disconnected from scientific fieldwork, although the participants noted the obvious difficulties with organizing camps or outings to facilitate engagement (Lysne et al., 2013). However, the sample size was small, and the methodology and conclusions may not apply to larger classes.

Partin et al. (2011) considered the interaction of student motivation, engagement, and course performance in a biology course for nonmajors. The authors measured variables such as attitude, extrinsic motivation, intrinsic motivation, test anxiety, task value, self-efficacy (a person's belief in their ability to complete a difficult task), and the ability to control learning beliefs against students' final grade outcomes. The results showed that

self-efficacy, test anxiety, and attitudes towards mathematics were most significant in predicting course performance. With regards to predicting self-efficacy, the significant predictors of students' performance were intrinsic goal orientation, extrinsic goal orientation, task value, control of learning beliefs, test anxiety, and biology attitudes (Partin et al., 2011).

Students who attend class and participate in additional performance tasks generally receive better grades than their nonattending counterparts (Chen & Lin, 2008; Golding, 2011; Moore, 2005, 2007a, 2007b, 2008; Soto & Anand, 2009; Taylor III, 2012; Westerman et al., 2011). However, overall class attendance appears to be a problem despite studies that confirm a positive correlation among the variables of attendance, classroom engagement, and performance. Reeve and Lee (2014) showed that students' engagement was positively correlated with motivation; participation and class attendance may also be indicators of motivation.

Other factors affecting student engagement, and therefore success, include variation in student populations across time (i.e., semesters). Observations of student attitudes, and their tendency to participate in class, indicate that these characteristics are affected by time and course. Darby et al. (2013) examined students' motivation in an academic-learning course and found differences based on semester and gender. Female students had higher motivation levels that decreased midsemester, while male students' motivation levels peaked at this time. Soto and Anand (2009) examined the factors influencing academic performance in Cell Biology courses, one in Spring 2004, the other in Spring 2005. Pass rates for the two classes, as well as most other variables, were similar.

A study at Blinn College (Blinn College, 1994) analyzed Fall and Spring semesters for one school year, but the courses were sequential; those who passed the first course would take the second course in the Spring semester. The DFW rates (earned D or F in the class or withdrew) were higher in the Fall semester than the Spring semester. However, the literature is lacking on the effect of Fall or Spring semester on the same course. Our observations on student attitudes, and their tendency to participate in class, indicate that these characteristics were not

as conducive to success in the Spring semesters. Indeed, data from the previous school year (2012/2013) indicate a greater DFW rate in the Spring semester (52%) as compared to the Fall semester (19%), which may be an indicator of reduced student motivation and dedication in the Spring. Understanding student motivation and how student populations vary from semester to semester are important in planning strategies to assist in student motivation and, ultimately, student success.

Review Sessions

Efforts by instructors to encourage student participation and success are often supplemented by offering review sessions to improve student performance. However, review sessions pose an interesting hurdle for instructors because they are often voluntary and are assessed few or no grade points. Although many students show preliminary interest in attending review sessions or doing extra credit work, several studies at large institutions have shown that students often behave in ways that undermine their academic interests (Jensen & Moore, 2008b, 2009; Lysne et al., 2013) since most students rarely attend study sessions and many fail to complete additional assignments to bolster their grades (Moore, 2005, 2007b, 2008). This reality is especially true for low-performing or failing students, who need the most assistance (Jensen & Moore, 2008b, 2009; Moore, 2005, 2007a, 2008).

Several studies have shown that review sessions often have a positive impact on student grades irrespective of the subject matter. In a study involving 303 first year biology students, Jensen and Moore (2009) examined the impact of voluntary review sessions on course performance. All students had the option of attending three review sessions held before course exams. Students earning A and B grades comprised 73% of the attendees of the first review session that was held before any grade feedback was provided. Overall, students who attended one review session had better exam scores than students who never attended any, but their scores were not better than those who attended two sessions. Therefore, the authors posited that attendance at help sessions was “a characteristic of, but not a cause, of being a good student” (Jensen & Moore, 2009, p. 63). A study by Moore (2008) also supported these findings: Students with the best grades and overall

class attendance were more likely to attend review sessions than their failing counterparts.

