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
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
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?
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
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
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

**Motivation Questionnaire Mean Comparisons**

<table>
<thead>
<tr>
<th></th>
<th>Pre-Course</th>
<th>Post-Course</th>
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<tbody>
<tr>
<td><strong>SI Bio</strong></td>
<td>70.97</td>
<td>68.14</td>
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<tr>
<td><strong>ABS</strong></td>
<td></td>
<td>68.75</td>
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<td><strong>Pre-Course</strong></td>
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<td><strong>Post-Course</strong></td>
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**Pre-Course**: SI-Bio not significantly different than ABS

**Post-Course**: SI-Bio significantly stronger than ABS (p ≤ .001)
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
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
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
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
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
    - Allows for differentiation and scaffolding
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
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
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
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