Recommendations for Core Biology Program to the Board of Trustees May 20, 2020

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Outline

Reimagining Introductory Biology: A Pilot Study (Office of Institutional Research)

- Response to research questions
- Changes to study design

Advanced Biological Systems (ABS) Pedagogy

- Alignment with institutional priorities
- Science education research
- Science elective courses

Future directions

- Recommendations for 20-21 school year
- Work Plan for 21-22 school year

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Purpose of the Pilot Study

- To compare and contrast the effectiveness of the ABS course to the Scientific Inquiry (SI)-Biology course

- To identify whether the ABS course leads to:
  - Better teaching and learning of complex biological concepts
  - Better student outcomes

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Research Questions

- 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?
  - Are they more likely to get higher grades and less likely to fail the course?
  - Do they report higher levels of engagement with the course material?
- Do students who complete ABS course have better course performance in subsequent science courses?
  - How is their subsequent performance in other courses?
- Do students who complete the ABS course have a different electives-taking pattern?

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Increased Content Knowledge and Enhanced Critical Thinking

- Pre-Post Study & Pre-Post Course Exams
  - Inconclusive based on the psychometric properties of the assessments (i.e., validity and reliability)
- CWRA+ Exam
  - No significant differences between ABS and SI-Biology in Fall 2017/Spring 2019 administrations
  - No significant differences in growth on CWRA+ from Fall 2017 to Spring 2019
- Lack of student effort on the Post-Study, Post-Course, & CWRA+ Exams may have influenced results
  - Students spent a minimal amount of time completing the assessments due to their low-stakes nature

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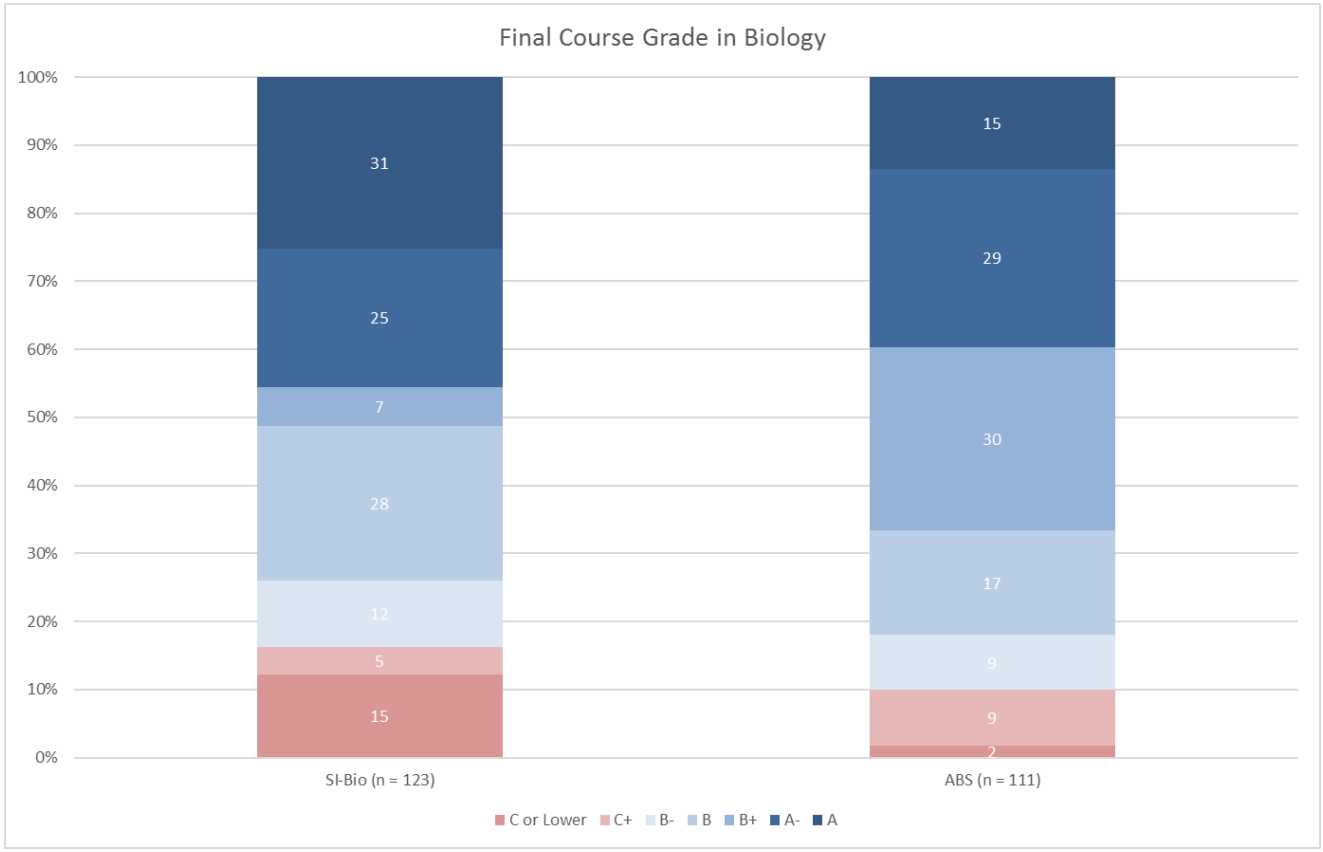
Increased Content Knowledge and Enhanced Critical Thinking

