Synopsis

Active Learning vs Traditional Lecture Approach in Introductory College Biology: Comparison of Student Performance on Exams

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This paper describes the results of a comparison study that investigated biology students' understandings of key science concepts in an active/constructivist learning environment and in traditional lecture settings. The purpose of the study was to compare student performance on shared exam questions given in three sections of Biology 100: Concepts in Biology, an introductory biology course for majors.

After more than two decades of teaching Biology 100: Concepts in Biology; Professor A (Section A) of biology, had become increasing concerned about the apathy of the majority of the students taking the course. Few students appeared to begin or end the course feeling that science in general, or biology in particular, was exciting or relevant, although most gave his teaching style high ratings on student evaluations. Biology 100 is a four-credit, one semester course designed primarily for beginning biology and biochemistry majors. Typically, two sections are offered during the fall semester (Section A & B) and one in the spring semester (Section C). In this study, Professor A teamed up with other colleagues to implement a variety of active learning approaches based on constructivist theory and to compare student performance on shared exam questions in his section to the other traditionally taught sections of Biology 100.

Researchers involved in this study represent a unique university research partnership linking the Departments of Biological Sciences, Education, and Mathematics /Statistics through a statewide Collaborative for Excellence in Teacher Preparation - an NSF funded program focused on better preparing middle school science and mathematics teachers. Through this program biologists and science educators joined with a statistician to collect and analyze evidence related to determining the effectiveness of introductory biology teaching - active approaches vs. tractional lecture format.

The research team was comprised of two biology professors, a science education professor, and a professor of statistics. Professor A, with over twenty years of experience teaching introductory biology, was the sole instructor of Biology 100 - active learning section (Section A, n = 242; Fall 1995). An assistant professor science education served as the classroom observer. She served as the evaluator and professional development mentor in Section A and provided advice on implementing constructivist ideas, cooperative learning, and issue-oriented science

teaching approaches with which she had extensive prior experience. A comparison section of Biology 100 (Section B, n = 179; Fall 1995) was taught by Professor B using the tractional lecture approach. Professor B had five years of teaching experience with the course. Both Professor A and B had received highly favorable end of the semester student evaluations. In addition to Sections A and B offered in the Fall 1995, an additional comparison section (Section C, n = 236) was team taught by Professor A and two other faculty members in the Spring 1996. A mathematics/statistics professor provided expertise in analyzing the assessment findings.

The research team asked two fundamental questions. First, what could be done in a large lecture course to make the learning more active? Second, how would student performance compare on exams in the active learning and tractional lecture sections? Not often do educational researchers find themselves in a situation where they can compare teaching approaches. The research team felt that this action research comparison should be done as a first step in exploring different ways of teaching and learning in undergraduate science courses.

Students enrolled in three large [ca. 200 students] sections of Biology 100 participated in the study. A comparison of student performance on shared, multiple-choice exam items was conducted to determine if there were differences in performance between active learning and traditional lecture sections.

Students enrolled in the active learning section (Section A) were involved in a variety of individual and group discussions, projects, and research challenges. In the active learning section (Section A), value was placed on finding out what students knew through class discourse, what they wanted to know through analysis of their questions and conversations, and what they were learning through reasoning checks. Instruction in the active learning section was rooted in constructivist principles. The primary instructional goal was to have students actively participate in the learning process. Students were expected to question, think scientifically, and apply understandings of key biological concepts. Students in the lecture sections (Sections B & C) were taught using the typical lecture method with very little discussion or interaction between students and professor.

University science faculty have frequently voiced concern that student-centered learning is fine in principle, but it takes too much class time to allow for student discussion and reflection and that the approach does not allow for enough time to get "through the material". In this study, it is true that less time was available for "coverage" in the active learning section. Yet, a quantitative analysis of mean percent scores revealed that students enrolled in the active learning section did as well or better than the students in the traditional lecture sections on a majority of the shared test items, and that the performance on shared exam items of students in the active learning section improved significantly across the semester.