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DATE: November 21, 2019

SUBJECT: Preliminary Results from Cohort 1 of the Advanced Biological Systems (ABS) Pilot Study

INTRODUCTION

This memo outlines preliminary findings from the first cohort – IMSA Class of 2020 – to participate in a pilot study of a new, one-year introduction to Biology course called Advanced Biological Systems (ABS). The purpose of the study is to compare and contrast the effectiveness of the new course with the traditionally offered one-semester Scientific Inquiries-Biology (SI-Biology) course. The pilot study began in fall 2017 and will continue through spring 2021.

The pilot study's research questions are as follows:

1. Do students who complete the ABS course have an increased level of content knowledge and enhanced critical thinking, model-building, and ability to make connections to real world issues?
    a. Are they more likely to get higher grades and less likely to fail the course?
    b. Do they report higher levels of engagement with the course material?
2. Do students who complete ABS course have better course performance in subsequent science courses?
    a. How is their subsequent performance in other courses?
3. Do students who complete the ABS course have a different electives-taking pattern?

In order to identify the impact of the course on students' subsequent outcomes, IMSA Classes of 2020 and 2021 were randomly assigned to either the treatment (ABS) group or control (SI-Biology) group using a stratified, randomization method. In this process, students were stratified into blocks based on race/ethnicity and gender. Then, half of the students in each block were randomly assigned to either the treatment or the control group.

Students' outcomes and engagement are assessed using a variety of measures, including the following: incoming grades and test scores; scores on pre- and post-study assessments of biology content knowledge; scores on pre- and post-course assessments; scores on a survey of engagement in Biology; course grades in Biology and subsequent science classes; scores on the College Work and Readiness Assessment (CWRA+); elective-taking patterns across the sciences; and retention rate.

CLASS OF 2020 PRELIMINARY RESULTS

Stratified Randomization

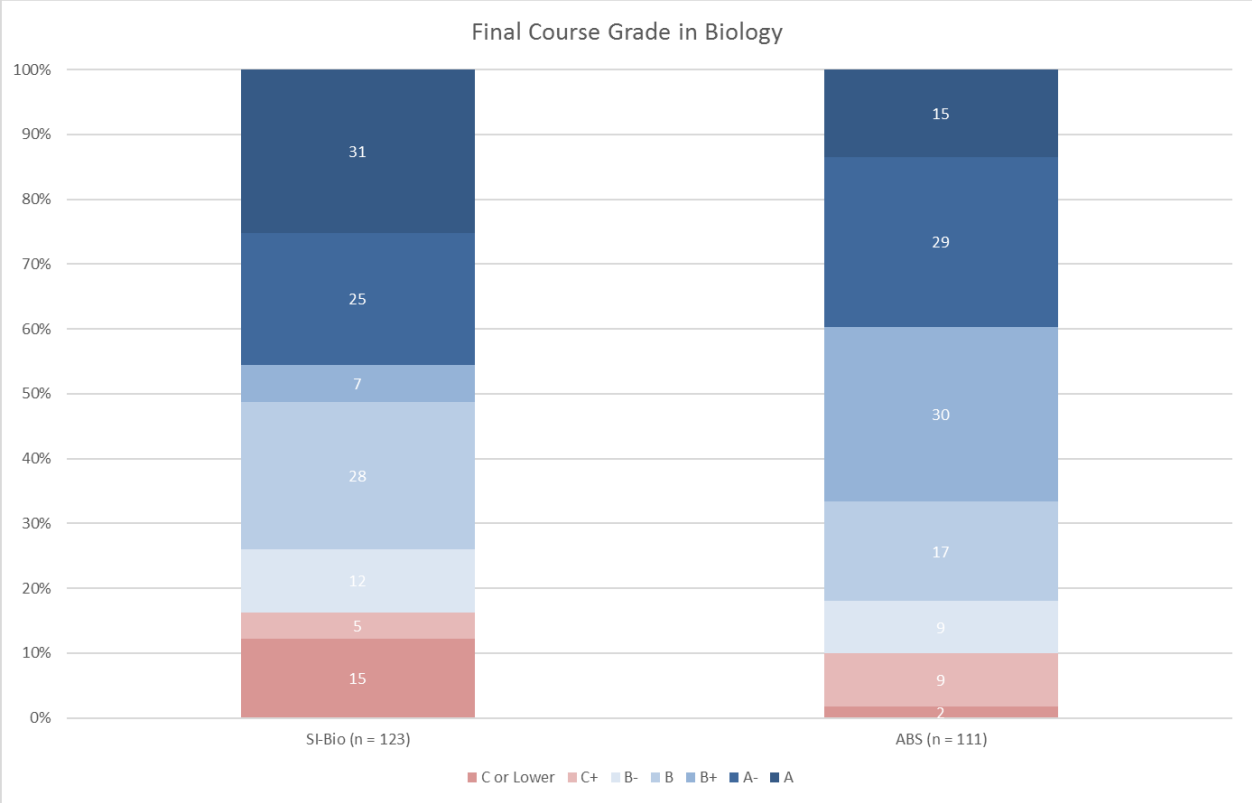
There were no significant differences between incoming skill levels for students assigned to ABS and those assigned to SI-Biology in terms of their SAT scores and grades. Thus, the randomization was