- Biology Course Grades
  - On average, students in ABS received higher course grades than students in SI-Biology
    - Mean of 3.14 (SI-Bio) vs. 3.23 (ABS) with $p < .05$



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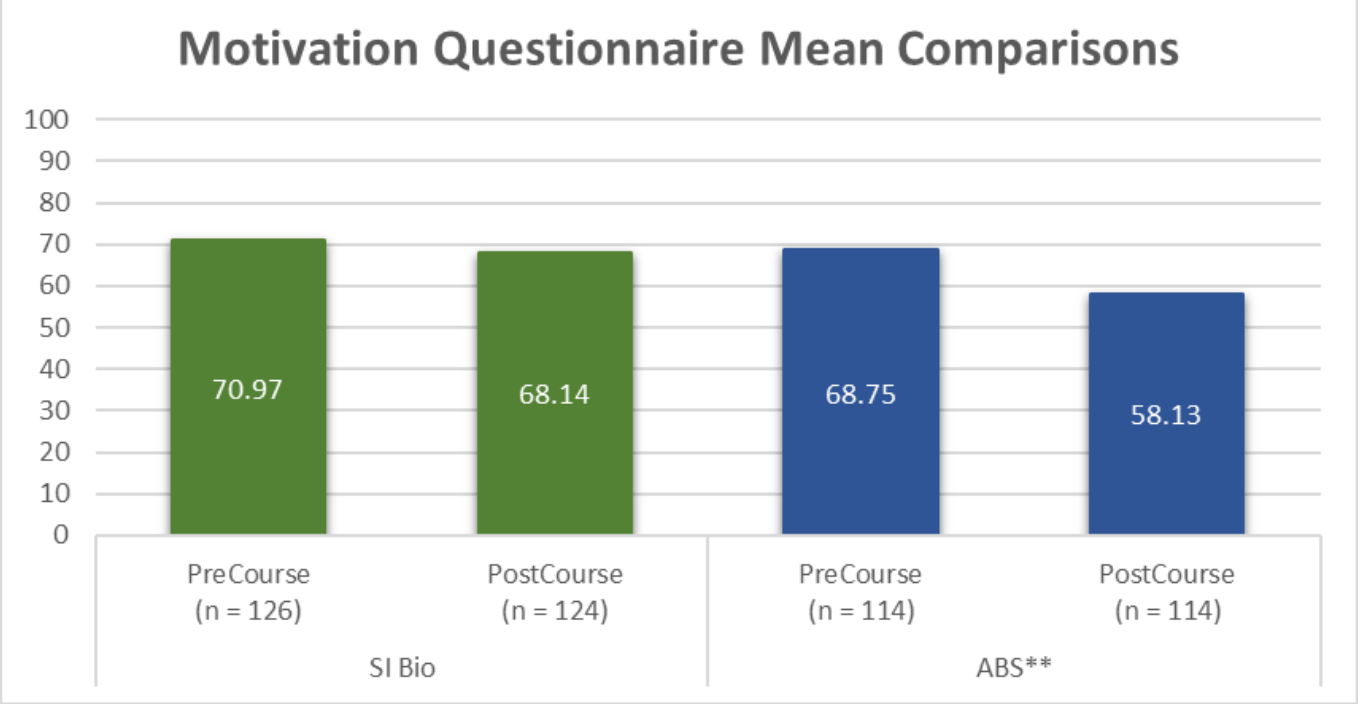
Increased Content Knowledge and Enhanced Critical Thinking

