CBE—Life Sciences Education
Vol. 9, 384–386, Winter 2010

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.

1. Boggs, G. R. (2010). Education forum: growing roles for science education in community colleges. Science *329*, 1151–1152.

[Abstract available: www.sciencemag.org/cgi/content/summary/329/5996/1151]

This essay, cited in the feature "From the National Science Foundation" in this issue of *CBE–Life Sciences Education*, highlights the important role that community colleges play in the education of scientists and engineers and of a scientifically literate public. Written by George Boggs, president and chief executive officer of the American Association of Community Colleges, the essay describes the impact of community colleges on development of a skilled and diverse technological workforce, an impact that can be attributed in part to the typical responsiveness of their curricula to the changing needs of local industries, government, and other educational sectors. It addresses the challenges that community colleges currently face, often exacerbated by the current state of the economy, including the relatively low completion rates (of program, certificate or degree requirements) and transfer rates to four-year college or university programs. Boggs concludes the essay by making a persuasive case for the value of two-year and four-year institutions of higher education working together with elementary and secondary partners to improve educational attainment in the United States—to set into place an educational continuum that more seamlessly bridges all educational levels.

DOI: 10.1187/cbe.10–09–0121
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2. Blanchard, M. R., Southerland, S. A., Osborne, J. W., Sampson, V. D., Annetta, L. A., and Granger, E. M. (2010). Is inquiry possible in light of accountability? A quantitative comparison of the relative effectiveness of guided inquiry and verification laboratory instruction. Sci. Educ. *94*, 577–616.

[Abstract available: http://onlinelibrary.wiley.com/doi/10.1002/sce.20390/abstract]

National reform documents urge teachers to use inquiry-based instructional practices to help students learn science. However, the current environment of high-stakes assessment and school and teacher accountability has prompted many teachers to "teach to the test," under the assumption that inquiry-based instruction would not lead to higher test scores. The authors critically examine this assumption by asking: If teachers practice inquiry, is learning of science content and process enhanced, or does it suffer? They explored this question in the context of a week-long forensics unit taught using two distinct instructional modes, referred to as verification inquiry and guided inquiry. A total of 1705 middle or high school students and 24 teachers in seven schools participated in the study. In verification inquiry classrooms, the teacher prescribed the question and the methods for data collection and interpretation of results; in guided inquiry classrooms, the teacher provided the question, but the data collection methods and interpretation of results were left up to the students. Student learning was assessed using multiple-choice pre-, post-, and delayed post-tests that explored understandings of conceptual knowledge, procedural knowledge, and the nature of science. To assess effects of student socioeconomic status (SES) and different teaching approaches, learning outcomes were compared in schools with low, middle, and high SES status, and the classroom lessons were videotaped for later analysis of teacher practices using the Reformed Teaching Observation Protocol (RTOP). Scores were analyzed as a function of instructional method, teacher RTOP scores, and school SES. With reference to instructional method, the authors found that guided-inquiry instruction produced a greater change in test scores and stronger growth, particularly for high school students. With reference to teaching approaches, students in the guided-inquiry classrooms of teachers with high RTOP scores had higher scores and stronger growth than the other students. However, students in guided inquiry classrooms taught by teachers with low RTOP scores tended to score lower and had poorer growth than the students in the verification classrooms. The analysis as a function of SES in general indicated that the school's poverty level had a substantial effect on score and growth in score; however, students in the high-poverty schools showed a greater benefit from guided inquiry than did students in the low-poverty schools. The authors conclude that inquiry approaches are not incompatible with high-stakes test performance, particularly if teachers' fidelity of enactment of the inquiry lesson is enhanced by intensive professional development experiences. The SES results highlight the need for more research into ways to bolster the learning of nonmainstream students—particularly in light of the fact that some low SES schools use drill and rote memorization (rather than inquiry) as strategies aimed at improving scores on state assessments that are used for purposes related to No Child Left Behind legislation. Of additional value in this article is the extensive review of the literature on the impact of inquiry-based instruction in the K–12 setting—in the words of the authors, "rich but inconclusive."

3. Stevens, S. Y., Delgado, C., and J. S. Krajcik. (2009). Developing a hypothetical multi-dimensional learning progression for the nature of matter. J. Res. Sci. Teach. *47*, 687–715.

