

STEM Topic: Student Retention

Haak, D.C., Hillerislambers, J., Pitre, E., Freeman, S. 2011. Increased structure and active learning reduce the achievement gap in introductory biology. *Science*. Vol. 332, 1213-1230.

Science, technology, engineering, and mathematics instructors have been charged with improving the performance and retention of students from diverse backgrounds. To date, programs that close the achievement gap between students from disadvantaged versus nondisadvantaged educational backgrounds have required extensive extramural funding. We show that a highly structured course design, based on daily and weekly practice with problem-solving, data analysis, and other higher-order cognitive skills, improved the performance of all students in a college-level introductory biology class and reduced the achievement gap between disadvantaged and nondisadvantaged students—without increased expenditures. These results support the Carnegie Hall hypothesis: Intensive practice, via active-learning exercises, has a disproportionate benefit for capable but poorly prepared students.

Halcrow, C., Iiams, M. 2011. You can build it, but will they come? *Primus*. Vol. 21, 323-337.

Studies show that more students fail or withdraw from college mathematics courses than any other. To address this concern, the Mathematics Department at the University of North Dakota opened its Mathematics Learning Center (MLC) in the fall of 2000. In this study, the effectiveness of the MLC and the free tutoring offered for students in freshman level mathematics courses was examined.

The quantitative portion of the study examined the difference between course grades in experimental and control sections of four distinct freshman level mathematics courses. Students in the experimental sections were required to attend the Mathematics Learning Center (MLC) for one hour weekly while students in the control sections were simply informed of the availability of tutoring in the MLC. The qualitative portion of the research utilized methodologies of a phenomenological study through in-depth interviews with 13 participants. Three conclusions are offered: 1) Lower level or lower ability students are less likely to attend the MLC and seek help from tutors; 2) Once students got over their fears of engaging with tutors, they found them friendly and helpful, and believed they had greater success because of the tutoring; and 3) A positive correlation existed between time spent in the MLC and course grade for experimental section students.

Maltese, A.V., Tai, R.H. 2011. Pipeline persistence: Examining the association of educational experiences with earned degrees in STEM among U.S. students. Wiley Periodicals, Inc. *Science Education*. 1-31.

As the global economic crisis continues, sustaining the United States' position as a leader in research and development is a top concern of policy makers. Looking to increase the number of students pursuing degrees in STEM (science, technology, engineering, and mathematics), calls for improved mathematics and science education abound. We completed a two-part analysis to assess the school-based factors related to students choosing to complete a major in STEM. The results indicate that the majority of students who concentrate in STEM make that choice during high school, and that choice is related to a growing interest in mathematics and science rather than enrollment or achievement. These results indicate that the current policy focus on

advanced-level course taking and achievement as measures to increase the flow of students into STEM may be misguided.

Richards-Babb, M., Drelick, J., Henry, Z., Robertson-Honecker, J. 2011. Online homework, help or hindrance? What students think and how they perform. *Research and Teaching*. Vol. 40, 81-94.

To improve students' retention rates in general chemistry, online homework was introduced into our curriculum. Replacing quizzes directly by online homework significantly improved ($p < .0005$) success rates in second-term general chemistry. Attitudinal Likert survey results indicate that the majority of students completed the online homework assignments (90%) and viewed the assignments as worth the effort (83.5%). Students were overwhelming (85.7%) in their recommendation that online homework use should continue. More consistent study habits were reported by 75.6% of students, and students reported using a suite of effective problem-solving approaches for questions marked as incorrect. Our instructors have willingly embraced the use of online homework and point to the incredible amount of time savings for the instructor as reason enough to use online homework.

Crossgrove, K., Curran, K. 2008. Using clickers in nonmajor- and major-level biology courses: Student opinion, learning, and long-term retention of course material. *Life Sciences Education*. Vol. 7, 146-154.

Student response systems (clickers) are viewed positively by students and instructors in numerous studies. Evidence that clickers enhance student learning is more variable. After becoming comfortable with the technology during fall 2005–spring 2006, we compared student opinion and student achievement in two different courses taught with clickers in fall 2006. One course was an introductory biology class for nonmajors, and the other course was a 200 level genetics class for biology majors. Students in both courses had positive opinions of the clickers, although we observed some interesting differences between the two groups of students. Student performance was significantly higher on exam questions covering material taught with clickers, although the differences were more dramatic for the nonmajors biology course than the genetics course. We also compared retention of information 4 mo. after the course ended, and we saw increased retention of material taught with clickers for the nonmajors course, but not for the genetics course. We discuss the implications of our results in light of differences in how the two courses were taught and differences between science majors and nonmajors.

McConnell, D. 2008. Less talk, more action: Active learning in introductory geoscience courses. *McConnell NAS White Paper*, October.