successful and the ABS and SI-Biology groups were equivalent in terms of the students' measured skill levels prior to their participation in the study.

Biology Course Grades

On average, students in ABS received significantly higher biology course grades than students in SI-Biology. The average biology course grade in ABS was 3.41, while it was 3.23 in SI-Biology ($p < .05$). This was due in part to the fact that students in SI-Biology were more likely to receive a C or lower than were students in ABS. Refer to Figure 1 for a breakdown of the biology course grades that students received.

Figure 1



Biology Motivation Questionnaire II

There was a decrease in overall scores on the Biology Motivation Questionnaire II among both students in SI-Biology and ABS from pre-course to post-course. When measured pre-course, there was no significant difference between the scores of students in SI-Biology and the scores of students in ABS on the Biology Motivation Questionnaire II. However, when measured at the end of their biology course, students in ABS scored significantly lower than students in SI-Biology on Overall Motivation ($p \leq .001$) as well as four of the five components of the assessment – Intrinsic Motivation ($p \leq .001$), Self-Determination ($p \leq .001$), Grade Motivation ($p < .01$), and Career Motivation ($p \leq .001$). Refer to Figures 2 and 3 for students' pre- and post-course scores on the Biology Motivation assessment.

Figure 2

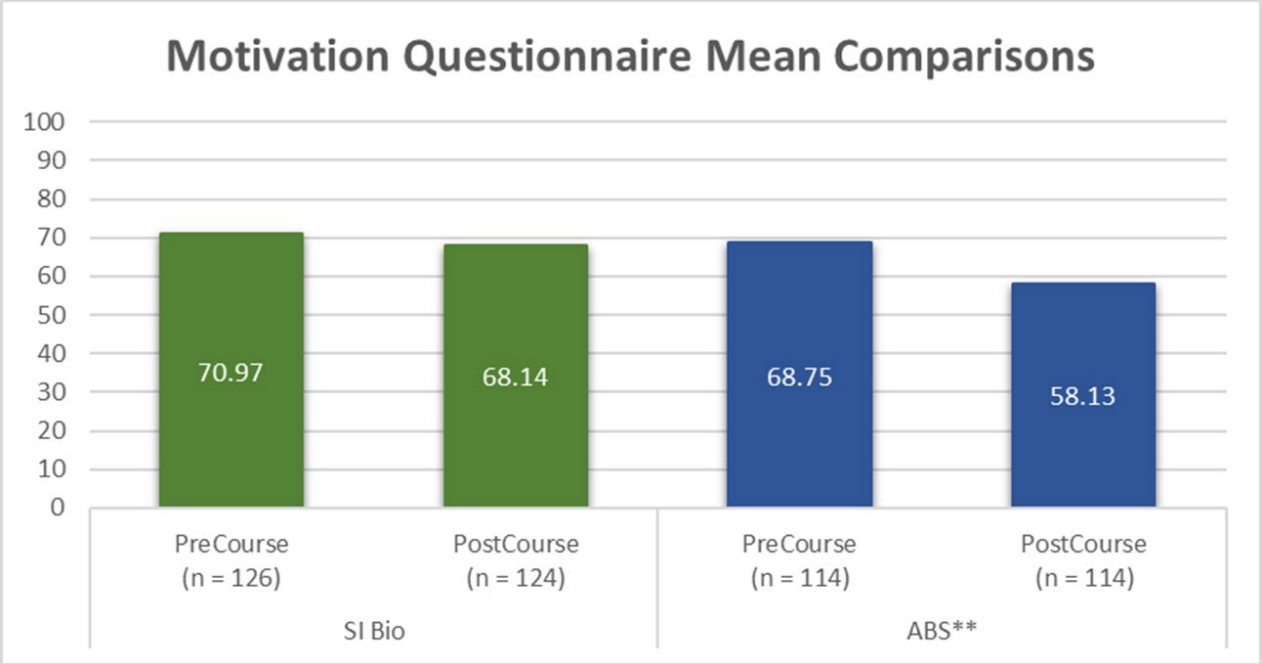
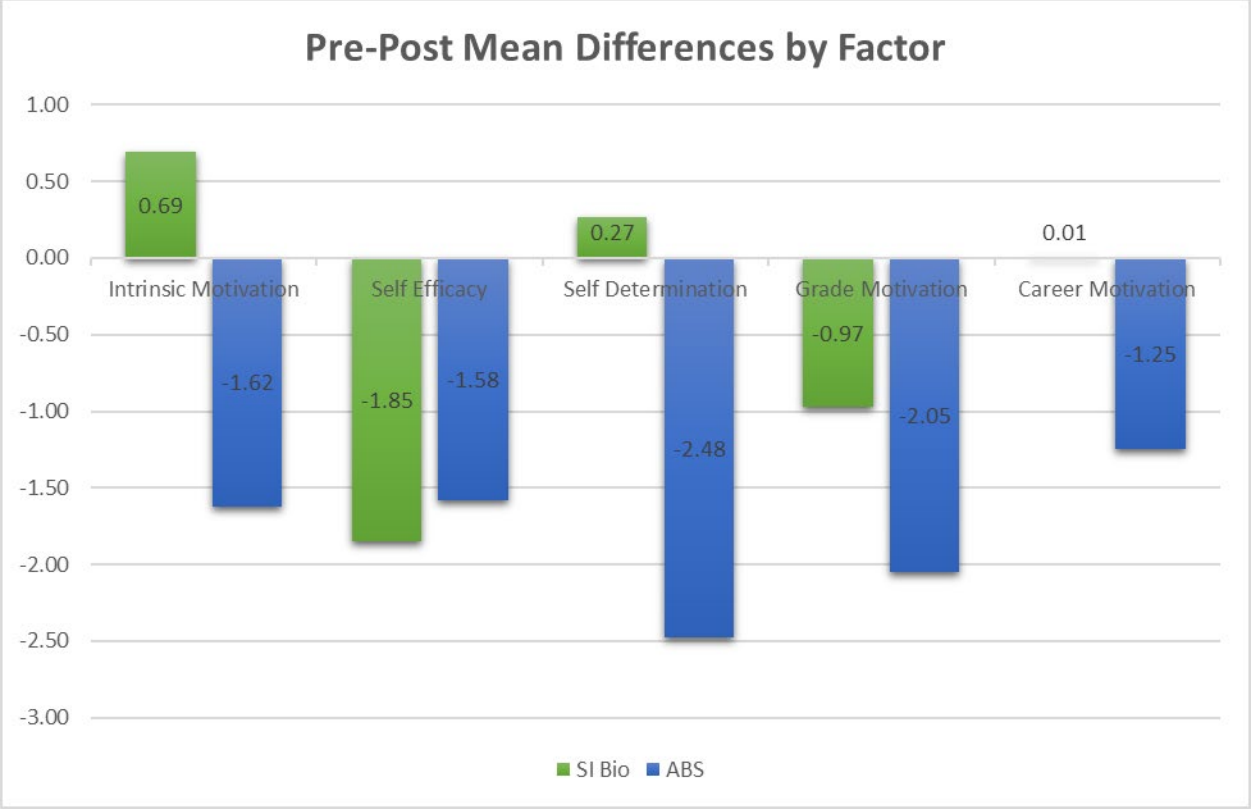