The use and success of review sessions extend outside of introductory science courses. Barry et al. (2015) examined the impact that review sessions had on student performance in a pharmacology class. To reinforce course lectures and facilitate more in-depth learning, review sessions were held for 89 students in various disciplines such as biochemistry, physiology, medicine, and chemistry. The results showed that review sessions were highly attended with participation rates greater than 75%. Specifically, there were significant increases in exam scores for all the topics reviewed during the sessions (Barry et al., 2015).

Parente et al. (2005) studied the effectiveness of review sessions in a capstone business course. They used two different models to assess the benefits of study sessions provided for a Strategic Management course. The first model (A) involved review sessions that took place prior to a course exam, while model (B) held these reviews after the first exam. The results showed that both models were effective in increasing overall student pass rates but model (A) significantly increased the first-time pass rates for most students. An earlier start was more beneficial for the students.

Finally, Sturm-Beiss (2013) considered the efficacy of review sessions in a precalculus course. Using online exam-review sessions easily accessible by YouTube, the results showed that both high- and low-performing students who viewed all the videos had higher test scores than other students. The sessions were given before the course's second exam. Further, the study found that both low- and high-performing students utilized the review sessions in equal measures, bypassing the issues experienced by Jensen and Moore (2008b, 2009) and Moore (2005, 2007a, 2008), where low-performing students failed to do additional coursework or attend voluntary review sessions.

Review sessions often positively affect a student's grade in biology (Jensen & Moore, 2009; Moore, 2008), chemistry (King, 2010), and mathematics courses (Sturm-Beiss, 2013). Further, these findings are not specific to science or mathematics courses. Students who attended review sessions in pharmacology (Barry et al., 2005) and business (Parente et al., 2005) earned

higher final grades than their nonattending counterparts. Attendance in review sessions is often related to attendance in the classroom. Students who attend class and are fully engaged in learning seem more likely to attend review sessions to ensure they master key concepts and earn final good grades. Though most researchers have found that review sessions are attended by high-achieving students (see Jensen and Moore, 2009), others, such as Sturm-Beiss (2013), showed similar numbers of achieving and struggling students. In our study, we explored the relationship of class participation and attendance to student success, and the relationship of review session attendance and student success, in a majors-level Introductory Biology course at a rapidly growing university. We also assessed the perceived differences in Fall and Spring performance by students over a period of two years (i.e., four semesters).

HYPOTHESES

We tested the hypotheses that:

1. A significant correlation exists between class participation and final grade. $H_0: \rho_{\text{GPA}^*\text{Part}}=0$.
2. A significant participation difference exists between Fall and Spring semesters. $H_0: \text{Total Participation}_{\text{Fall}} = \text{Total Participation}_{\text{Spring}}$ for each school year.
3. There is a significant correlation between final grade and the number of review sessions attended. $H_0: \rho_{\text{GPA}^*\text{ATT}}=0$.
4. The final grade (Final GPA) of students will be different depending on beginning biology strength as well as review session attendance. $H_0: \text{GPA}_{\text{TRT1}} = \text{GPA}_{\text{TRT2}} = \text{GPA}_{\text{TRT3}} = \text{GPA}_{\text{TRT4}}$.
5. Among students who did well on the first exam, those who attended review sessions will have a different Final GPA than those who did not. $H_0: \text{GPA}_{\text{TRT1}} = \text{GPA}_{\text{TRT2}}$.
6. Among students who did not do well on the first exam, those who attended review sessions will have different Final GPA than those who did not. $H_0: \text{GPA}_{\text{TRT3}} = \text{GPA}_{\text{TRT4}}$.