- Biology Motivation Questionnaire II
  - Assesses five components of students' motivation to learn Biology: Intrinsic Motivation, Self-Efficacy, Self-Determination, Grade Motivation, and Career Motivation (Glynn et al., 2011)
  - Results may have been influenced by student attitudes regarding the study



Pre-Course: SI-Bio not significantly different than ABS

Post-Course: SI-Bio significantly stronger than ABS ($p \leq .001$)

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Performance in Non-Biology Courses

- Students in ABS received slightly higher grades than students in SI-Bio: 90.34 vs. 89.99 ($p < .01$)
- Grades by Year
  - ABS significantly higher than SI-Biology during sophomore year: 90.29 vs. 87.26 ($p < .01$)
  - No significant difference between ABS and SI-Biology during junior or senior years
- Science vs. Non-Science Grades
  - ABS significantly higher than SI-Biology for non-science courses, during sophomore year: 90.42 vs. 89.89 ($p < .05$)
  - No significant difference between ABS and SI-Bio for science courses, during sophomore year
  - No significant difference between for science and non-science courses during junior or senior years

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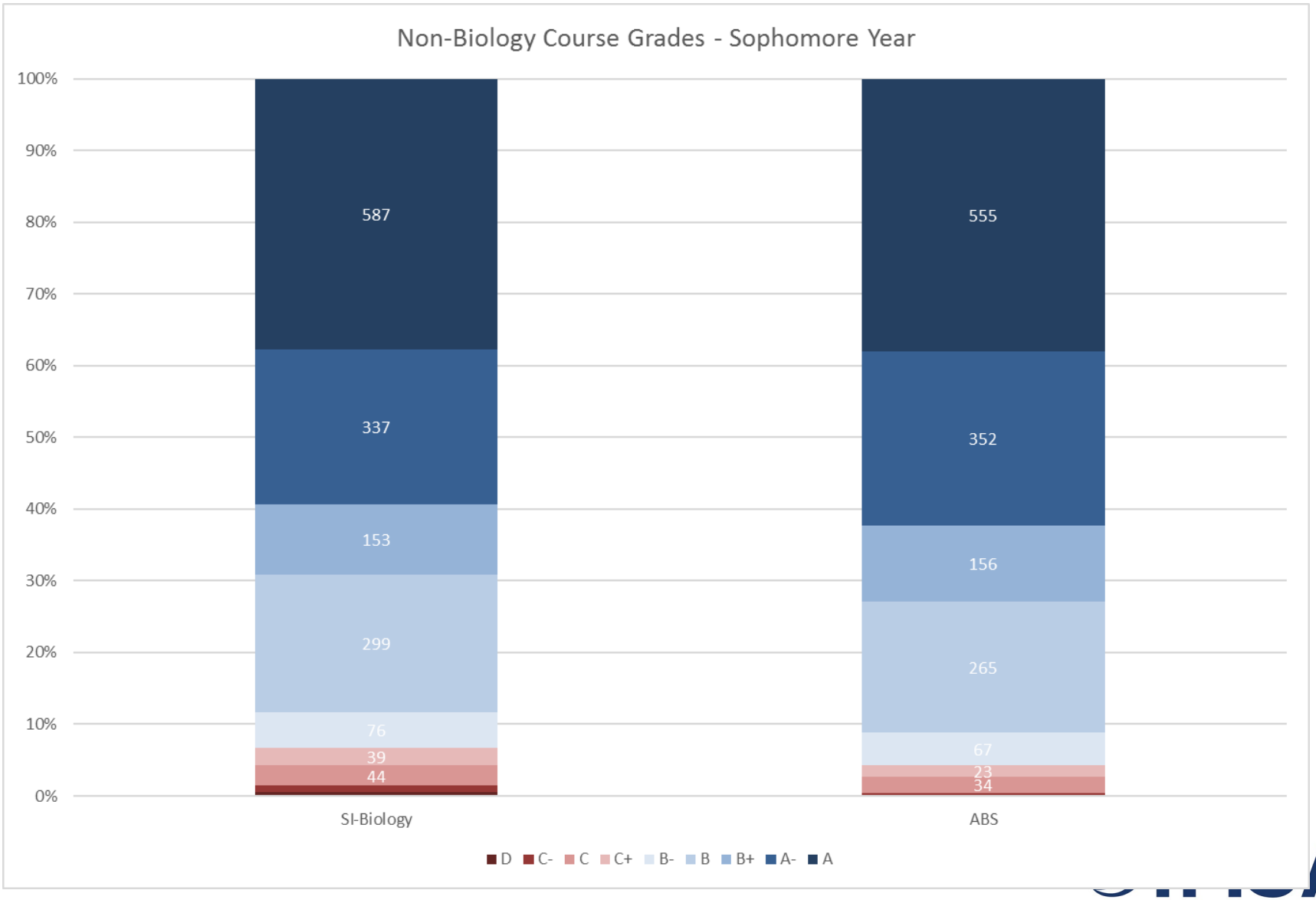
Course Performance