Figure 3

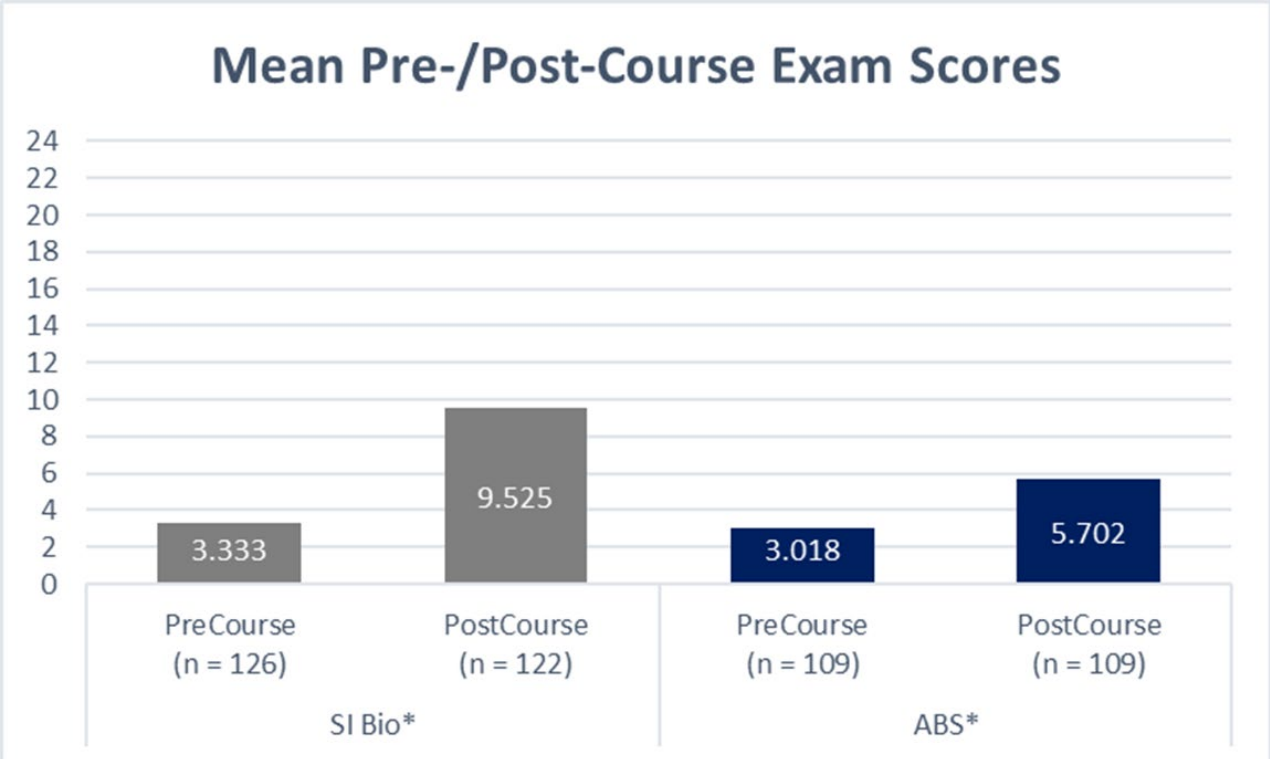


Pre-/Post-Course Exam

The analysis of the pre-/post-course exam indicated that a single factor is present, with the exception of Item 5, which is no longer taught in either SI-Biology or ABS. Test-Retest Reliability estimate was weak to moderate with Pearson's r = .448 ($p < .001$). Internal Consistency Reliability estimates ranged from $\alpha = .533$ to $\alpha = .636$. Values less than .50 are generally considered unacceptable indicating that the exam is unstable across the various administrations. Frisbie (1988) states that reliability measures for teacher-made assessments are generally around .50. Reliability is impacted by factors such as test length (nine items), item difficulty and discrimination, and group characteristics such as student motivation. For higher-stakes situations where a decision is to be made about students' educational outcomes, reliability estimates of .80 or higher are recommended.

On the pre-course exam, there was no significant difference between the scores of SI-Biology students and ABS students. On the post-course exam, students in SI-Biology scored significantly higher than students in ABS ($p < .001$). Refer to Figure 4 for the students' mean scores on the exam. However, this finding should be interpreted with caution due to the following two reasons: 1) the reliability estimates are weak to moderate if making a high-stakes decision such as students' educational outcomes; and 2) the content of the pre-/post-course exam was more representative of content taught in SI-Biology – only two out of the nine items were taught in both SI-Biology and ABS.