[Abstract available: http://onlinelibrary.wiley.com/doi/10.1002/tea.20324/abstract]

This article describes the authors' efforts to develop a hypothetical learning progression for the growth of grade 7–14 students' understandings of the properties, structure, and behavior of matter related to nanoscale science and engineering (NSE), as shaped by classroom instruction. A recent report (National Research Council, 2007; p. 219) defines learning progressions as "descriptions of the successively more sophisticated ways of thinking about a topic that can follow one another as children learn about and investigate a topic over a broad span of time (e.g., 6–8 years)." Learning progressions are anchored at the lower end by what is currently known about the reasoning and conceptual understandings that young children bring with them to school, and at the upper end by societal expectations about their understandings within a content domain when they achieve a certain grade level. This study of learning progressions related to the properties, behavior, and structure of matter is part of a larger effort to inform the development of instructional strategies that would enable students to connect ideas across different areas of the physical sciences to understand NSE predictions about the societal impact of new information and technologies arising from NSE have prompted a move to incorporate NSE into the science curriculum. In the article, the authors step the reader through their process of determining the lower and upper anchors of the learning progression, through a research-based analysis to hypothesize progressions for atomic structure and for the forces and interactions that occur between atoms and molecules, and then through the iterative process of developing empirical progressions that trace students' actual ideas. The latter process was informed by use of open-ended assessment tasks that measured the related understandings of 103 middle school, high school, and university students during a semistructured interview protocol. Analysis of the interview data allowed for mapping of the students' performance to reveal connections among the elements of the progressions. The paper presents the content of the multi-dimensional, hypothetical learning progression that was developed to describe potential routes to understanding of several "big ideas" of NSE and describes the empirical learning progressions that emerged from the analysis of student interviews. These latter progressions are offered by the authors as being particularly important to designing and sequencing of instructional strategies to support students' movement from one level of the learning progression to the next and to development and use of assessments. The paper concludes with a discussion of instructional strategies used to move students along the learning progression. Interested readers can learn more about current work on the development of learning progressions in science in a recent report prepared by Corcoran *et al.* (2009) for the Consortium for Policy Research in Education.

4. Chevalier, C. D., Ashley, D. C., and Rushin, J. W. (2010). Acquisition and retention of quantitative communication skills in an undergraduate biology curriculum: long-term retention results. J. College Sci. Teach. *39*, 64–70.

[Abstract available: www.nsta.org/publications/browse_journals.aspx?action=issue&thetype=all&id=10.2505/3/jcst10_039_05]

Chevalier and colleagues use a pretest/posttest design to study the impact of a "nontraditional experimental learning approach" implemented to foster improvement in and retention of quantitative communication skills (QCS) in an entry-level organismal biology course for majors. Communication skills in this context refer to competencies in areas of descriptive and inferential statistics, experimental design, formulation of hypotheses, and data analysis and evaluation. These skills were fostered in the majors biology course by introductory presentations in the lecture class, by laboratory class discussions (before and after completion of the experiments) that featured experimental design, data analysis, and interpretation of results, and by numerous homework assignments to develop competency in statistical analysis. The 36-item multiple-choice instrument used to assess students' content-oriented proficiency was developed by the authors to be in alignment with the QCS course objectives and practices and to require use of a range of cognitive levels (from comprehension to application, analysis, and evaluation) on the part of the successful test-taker. Average scores (at the beginning and end of the semester) of 170 students from the "reformed" organismal biology course were compared with those of students in a nonmajors biology course ($n = 194$), and with scores of students in five more advanced courses for majors ($n = 6–76$). The organismal biology course was a prerequisite for all of the upper-level courses. Although all courses included in the study had a laboratory component—a traditional one in the nonmajors course, and investigative laboratories in the upper-division majors courses—only the laboratory for the entry-level majors course incorporated the QCS enrichment experiences. Comparison of scores using analysis of variance, followed by the Tukey-Kramer multiple range test, revealed a statistically significant improvement in QCS in the organismal biology course. Although students in the nonmajors course with the traditional laboratory had pretest scores that were not significantly different from those for the majors course, the nonmajors' posttest scores showed no improvement in QCS.

The pretest scores for the biology majors enrolled in the upper-level courses were not significantly different from the posttest scores from the entry-level course, indicating retention of QCS for periods as long as two years. However, the QCS scores did not improve during the semester-long experience in any of the upper-level courses. Although the authors do not present information about the reliability (using a typical definition) and validity of the QCS instrument, or about how well matched the student study population subsets were, the results can be interpreted to suggest that continued development of QCS competency in college students (both majors and nonmajors) requires the reinforcement of intentional exposure to QCS-building experiences throughout college.

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 Deborah Allen (deallen@udel.edu).

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