Enduring Attitudes of Life Science Students Towards Physics and Interdisciplinary Learning

Haley Gerardi '17[1], Aqil Tarzan MacMood '20[1], Benjamin D. Geller[1], Catherine H. Crouch[1], Chandra Turpen[2]
[1]Department of Physics and Astronomy, Swarthmore College
[2]Department of Physics, University of Maryland, College Park

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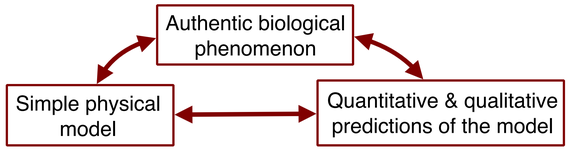
Introduction

Our Introductory Physics for Life Sciences (IPLS) courses at Swarthmore are designed to give life science students the tools necessary to use physical reasoning in later biology coursework. Additionally, we hope that students develop the attitudes that physics is relevant to biology, and that interdisciplinary learning is valuable.

One of the central elements of the second semester IPLS course at Swarthmore is a discussion of electrical circuitry in neurobiological models. Examples that activate knowledge from previous coursework and make personal connections to life science students' interests have been shown to increase students' levels of engagement[1]. To date, no longitudinal study has examined whether these attitudes persist.

IPLS at Swarthmore

Students can enroll in either a traditional or IPLS first-semester mechanics course, and then take an IPLS second-semester E&M course. IPLS students are typically life science majors pursuing a career in the health profession. The IPLS courses at Swarthmore emphasize the coordination between biological phenomena, simple physical models, and the quantitative and qualitative analysis of those models.



Research Questions

In this study we assess students' attitudes about the relevance of physics and math to biology. In particular, we investigate the following research questions:

1. **How do attitudes of life science students towards physics and interdisciplinary learning develop during and persist after their IPLS experiences?**
2. **Do IPLS students, compared to their peers with no physics or traditional introductory physics, view physics and math as more relevant to their life science coursework?**

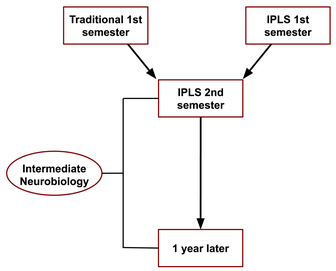
Methodology

We collected data on students' attitudes to interdisciplinary connections in biology using the interdisciplinary cluster items from the revised Maryland Biology Expectations Survey (MBEX II). These items included statements such as:
It is beneficial to me, as a biologist, to also be proficient in physics.

Respondents indicated their agreement or disagreement with each item on a 5-point Likert scale (strongly disagree to strongly agree). The responses were then reversed as needed so that a strongly favorable (expert-like) response was assigned to 5 and a strongly unfavorable response was assigned to 1.

These surveys were administered to two student populations: IPLS students from 2017-18, and Neurobiology students in Spring 2019, at the following times:
IPLS students:
- pre-second semester (January 2018)
- post-second semester (May 2018)
- one year later (June 2019)

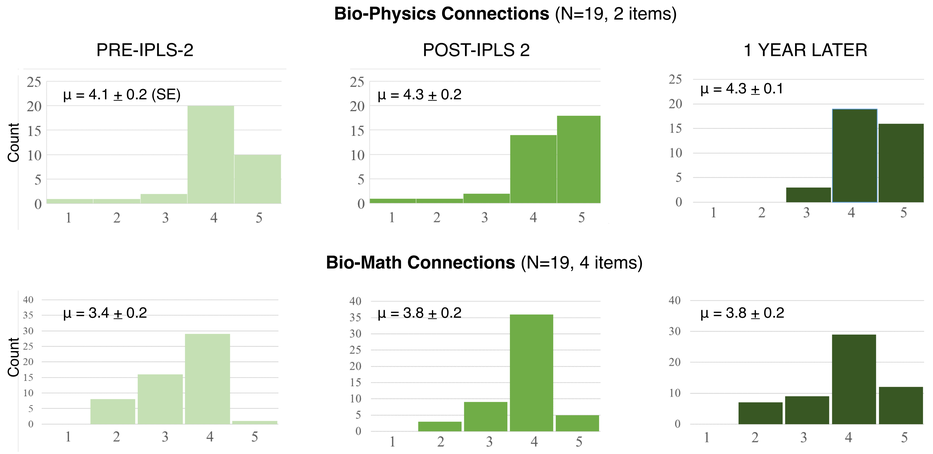
Neurobiology students:
- pre-Neurobiology
- post-Neurobiology