Figure 4



Pre-/Post-Study Exam

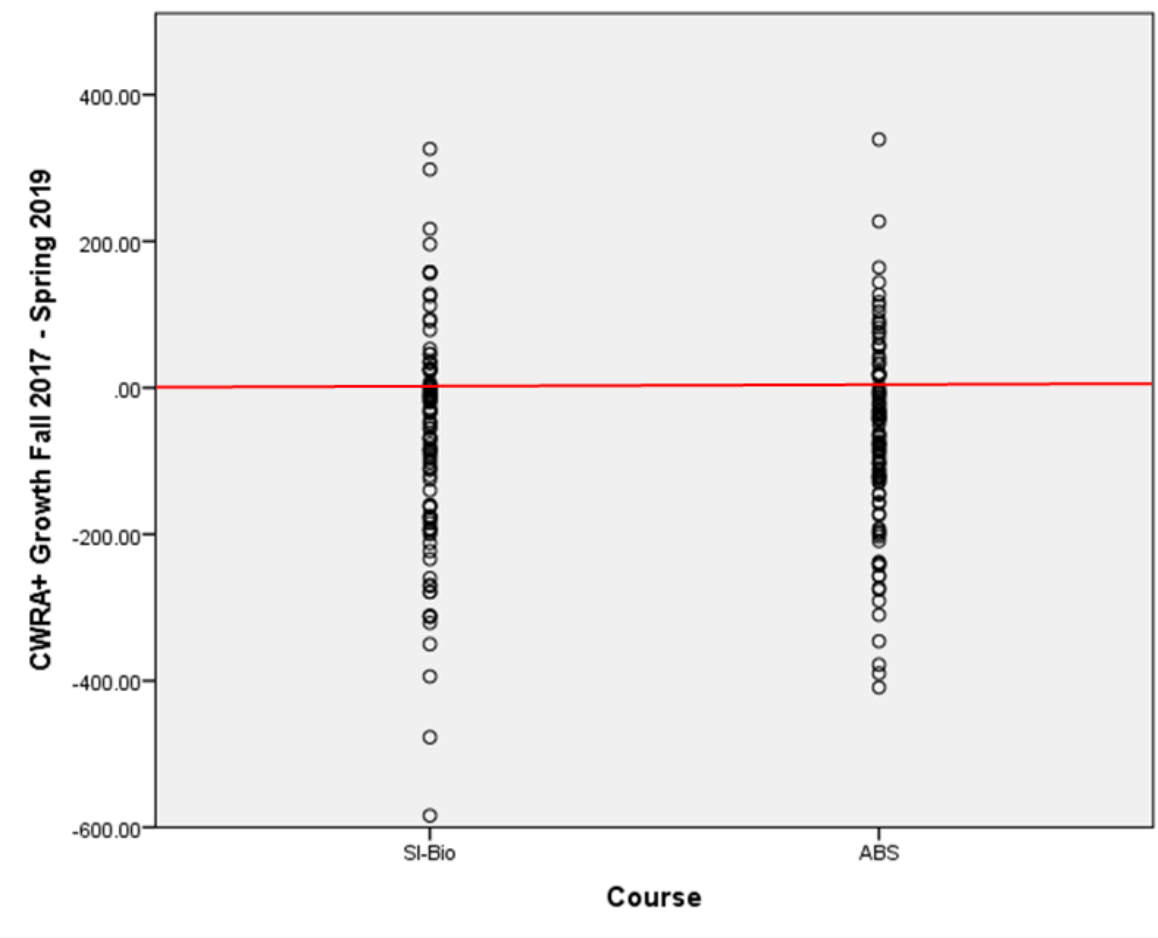
Analyses of the pre-/post-study exam indicate that the exam was inconclusive as no clear factor structure emerged. The Test-Retest Reliability estimate was unstable across the two administrations of the assessment (Pearson's r = .376, p < .001), in addition to the Internal Consistency Reliability estimates being weak – α = .391 for pre-study exam and α = .593 for the post-study exam.

There were no significant differences between the scores of the students in SI-Biology when compared with those of students in ABS for both Pre- and Post-Study Exams. This statement should be interpreted with caution as the exam properties do not meet the generally accepted parameters.

CWRA+ Exam

There were no significant differences the CWRA+ scores of students in SI-Biology and students in ABS in the Fall 2017 (sophomore year) nor in the Spring 2019 (junior year). Similarly, there were no significant differences in the growth on the CWRA+ from Fall 2017 to Spring 2019 between students in ABS and those in SI-Biology. Refer to Figure 5 for an illustration of the students' growth on the CWRA+.