MATERIALS AND METHODS

Two college professors conducted review sessions in the 2013-2014 and the 2014-2015 school years to provide interested Introductory

Biology students in prehealth programs with an opportunity to master concepts and ask questions. Review sessions were held at least once per week during the semester, such that two or more review sessions were conducted by one of the professors for each of the sectional exams. Review sessions were announced multiple times and were placed in the calendar in the Learning Management System (LMS). Students doing poorly were additionally encouraged to attend through either the LMS, individual contact, or their student advisor. Attendance at the review sessions was voluntary, and sign-in sheets were used to log the students who attended. Review sessions were informal, and students were quizzed verbally and allowed to ask questions. Students that attended the review sessions who were not in the classes of those two professors were removed from the analysis. Students who withdrew from the class and did not have a Final GPA value were removed from any analysis that included the Final GPA.

To understand the differences in student populations in Fall versus Spring semesters, the percentages of students attending the review sessions were calculated for each semester. Grades for participation and for the major exams were retrieved from the database. Participation grades were an indicator of class attendance and could also be used to compare the semesters. Because the final grade shown in the database was in letter form, those grades were converted to their corresponding GPA values.

Treatments were defined to determine the effect of the review sessions. It was desirable to compare the grades of students who attended the review sessions to grades of students who did not. However, it was obvious that some students began the course with a strong high school biology background, while other students did not have that advantage. The students were therefore divided into four treatments: (1) students who scored 80% or above on the first exam and attended at least one review session; (2) students who scored 80% or above on the first exam and did not attend the sessions; (3) students who scored below 80% on the first exam and attended review sessions; and (4) students who scored below 80% on the first exam and did not attend review sessions.

Due to a lack of normality of data and to

the heterogeneity of variances, the Kruskal-Wallis H nonparametric test was used to assess differences in Final GPA among the four assigned groups. Specific preplanned, pairwise differences among treatments were assessed using post hoc tests according to Keselman, Games, & Rogan (1979). Preplanned comparisons included review attendance versus nonattendance for each of the two initial exam performance groups. A Kruskal-Wallis H nonparametric test was also used to test for differences in participation scores between the semesters. A significance level $\alpha = 0.05$ was assumed for all analyses.

RESULTS

Student engagement and motivation

A significant correlation between total participation points and Final GPA across semesters was found ($r = 0.395, p < 0.001, n = 605$), and this indicates the importance of attendance and participation in student success. Observations have hinted at a greater dedication among Fall students as compared to Spring students. For both school years there is a lower DFW rate in the Fall semester, and there were greater average participation points among Fall students as compared to Spring students within each school year (see Table 1). This was also true for the previous academic year (2012-2013) under an eight-week course format and while BIO 181 was still a nursing school prerequisite (Fall 19% DFW and Spring 52% DFW). A Kruskal-Wallis analysis of the two years beginning in Fall 2013 showed that the mean ranks among the four semesters for Total Participation were significantly different ($\chi^2(3) = 259.1, p < 0.001$) and that Fall 2013 had significantly higher mean rank than Spring 2014 ($\chi^2(1) = 7.726, p = 0.005$; see Table 2). Fall 2014 Participation mean rank was also significantly higher than the Spring 2015 mean rank ($\chi^2(1) = 32.624, p < 0.001$; see Table 3).

Review Sessions

Review session attendance did not as clearly reflect this pattern. A much greater number and percentage (47%) of students attended the review sessions in Fall 2014 compared to the other semesters considered (Table 1). However, the other three semesters were similar at 24%–29%. Among those students who attended the review sessions at least once, there was a significant correlation

($r = 0.29311, p < 0.001, n = 229$) between number of attendances and Final GPA. Some students attended as many as 12 review sessions.

For all the semesters considered, of those students who scored 80% or greater on the first exam, 89.2% earned 3.0 or greater as a Final GPA for the class whether or not they attended a review session. Consideration of the four treatments specified reveals that, among those who scored high on the first test and attended the review sessions, 96.6% also had a Final GPA of at least 3.0. For those who scored high on the first exam but did not attend the review sessions, 81% earned a Final GPA of at least 3.0. For those students who did not score 80% or greater on the first exam, 25.7% attained a Final GPA of at least 3.0 if they attended the review sessions. If they did not attend, only 13.7% finished the class with a Final GPA of at least 3.0.