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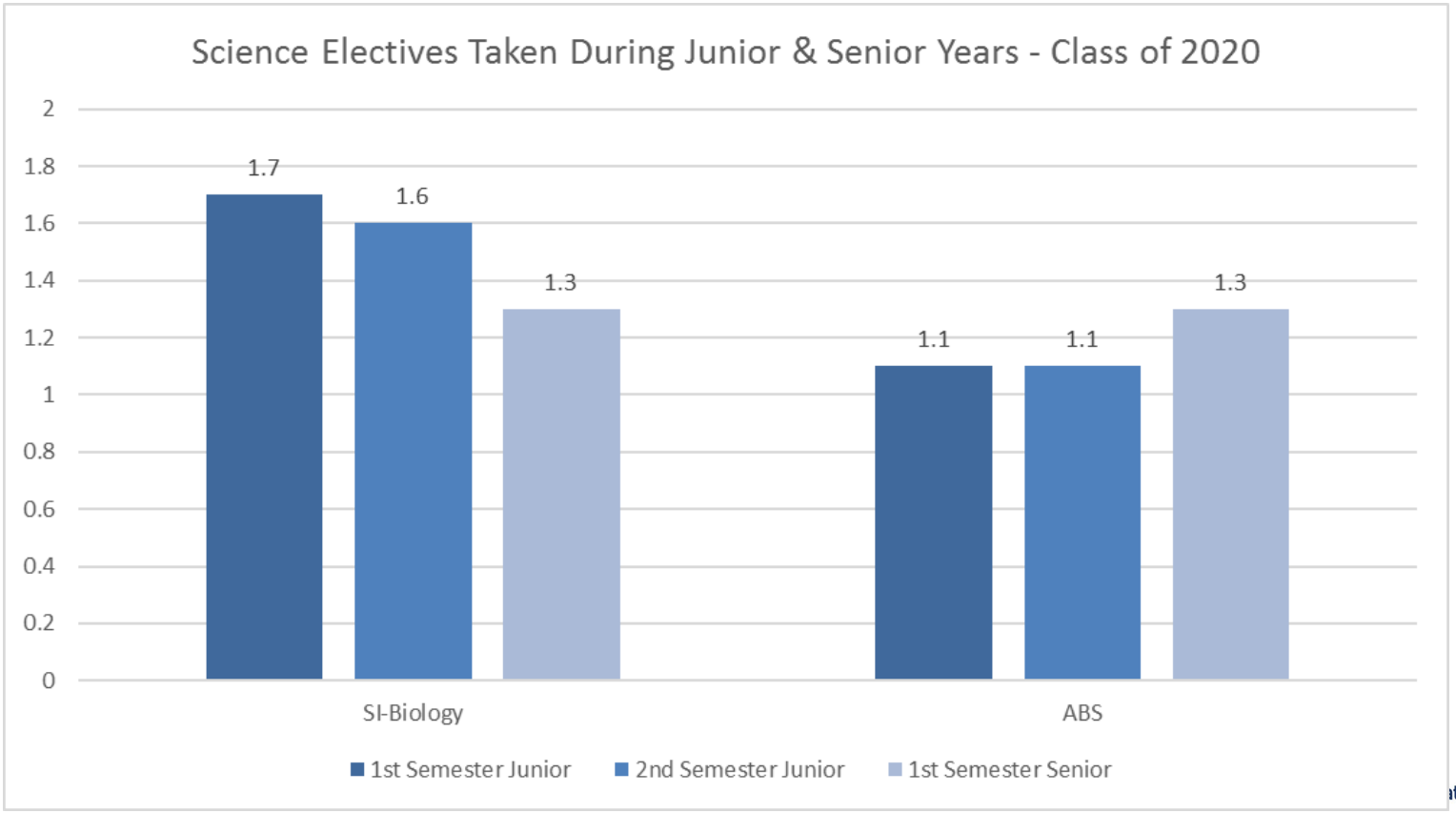
Electives-Taking Pattern

