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Feature
Current Insights

Recent Research in Science Teaching and Learning

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This feature is designed to point *CBE—Life Sciences Education* readers to current articles of interest in life sciences education as well as more general and noteworthy publications in education research. URLs are provided for the abstracts or full text of articles. For articles listed as Abstract available, full text may be accessible at the indicated URL for readers whose institutions subscribe to the corresponding journal. This themed issue focuses on recent studies of teaching and learning at the intersection of mathematics and biology.

Research on the integration of mathematics and biology in teaching and learning is still relatively rare. Most examples of integration of mathematics and science education are from the physical sciences. The journal *PRIMUS: Problems, Resources & Issues in Mathematics Undergraduate Studies* published a special issue on the integration of mathematics and biology in undergraduate education. The articles in this issue offer first-person accounts of curricular and pedagogical innovations developed in response to calls for action from the American Association for the Advancement of Science (2009), Howard Hughes Medical Institute (2008), National Research Council (2003), and National Science Foundation, among others, to integrate mathematics teaching into biology learning and develop the quantitative and computational skills of future biologists.

Only two of the articles, both of which are summarized below, take steps to document the impact of integrating mathematics and biology teaching on students' attitudes, learning, and behaviors. The apparent dearth of research on the integration of mathematics and biology learning highlights the timeliness of this themed issue as well as the need not only to develop and use integrated curricula but also to study the impact of doing so.

1. Fulton, J. P., and Sabatino, L. (2008). Using the scientific method to motivate biology students to study precalculus. PRIMUS *18*, 5–21.

[Abstract available: www.informaworld.com/smpp/content~db=all~content=a789837904]

In this study, Fulton and Sabatino aim to make precalculus learning more accessible to biology students by using what they describe as four phases of the scientific method: observation/characterization, hypothesis formation, prediction, and experimentation/validation. For example, students are tasked with determining the concentration of a substance by assaying known concentrations, constructing a standard curve, and comparing their unknown against the curve to determine its concentration (observation phase). This experience serves as the foundation for discussion of linear regression as a way to model the data (hypothesis phase). The authors emphasize the development of students' intuition about relationships among variables, and how functions can be used to model biological data (prediction phase). The authors examined impact of this approach to teaching mathematics in three ways: retention in the course, final grades, and course surveys. Notably, there was no attrition from the course (i.e., 100% retention) during two different semesters the course was taught. The traditional precalculus course has a retention rate of approximately 80%. No differences in course grades were observed between the traditional versus the integrated courses, which is laudable given the lack of attrition. The study population is not described in any detail (e.g., class size, intended major, gender/ethnic makeup) for either the integrated or traditional courses, making it difficult to determine other factors that might be influencing these outcomes. The course survey results are described only briefly. Student responses on open-ended questions indicate that students' attitudes toward math, as well as its usefulness in biology, may have changed as a result of the integration.

2. White, J. D., and Carpenter, J. P. (2008). Integrating mathematics into the introductory biology laboratory course. PRIMUS *18*, 22–38.

[Abstract available: www.informaworld.com/smpp/content~db=all~content=a789836354]

White and Carpenter describe a series of introductory biology laboratory exercises in which conceptual understanding and application of calculus have been integrated. Several aspects of the article are particularly useful. First, the authors describe particular exercises in detail, including questions posed to students to steer their investigations. Second, the authors explain the process of developing an institution-

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wide, integrated curriculum, which could serve as a model for others interested in doing so. Third, the authors document challenges of implementing an integrated curriculum and offer practical advice for overcoming them. Although no data are included, the authors state that students have completed pre- and posttests on lab safety, research skills, and science content knowledge and that the only consistent trend in their results to date is an increase in lab safety knowledge. In other words, no changes have been observed in students' research skills or science content knowledge as a result of participating in the integrated curriculum. The authors speculate that lack of improvements on these measures may be due to the integrated curriculum being only partially in place for students who have completed the assessments thus far. The methods used to collect and analyze data on student outcomes were not described in sufficient detail to rule out other explanations.

3. Wilensky, U., and Reisman, K. (2006). Thinking like a wolf, a sheep, or a firefly: learning biology through constructing and testing computational theories—an embodied modeling approach. Cogn. Instruct. *24*, 171–209.

[Abstract available: www.informaworld.com/smpp/content~db=all~content=a783760012]

In this study, Wilensky and Reisman use an embodied approach to engage students in biological modeling and learning about complex systems. Specifically, high school students use the agent-based modeling language NetLogo to represent the elements of a system and then study how the elements interact, including identifying emergent properties of their interactions that are not easily predicted from the behaviors of individual elements. For example, one of the students in the study formulates rules for how a wolf and a sheep behave as predator and prey, respectively. In her model, wolves move about looking for sheep, lose energy with each movement, gain energy if they encounter and thus eat sheep, and reproduce. In contrast, sheep move about and reproduce, failing to do so only if they are eaten by wolves. The student runs her model, which yields inconsistent oscillations in sheep and wolf populations and eventual population crashes. She develops ideas about why her model yields these results, and then revises her model to test her ideas. In a second example, another student develops and tests a model to explain synchronous flashing behavior within a firefly population. Notably, both students were encouraged to review relevant biological information to ensure that their models were plausible, rather than just sufficient to yield the observed behaviors. Using a qualitative case study approach, the authors document how these two students approach their respective biological problems, develop initial models, recognize or fail to recognize assumptions in their models, and revise and retest their models. The authors also add their reflections on teaching by using this approach, contrasting it with more traditional equation-based approaches. They argue that embodied modeling offers opportunities for students to develop conceptual understanding without memorizing many facts, but may prompt discomfort from instructors looking for a single correct model as an outcome.

I invite readers to suggest current themes or articles of interest in life science education as well as influential papers published in the more distant past or in the broader field of education research to be featured in *Current Insights*. Please send any suggestions to Erin Dolan (edolan@vt.edu).

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