Review of research-supported practices in large, general-education Earth Science classes. Practices focused on conceptual understanding and included a variety of practices from simple multiple choice questions to physical modeling. Analyses of data show that these methods were preferred by students. These processes also improved student retention and increased logical thinking skills (McConnell, 2008).

Morse, D., Jutras, F. 2008. Implementing concept-based learning in a large undergraduate classroom. *Life Sciences Education*. Vol 7, 243-253.

An experiment explicitly introducing learning strategies to a large, first-year undergraduate cell biology course was undertaken to see whether awareness and use of strategies had a measurable impact on student performance. The construction of concept maps was selected as the strategy to be introduced because of an inherent coherence with a course structured by concepts. Data were collected over three different semesters of an introductory cell biology course, all teaching similar course material with the same professor and all evaluated using similar examinations. The first group, used as a control, did not construct concept maps, the second group constructed individual concept maps, and the third group first constructed individual maps then validated their maps in small teams to provide peer feedback about the individual maps. Assessment of the experiment involved student performance on the final exam, anonymous polls of student perceptions, failure rate, and retention of information at the start of the following year. The main conclusion drawn is that concept maps without feedback have no significant effect on student performance, whereas concept maps with feedback produced a measurable increase in student problem-solving performance and a decrease in failure rates.

Rath, K.A., Peterfreund, A.R., Xenos, S.P., Bayliss, F., Carnal, N. 2007. Supplemental instruction in introductory biology I: Enhancing the performance and retention of underrepresented minority students. *Life Sciences Education*. Vol. 6, 203-216.

Supplemental instruction classes have been shown in many studies to enhance performance in the supported courses and even to improve graduation rates. Generally, there has been little evidence of a differential impact on students from different ethnic/racial backgrounds. At San Francisco State University, however, supplemental instruction in the Introductory Biology I class is associated with even more dramatic gains among students from underrepresented minority populations than the gains found among their peers. These gains do not seem to be the product of better students availing themselves of supplemental instruction or other outside factors. The Introductory Biology I class consists of a team-taught lecture component, taught in a large lecture classroom, and a laboratory component where students participate in smaller lab sections. Students are expected to master an understanding of basic concepts, content, and vocabulary in biology as well as gain laboratory investigation skills and experience applying scientific methodology. In this context, supplemental instruction classes are cooperative learning environments where students participate in learning activities that complement the course material, focusing on student misconceptions and difficulties, construction of a scaffolded knowledge base, applications involving problem solving, and articulation of constructs with peers.

El-Rady, J. 2006. To click or not to click: That is the question. *Innovate, Journal of Online Education*. Vol. 2, 18.

It is not unusual in higher education these days to have classes with large enrollment. Indeed at the University of South Florida ([USF](#)) (enrollment 41,000), large classes are the norm. In the eight years during which I have been an instructor in the [Biology Department](#) at USF, my mid-level and lower-level classes have had enrollments ranging from 100-300 students. This large class size generates a few problems, especially in terms of engaging students in active learning. While a well-designed traditional lecture can be very effective, students can engage more

directly with the material when they actively take part in their learning instead of simply passively receiving information. Another problem in large enrollment courses is low attendance, especially by students taking a non-major course.

DeHaan, R.L. 2005. The impending revolution in undergraduate science education. *Journal of Science Education and Technology*. Vol. 14, 253-270.

There is substantial evidence that scientific teaching in the sciences, i.e. teaching that employs instructional strategies that encourage undergraduates to become actively engaged in their own learning, can produce levels of understanding, retention and transfer of knowledge that are greater than those resulting from traditional lecture/lab classes. But widespread acceptance by university faculty of new pedagogies and curricular materials still lies in the future. In this essay we review recent literature that sheds light on the following questions:

- What has evidence from education research and the cognitive sciences told us about undergraduate instruction and student learning in the sciences?
- What role can undergraduate student research play in a science curriculum?
- What benefits does information technology have to offer?
- What changes are needed in institutions of higher learning to improve science teaching?

We conclude that widespread promotion and adoption of the elements of scientific teaching by university science departments could have profound effects in promoting a scientifically literate society and a reinvigorated research enterprise.

Moore, R. 2004. Helping students succeed in introductory science courses. *Journal of College Science Teaching*. Vol. 33, 14-17.

I measured the reliability of introductory biology students' claims regarding lecture attendance, help session attendance, and reading assignment compliance. In all areas, students' reported behaviors were different than their actual behaviors. Also, penalties for excessive absences did not substantially improve either attendance or academic performance. These data indicate that students' self-reports of these course-related behaviors are unreliable and that penalties for absenteeism are ineffective for improving attendance and grades. Strategies for enhancing students' success in introductory science classes are also discussed.