- Students in ABS took fewer science electives during junior year compared to students in SI-Biology
- During senior year, the number of science electives was the same



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Changes to Study Design

- Student Interviews
  - Study Effect
    - Incoming sophomores influenced by upperclassmen to oppose new ABS course
    - Opposition from some faculty members communicated to students
    - Difficult to assess whether or not the opinions held by the students are specific to the course or are a result of influences above
  - Significant time to interview, transcribe, code, and analyze
  - Substituted interviews with the Biology Motivation Questionnaire II to assess student engagement

- Teacher Journaling
  - Significant time to execute on a weekly basis
  - Substituted journaling with teacher interviews conducted about once a semester

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Challenges with Data Interpretation

- Assessments
  - Significant student push back
  - Low stakes assessment
  - Exams inconclusive
  - ABS curriculum developed after the study began and not fully align with assessments
- Student surveys (motivation and course)
  - Students often resistant to active learning despite the benefits
    - Deslauriers, L *et al.* (2019) ***Measuring actual learning versus feeling of learning in response to being actively engaged in the classroom.*** PNAS, 116 (39) 19251-19258
    - Finelli, C. J.,*et al.* (2018). **Reducing student resistance to active learning: Strategies for instructors**. *Journal of College Science Teaching, 47*(5), 80–91

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ABS Pedagogy

- Alignment with institutional priorities
  - United Nations Sustainable Development Goals (UNSDG)
    - Provide context for curriculum
    - Allows students to see interdisciplinary nature of biological problems
  - Equity
    - Student centered learning
      - No prior knowledge needed
      - Increases student access to core concepts
        - Chamany K.*et al.*(2017)*Making biology learning relevant to students: Integrating peolple, history and context into college biology teaching.* CBE-Life Sciences Education 7(3),267-278
      - Allows for differentiation and scaffolding
        - Eddy L. Sarah and Hogan A Kelly.(2014)*Getting Under the Hood: How and for Whom Does Increasing Course Structure Work?* CBE—Life Sciences Education.13(3),453-468

Vision and Change: A Science Education Report

- American Association for the Advancement of Science (AAAS): Vision and Change
  - Outlines best practices for teaching biology
    - Student centered learning
    - Content in context
    - Varied assessment strategies
    - Core competencies and disciplinary practices
      - Table 2.1 (pg 17)
  - ABS models vision and change pedagogy
    - Report could guide competency based assessment in ABS

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Science Electives

- ABS and electives in biology
  - Only seniors take electives
  - Fewer sections
  - Authentic research based labs
  - Deeper learning
- Science electives
  - A year-long core
    - Junior and senior electives in Chemistry and Physics
    - Electives change in response
    - Interdisciplinary electives
    - Authentic inquiry based courses

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Recommend ABS in Junior Year

- Science education literature
  - Vision and change AAAS report
- Alignment with institutional priorities
  - UN SDG
  - Equity
- ABS study
  - Students in ABS had better grades than students in SI Biology
  - Students in ABS also had higher grades for all classes during their sophomore year
  - Higher GPAs have been shown to be a strong predictor for success in college
    - Allensworth *et al.*(2020) *High School GPAs and ACT Scores as Predictors of College Completion: Examining Assumptions About Consistency Across High Schools*. Educational Researcher. 47 (3),198-211

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Future directions

- Recommendations for 20-21 school year
  - ABS in the junior year
  - Discontinue SI-Biology
- Work Plan for 21-22 school year
  - Begin to incorporate Methods of Scientific inquiry (MSI) into core curriculum and recommend graduation requirement changes to the Board of Trustees
  - Assess the staffing feasibility of a year-long chemistry and physics courses
  - Explore the rationale and develop curriculum for year-long chemistry and physics courses

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