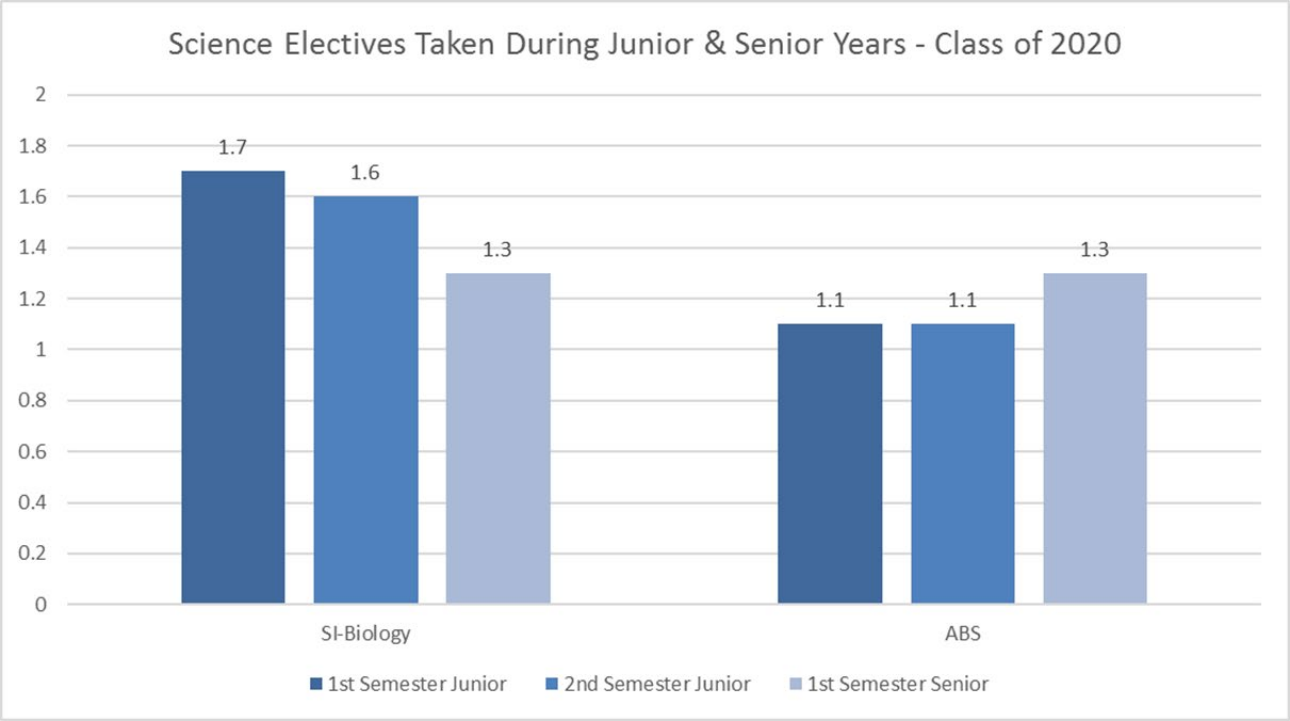
Figure 5



Science Electives

As expected, students in SI-Biology took a higher number of science electives in their junior year, on average, than students in ABS. As can be seen in Figure 6, students in SI-Biology took an average of 1.7 science electives in the first semester and an average of 1.6 science electives in the second semester of their junior year, while students in ABS took an average of 1.1 science electives during both semesters of their junior year. Students in ABS and students in SI-Biology took the same number of science electives during the first semester of their senior year (1.3).

