

E. Similarities in Being a Part of Science

During a discussion on NOB, the educator makes statements on the use of mathematics in the sciences and implicitly includes biology in the category of a science alongside of physics.

Educator: Math is extremely important in science. And this is why they make you [biological science students] take math classes... there's lots of things that is really important about the science that is added on top of the math that makes it much more challenging than the way the math is done in the math classes.

The educator communicates that they take math classes so that it can be used in the sciences. The educator in this message sets up why this class will be relying on the mathematics that the students have already learned.

F. Similarities in Examining Physical Systems

Embedded in a discussion on the importance of using math in physics, the educator describes both physics and biology in the context of working with a physical system.

Educator: A critical point about the whole process of using math—and it is not just math because once we talk about this you will be able to see that this is very much the same as a lot of what you do in qualitative biology—is that we are going to begin with some physical system. And it could be a biological system. All systems are physical systems.

The educator explicitly brings in biology by commenting on the similarity about both examining physical systems. This shows an aligning of physics and biology in that biologists work with physical systems just as physicists do.

V. WHAT CONTRIBUTES TO THE EDUCATOR SHIFT IN MESSAGING?

While we cannot say with certainty what contributed to the educator shifting the messaging about NOP and NOB in the classroom, we can point to a couple of potential influences. During the first iteration of the course, a research team was actively recording students in class and interviewing them outside of class. In between the first and second semester of the first iteration of the course, the research team had a meeting with the educator in which they showed him examples of how his messaging about the disciplines was being taken up by students (e.g. interview transcripts.). Upon reflection of this data the educator noted that some of the ways the students were positioning the disciplines were not how he intended. Additionally, in the second iteration of the course, a biophysics colleague joined

the instructional team. This colleague viewed biology and physics and much more congruent than the original educator, and they had many discussions on how physics and biology were similar. It is likely that both of these types of discussions—with both the research team and the biophysics colleague—contributed to the shift in the educator's messaging from one iteration to the next.

VI. CONCLUSION

Our analysis shows that the first iteration of the course included comments that positioned the nature of physics as distinct and different from the nature of biology (4 out of 5 instances). The second iteration revealed communications describing the nature of physics and the nature of biology as similar and less siloed (6 out of 7 instances). During the first iteration of the course, the educator led a lengthy eight-minute discussion on the differences between “thinking like a physicist” and “thinking like a biologist”. This discussion is notably absent from the second iteration of the course.

In follow-up reflections by the educator, he was unaware of any change in his messaging about disciplinary similarities and difference from the first and second iterations of the course. It was only after reviewing this analysis that the educator acknowledged a shift in the communicated nature of the given disciplines. For the PER community, these results demonstrate that without being aware, educators can shift in communicated messages. We, as educators, may believe that we undergo perhaps only small internal shifts that are undetectable externally. Even in the presence of a recognized internal shift, we may not acknowledge any shift in the external messages we communicate. The messages sent to students are sometimes hidden, not only from the students, but also from ourselves.

Further study regarding the change in the discussions on the nature of the given disciplines could examine the effect of these communicated statements on students. Such analysis may contribute to raising instructors' critical awareness of the disciplinary messages they communicate.

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