The Kruskal-Wallis H nonparametric mean rank test of Final GPA showed that there was a significant difference between the assigned groups/treatments ($\chi^2(3) = 333.2, p < 0.001$) with mean ranks as presented in Table 4. Preplanned comparisons were significant as well (Table 5). Among those who did well on the first exam, those who attended the review sessions had a higher mean rank Final GPA than those who did not attend the review sessions ($p < 0.001$). Likewise, among those who did not do well on the first exam, those who attended the review sessions also had a higher mean rank Final GPA than those who did not attend ($p < 0.001$).

DISCUSSION

Student involvement

The importance of student participation and active involvement in their education has been demonstrated in this research as well as other research. We showed that class attendance, i.e., participation grade, was higher for students who were successful in the class. Soto and Anand (2009) also found that students with nearly perfect attendance in class often passed a Cell Biology course at rates significantly higher than all other attendees. Though attendance and Final GPA are not mutually exclusive in that there were points awarded for attendance/participation, these were a small percentage of the overall grade. Also, although not all students who regularly attend class actively participate, there is at least a greater

effort demonstrated than for those who do not attend class.

It is clear, however, from informal verbal surveys, that many who attend class do not do the assigned reading. The correlation between the amount of study time outside the classroom and student performance is well known. Jensen and Moore (2008a) found out that freshman biology college students often received lower grades, compared to their high school biology grades, and that half of the students only studied one or even fewer hours per day. Therefore, though it is clear that attendance is beneficial, the combination of attendance and participation with outside study time would be even more beneficial. This troublesome statistic should be addressed to improve student performance.

We also showed that participation grades were significantly higher for Fall semester students than for Spring semester students over the two years of the study. This agrees with the pattern of %DFW for those two years; in the Fall semester %DFW values are lower than the Spring values. It is also consistent with the pattern for the previous year (2012-2013). In that school year, courses were eight weeks long instead of semester-long courses, and prenursing students were required to take this course. For the Fall/Spring pattern to remain consistent across these three years, given the rapid growth, the change in course format, and the presence of prenursing students, this indicates that it is an important phenomenon to consider in analyzing student success. Analysis of the student demographics of the two semesters may provide guidance in this area. They could indicate that different strategies for motivation are necessary in the two semesters.

Starting early

Students who start well tend to finish well. We found that, of the students who scored high on the first exam, 89.2% earned a final grade of 3.0 or higher in our course. Several reasons may explain this phenomenon. First, these students may come into college with stronger biology backgrounds than their peers from less academically rigorous programs. Second, these students may already possess the skill sets, engagement, and motivation necessary to be successful in a collegiate environment.

More importantly, according to Reeve and Lee

(2014), students' initial or early engagement in class often influenced whether they remained motivated throughout its duration or tenure. Students who do not already possess the previously mentioned skill sets or motivation will struggle from the start and would be more likely to fail, unless the necessary motivation can be stimulated. The relationship between early success and Final GPA shown in this research, by Parente et al. (2005), and others indicates that the motivation should come early. The difficulties that instructors face in their classrooms, such as getting students excited about learning, requires thinking about more than delivery modalities. It requires an early start.

Review Sessions

Our findings on voluntary review sessions for undergraduate biology students supported the results reported by most other authors. Students who regularly attend review sessions obtain higher final grades than those who rarely or never utilize extra assistance. Therefore, review session attendance remains an important predictor of student's academic performance (Chen & Lin, 2008; Golding, 2011; Jensen & Moore, 2008b, 2009; King, 2010; Moore, 2005, 2007a, 2007b, 2008; Soto & Anand, 2009; Westerman et al., 2011).

