

Status of the Field of Discipline-Based Education Research: A Workshop

These are slides from the committee presentations
following the release of the 2012 report

*Discipline-Based Education Research: Understanding
and Improving Learning in Undergraduate Science
and Engineering*

Discipline-Based Education Research (DBER)

Understanding and Improving
Learning in Undergraduate Science
and Engineering



http://www.nap.edu/catalog.php?record_id=13362

Undergraduate Science and Engineering Education: Goals

- Provide all students with foundational knowledge and skills
- Motivate some students to complete degrees in science or engineering
- Support students who wish to pursue careers in science or engineering

Undergraduate Science and Engineering Education: Challenges and Opportunities

- Retaining students in courses and majors
- Increasing diversity
- Improving the quality of instruction

What is Discipline-Based Education Research?

- Emerging from various parent disciplines
- Investigates teaching and learning in a given discipline
- Informed by and complementary to general research on human learning and cognition

Study Charge

- Synthesize empirical research on undergraduate teaching and learning in physics, chemistry, engineering, biology, the geosciences, and astronomy.
- Examine the extent to which this research currently influences undergraduate science instruction.
- Describe the intellectual and material resources that are required to further develop DBER.

Committee on the Status, Contributions, and Future Directions of Discipline-Based Education Research

- **SUSAN SINGER** (Chair), Carleton College
- **ROBERT BEICHNER**, North Carolina State University
- **STACEY LOWERY BRETZ**, Miami University
- **MELANIE COOPER**, Clemson University
- **SEAN DECATUR**, Oberlin College
- **JAMES FAIRWEATHER**, Michigan State University
- **KENNETH HELLER**, University of Minnesota
- **KIM KASTENS**, Columbia University
- **MICHAEL MARTINEZ**, University of California, Irvine
- **DAVID MOGK**, Montana State University
- **LAURA R. NOVICK**, Vanderbilt University
- **MARCY OSGOOD**, University of New Mexico
- **TIMOTHY F. SLATER**, University of Wyoming
- **KARL A. SMITH**, University of Minnesota and Purdue University
- **WILLIAM B. WOOD**, University of Colorado

Structure of the Report

- Section I. Status of Discipline-Based Education Research
- Section II. Contributions of Discipline-Based Education Research
- Section III. Future Directions for Discipline-Based Education Research

Section I. Status of Discipline-Based Education Research

Status of DBER: Goals

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

Status of DBER: Types of Knowledge Required To Conduct DBER

- Deep disciplinary knowledge
- The nature of human thinking and learning as they relate to a discipline
- Students' motivation to understand and apply findings of a discipline
- Research methods for investigating human thinking, motivation, and learning

Status of DBER: Conclusions

- DBER is a collection of related research fields rather than a single, unified field. (Conclusion 1)
- High-quality DBER combines expert knowledge of:
 - a science or engineering discipline,
 - learning and teaching in that discipline, and
 - the science of learning and teaching more generally.(Conclusion 4)

Section II. Contributions of Discipline-Based Education Research

Contributions of DBER: Conceptual Understanding and Conceptual Change

- In all disciplines, undergraduate students have incorrect ideas and beliefs about fundamental concepts. (Conclusion 6)
- Students have particular difficulties with concepts that involve very large or very small temporal or spatial scales. (Conclusion 6)
- Several types of instructional strategies have been shown to promote conceptual change.

Contributions of DBER: Problem Solving and the Use of Representations

- As novices in a domain, students are challenged by important aspects of the domain that can seem easy or obvious to experts. (Conclusion 7)
- Students can be taught more expert-like problem-solving skills and strategies to improve their understanding of representations.

Contributions of DBER: Research on Effective Instruction

- Effective instruction includes a range of well-implemented, research-based approaches. (Conclusion 8)
- Involving students actively in the learning process can enhance learning more effectively than lecturing.

Section III. Future Directions for Discipline-Based Education Research

Future Directions for DBER: Translating DBER into Practice

- Available evidence suggests that DBER and related research have not yet prompted widespread changes in teaching practice among science and engineering faculty. (Conclusion 12)
- Efforts to translate DBER and related research into practice are more likely to succeed if they:
 - are consistent with research on motivating adult learners,
 - include a deliberate focus on changing faculty conceptions about teaching and learning,
 - recognize the cultural and organizational norms of the department and institution, and
 - work to address those norms that pose barriers to change in teaching practice. (Conclusion 13)

Future Directions for DBER: Recommendations for Translating DBER Into Practice

- **RECOMMENDATION:** With support from institutions, disciplinary departments, and professional societies, faculty should adopt evidence-based teaching practices.
- **RECOMMENDATION:** Institutions, disciplinary departments, and professional societies should work together to prepare current and future faculty to apply the findings of DBER and related research, and then include teaching effectiveness in evaluation processes and reward systems throughout faculty members' careers.
(Paraphrased)

Future Directions for DBER: Advancing DBER through Collaborations

- Collaborations among the fields of DBER, and among DBER scholars and scholars from related disciplines, although relatively limited, have enhanced the quality of DBER.
(Conclusion 15)

Future Directions for DBER: Research Infrastructure

- Advancing DBER requires a robust infrastructure for research. (Conclusion 16)
- **RECOMMENDATION:** Science and engineering departments, professional societies, journal editors, funding agencies, and institutional leaders should:
 - clarify expectations for DBER faculty positions,
 - emphasize high-quality DBER work,
 - provide mentoring for new DBER scholars, and
 - support venues for DBER scholars to share their research findings

Future Directions for DBER: Some Key Elements of a Research Agenda

- Studies of similarities and differences among different groups of students
- Longitudinal studies
- Additional basic research in DBER
- Interdisciplinary studies of cross-cutting concepts and cognitive processes
- Additional research on the translational role of DBER

Acknowledgements

- National Science Foundation, Division of Undergraduate Education (Grant No. 0934453)
- Various volunteers:
 - Committee
 - Fifteen reviewers
 - Report Review Monitor (Susan Hanson, Clark University) and Coordinator (Adam Gamoran, University of Wisconsin-Madison)
- Commissioned paper authors
- NRC staff (Natalie Nielsen, Heidi Schweingruber, Margaret Hilton)