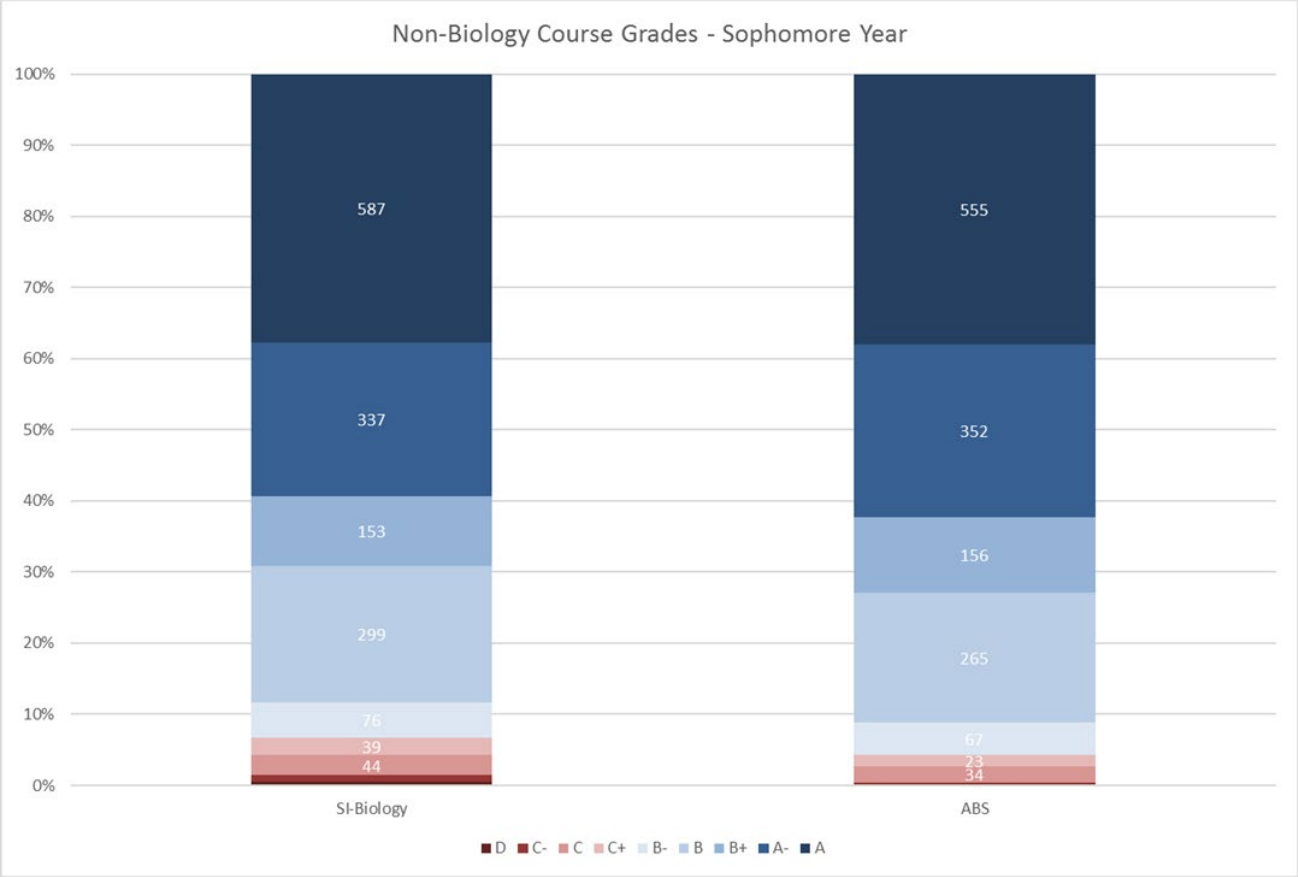
Figure 6



Grades in Non-Biology Courses

The grades that students received in their non-biology courses – all courses other than their introductory biology course – during sophomore, junior, and first quarter of senior year were analyzed. On average, students in ABS received slightly higher non-biology grades than did students in SI-Biology (90.34 vs. 89.99; $p < .01$). When broken down by year, the difference between the two groups of students' grades during their sophomore year was significant (90.29 vs. 89.76; $p < .01$), while there was no significant difference in non-biology grades during their junior or senior years. Looking further into students' non-biology grades during their sophomore year, there was a significant difference between students in ABS and students in SI-Biology in the grades they received for non-science courses (90.42 vs. 89.89; $p < .05$). However, there was no significant difference in the non-biology grades they received for science courses during their sophomore year. Refer to Figure 7 for a breakdown of the non-biology course grades that students received during their sophomore year.

Figure 7



CONCLUSION

In conclusion, the results of the preliminary analyses of students from the IMSA Class of 2020 do not indicate there was a difference in the effectiveness of the ABS course when compared with the SI-Biology course. On the one hand, students in SI-Biology demonstrated higher levels of motivation on the post-course Biology Motivation Questionnaire II and scored significantly higher on the post-course exam than did students in ABS. However, the reliability of the pre-/post-course exam was weak to moderate and six of the nine items were specific to SI-Biology content. On the other hand, students in ABS received significantly higher course grades in their introductory biology course and in their other sophomore year courses than did students in SI-Biology. There were no significant differences in students' CWRA+ scores or growth. Also, as expected, students in SI-Biology took a higher number of science electives during their junior year, but there was no difference in the number of science electives taken during their senior year. On the whole, the preliminary results do not provide sufficient evidence to indicate a clear preference for ABS or SI-Biology.