WHAT RESEARCH TELLS US ABOUT TEACHING AND LEARNING

DBER research results

EXPLORATION ACTIVITY

Three instructors taught a University science course during the same semester. Prof. A emphasized concepts, careful, logical; Prof. B used demonstrations and took extra preparation time; Prof. C had a problem solving emphasis. All used the same textbook and covered the same chapters. All professors received similar evaluations. Pre-test scores for each class were almost identical. ***Predict which professor's class showed the greatest gain in post-test score.***

A. Prof. A
B. Prof. B
C. Prof. C
D. No difference

Halloun, I.H. and D. Hestenes, American Journal of Physics, 1985. 53(11): p. 1043-1055.

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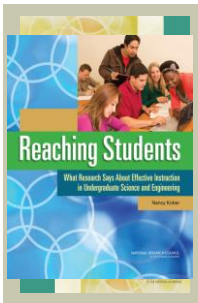
DISCIPLINE-BASED EDUCATION RESEARCH



DBER goals:

- Understand how people learn concepts, practices, and ways of thinking of science and engineering;
- Understand the nature and development of expertise in a discipline;
- Identify and measure appropriate learning objectives and instructional approaches that advance student learning;
- Contribute to the knowledge base to help guide DBER findings to classroom practice;
- Identify approaches to make science and engineering education broad and inclusive.

National Research Council, 2012, Singer, Nielsen, & Schweingruber, (Eds.) National Academies Press.

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STUDENT ACTIVITY AND LEARNING

*Humans are not information storage machines who receive deliveries of information and store the deliveries in memory. Instead, **humans are sense-makers** who engage in active cognitive processes during learning such as selecting relevant words and pictures, organizing the selected materials into verbal and visual mental models, and integrating the verbal and visual models.*

Richard E. Mayer
Multimedia Learning, 2009, p.158

DBER FINDINGS ABOUT STUDENT LEARNING

1. *Students learn key concepts better when they have opportunities to actively monitor their understanding in a variety of activities during class.*
2. *Students become better learners when we challenge them to answer questions that require the use of higher order thinking skills.*
3. *Knowledge is socially constructed and people learn best in supportive social settings (e.g., in small collaborative groups).*

Classes that support these learning strategies are termed reformed or student-centered or inquiry-based or active learning environments

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Active Learning vs. Traditional Lecture

Active learning engages students in the process of learning through activities and/or discussion in class, as opposed to passively listening to an expert. It emphasizes higher-order thinking and often involves group work.

(Freeman et al, 2014)

Traditional lecturing - Continuous exposition by the teacher. Student activity limited to taking notes and/or asking occasional, unprompted questions of the instructor.

Freeman et al., 2014, Proceedings of the National Academy of Sciences v.111, #23 p. 8410-8415.

Prediction Activity

Scott Freeman and colleagues completed a meta-analysis of DBER studies across multiple STEM disciplines. They compared DFW rates and student exam performance between versions of courses taught with traditional lecture and active learning methods. DFW rates averaged 34% in traditional lecture versions of these courses. **Predict the average change in DFW rates and the average change in exam performance in the active learning classes.**

A. +3% & +3% **B.** -3% & +3% **C.** -6% & +6%
D. -12% & +6% **E.** -6% & +12%

Freeman et al., 2014, Proceedings of the National Academy of Sciences v.111, #23 p. 8410-8415.

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Active Learning vs. Traditional Lecture

Freeman et al. coded studies that:

i. Contrasted traditional lecturing vs. any active learning intervention;
ii. Occurred in the context of a regularly scheduled course for undergraduates;
iii. Involved a course in a STEM discipline (e.g., biology, chemistry, geology, mathematics, physics);
iv. Largely limited analysis to changes in a regularly scheduled class or recitation session;
v. Included data on some aspect of student academic performance.

Failure rates (DFW) in active learning classes dropped from 34% to 22%
(n=67 studies; 29,300 students)

Freeman et al., 2014, Proceedings of the National Academy of Sciences v.111, #23 p. 8410-8415.
Wieman, 2014, Proceedings of the National Academy of Sciences v.111, #23 p. 8319-8320.

Active Learning vs. Traditional Lecture

Students in active learning classes out-performed those in traditional classes by ~6% on equivalent exams (n=158 studies)

- Stronger signal with
  - *Concept inventories (vs. exams)*
  - *Smaller classes (<50)*
- Similar results for
  - *Majors/non-majors*
  - *Intro/upper level*

Freeman et al., Proceedings of the National Academy of Sciences 111(23) (2014): 8410-8415.

Adoption of Reformed Teaching Strategies

- Thirty years of DBER has reported gains in student learning that result from the application of research-validated teaching and learning practices
- Various agencies and organizations have called for broad adoption of reformed teaching strategies
- But these practices are far from pervasive in college (science) classrooms