To build up longitudinal case studies, we conducted interviews about attitudes to interdisciplinarity with IPLS students before and after second semester IPLS. We also conducted interviews that combined problem-solving and attitudes about interdisciplinarity with Neurobiology students after Neurobiology. Over the period of our research, we intend to develop multi-year case studies of the same student, although at this point we only have one student who has been interviewed multiple years.

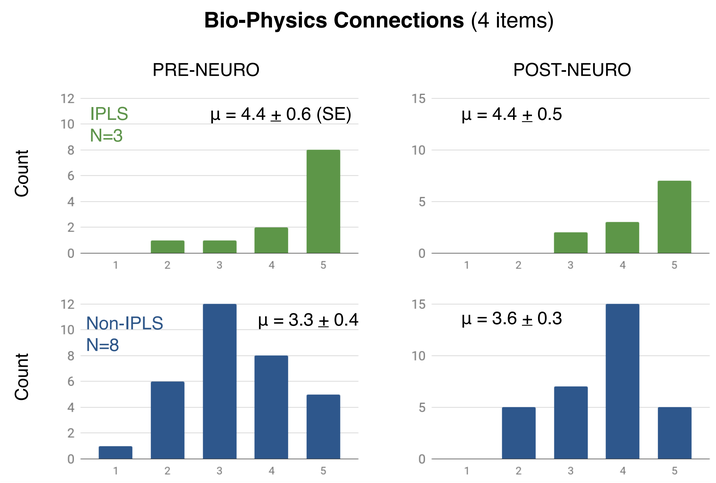
IPLS students express more positive attitudes toward the relevance of physics and math to biology. These attitudes persist one year later.

Growth and persistence of attitudes



Survey Analysis in Neurobiology

- IPLS students expressed more positive sentiments pre-Neuro than non-IPLS.
- Positive sentiments persisted over the course of the semester for IPLS students
- Non-IPLS students became more positive post-Neuro, but not reaching IPLS levels



Interview Analysis

Interview data support trends in survey data. Explanatory coherence, disciplinary identity, and course structures emerged from our analysis as influential factors shaping the attitudes expressed by students. Below are quotes from some of our interviewees:

> *"…it allowed me…to see the interconnectivity and interdisciplinary nature of the sciences overall, and how they need each other." — Clara*

> *"…it was interesting taking proteins not necessarily as strictly biological compounds, but also compounds that can have implications in the physics field." — Trevor*

> *"…what I most appreciated about [IPLS] was that it made clear a lot of physical phenomena that we take for granted in biology and chemistry. Really making it salient really supported the way I learned in those other disciplines." — Clark*

> *"…the lab really was very exciting for me as well because we got to measure our own heartbeat and that personal connection to the example also really reinforced its relevance." — Maddie*

References

1. Benjamin Geller, Chandra Turpen, and Catherine H. Crouch, "Sources of student engagement in introductory physics for life sciences," Phys. Rev. Phys. Educ. Res. 14, 010118 (2018).
2. Kristi Lyn Hall, "Examining the Effects of Students' Classroom Expectations on Undergraduate Biology Course Reform," Ph.D. Thesis, University of Maryland 2013

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Contact information: Haley Gerardi (haley.gerardi.324@gmail.com) and Aqil MacMood (amacmoo1@swarthmore.edu)