Moore (2005, 2008) found that the students who regularly attended review sessions or completed extra-credit work were often those who needed them the least; further, these students often used and relied on a host of positive academic strategies to help them succeed. Our data indicate that review sessions are beneficial to students. However, an additional consideration is that the link between class attendance, review session attendance, and student success may be the result of the underlying dedication of the students who do those things.

The absence of failing or low performing students in review sessions remains an important, yet troubling topic in educational research. These students would benefit the most from having good review session attendance, yet they are the least likely to do so. It is possible that some of these students are unable to attend sessions due to commuting difficulties or job responsibilities. Golding (2011) found that mandatory attendance policies resulted in higher exam scores for students. However, attempting to implement the same policy in a review session may prove problematic

especially if most students are commuters who live off campus or work part time.

Our research clearly indicated that voluntary attendance of additional study sessions had a significant impact on student performance in a freshman Biology course. This strategy can be further improved and developed to complement classroom experience in this course. In addition, this research, as well as other research, indicates that motivation determines both class attendance and review session attendance in that high achieving students are more likely to attend both. Reeve and Lee's (2014) research further indicates that students who originally lack motivation in a classroom can be encouraged to engage first and get motivated after the fact. Because early success influences or is related to final success, as shown in this and other studies, early engagement should have a significant impact on student success. Strategies to encourage early engagement merit further study.

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Tables

Table 1. DFW Rate and Average Participation Points among Freshman Biology (BIO-181) Students

	No. Students*	No. DFW	%DFW	Avg. Participation pts.	No. RVW attending	%attend
Fall 2013	146	29	0.199	185.1	42	0.287671
Spring 2014	69	22	0.319	170.9	20	0.289855
Fall 2014	327	74	0.226	134.8	153	0.46789
Spring 2015	100	25	0.250	123.9	24	0.24

Note. DFW=earned D or F in the class or withdrew from it.

Table 2. The Differences in Student Participation Ranks Between the Semesters.

	TRT	N	Mean Rank
Total Participation	Fall 2013	146	501.72 ^a
	Spring 2014	69	433.0 ^b
	Fall 2014	327	262.15 ^c
	Spring 2015	100	175.54 ^d
	Total	642	

Values with different superscript letters are different from each other at significance level $\alpha=0.05$.

Table 3. The Kruskal-Wallis Analysis of the Student Participation, comparing semesters within a year.

Variable	TRT Comparison	df	χ^2	p
Total Participation	Fall 2013 vs Spring 2014	1	7.726	0.005
	Fall 2014 vs Spring 2015	1	32.624	0.000

Values with different superscript letters are different from each other at significance level $\alpha=0.05$. In each case, Fall values are greater than Spring values (see Table 2).

Table 4. Comparison of Student Performance in Various Student Groups without and with Review Sessions.

	TRT	N	Mean Rank
Final GPA	I ⁰ grade high, RVW	116	497.90 ^a
	I ⁰ grade high, No RVW	106	434.06 ^b
	I ⁰ grade low, RVW	113	251.60 ^c
	I ⁰ grade low, No RVW	270	189.32 ^d
	Total	605	

Kruskal Wallis H non-parametric mean rank test for Final GPA, by semester. "I⁰ grade high" indicates Initial exam grade was greater than or equal to 80%. RVW indicates review session attendance, and No RVW indicates no review session attendance. Values with different superscript letters are different from each other at significance level $\alpha=0.05$.

Table 5. The Kruskal-Wallis Analysis of the Student Performance in Various Student Groups without and with Review Sessions.

Variable	TRT Comparison	df	χ^2	p
Final GPA	I ⁰ grade high, RVW vs No RVW	1	16.654	0.000
	I ⁰ grade low, RVW vs No RVW	1	19.439	0.000

"I⁰ grade high" indicates Initial exam grade was greater than or equal to 80%. RVW indicates review session attendance, and No RVW indicates no review session attendance. In each case, Fall values are greater than Spring values at significance level $\alpha=0.05$ (see Table 2).