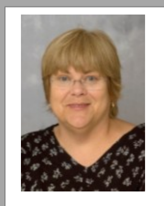
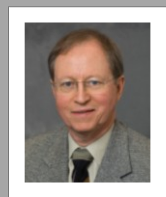
Fundamentals of Engineering Education Research

Rigorous Research in Engineering Education Initiative
(NSF DUE 0817461)
CLEERhub.org

Faculty Development Workshop (2013) – January 9, 2013 – Jeju Island, South Korea





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Karl A. Smith
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Overview
What are we going to do?

- **Welcome and introductions**
- **Topics of the workshop**
  - Background and context
  - Features of engineering education research
  - Research questions and methodologies
  - Print and online resources
  - Global communities and their networks
- **Format of the workshop**
  - Interactive and team-based work

Engineering Education Research and/or Innovation STORY

- **When and how did you become interested in engineering education research and/or innovation?**
- **Was there a critical incident or memorable event associated with your initial interest?**

Workshop frame of reference

- **Workshop is about**
  - Identifying faculty interested in engineering education research
  - Deepening understanding of engineering education research
  - Building engineering education research capabilities
- **Workshop is NOT about**
  - Pedagogical practice, i.e., “how to teach”
  - Convincing you that good teaching is important
  - Writing engineering education research grant proposals or papers
  - Advocating all faculty be engineering education researchers

Levels of inquiry in engineering education

- **Level 0** Teacher
  - Teach as taught
- **Level 1** Effective Teacher
  - Teach using accepted teaching theories and practices
- **Level 2** Scholarly Teacher
  - Assesses performance and makes improvements
- **Level 3** Scholar of Teaching and Learning
  - Engages in educational experimentation, shares results
- **Level 4** Engineering Education Researcher
  - Conducts educational research, publishes archival papers

Source: Streveler, R., Borrego, M. and Smith, K.A. 2007. Moving from the "Scholarship of Teaching and Learning" to "Educational Research:" An Example from Engineering. *Improve the Academy,* Vol. 25, 139-149.

Workshop Intentions / Participant Learning Outcomes

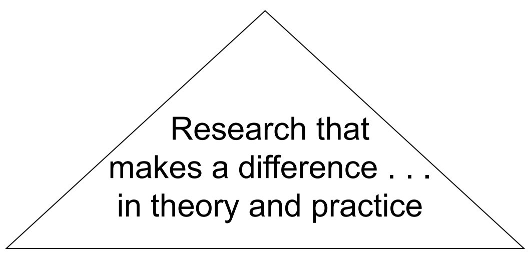
1. Describe key features of engineering education research
2. Explain emergence of engineering education research as a discipline
3. Describe recent reports and their relevance for and relationship with engineering education research
4. Summarize growth of engineering education research
5. Speculate on the future of engineering education research

Some history about this workshop

- **Rigorous Research in Engineering Education (RREE1)**
  - One-week summer workshop, year-long research project
  - Funded by National Science Foundation (NSF), 2004-2006
  - About 150 engineering faculty participated
- **Goals**
  - Identify engineering faculty interested in conducting engineering education research
  - Develop faculty knowledge and skills for conducting engineering education research (especially in theory and research methodology)
  - Cultivate the development of a Community of Practice of faculty conducting engineering education research

RREE Approach

Theory
(study grounded in theory/conceptual framework)

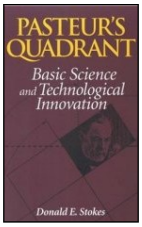


Research
(appropriate design and methodology)

Practice
(implications for teaching)

http://inside.mines.edu/research/cee/ND.htm

Research can be inspired by …



		Use (Applied)	
		No	Yes
Understanding (Basic)	Yes	Pure basic research (Bohr)	Use-inspired basic research (Pasteur)
	No		Pure applied research (Edison)

Source: Stokes, D. 1997. Pasteur's quadrant: Basic science and technological innovation. Washington, DC: Brookings Institution.

RREE2

Follow-up proposal (RREE2)

- Includes a series of 5 short courses*
  - Fundamentals of Engineering Education Research
  - Selecting Conceptual Frameworks
  - Understanding Qualitative Research
  - Designing Your Research Study
  - Collaborating with Learning and Social Scientists

*Recorded and posted on CLEERhub.org

Today's objectives

- Identify principal features of engineering education research
- Frame and situate research questions and methodologies
- Gain familiarity with several print and online resources
- Become aware of global communities and their networks

What does high-quality research in your discipline look like?

- What are the **qualities, characteristics, or standards** for **high-quality** research in your discipline?
- Think of it this way: "**Research in my field is high-quality when…."**

☞ Individually, list the qualities, characteristics or standards in your discipline

☞ Compare your lists, and as a group, develop a list of high-quality research qualities, characteristics or standards

What does high-quality research in your discipline look like?

- (Workshop list)
- (Workshop list)

What does <u>education</u> research in your discipline look like?

- What are the **qualities, characteristics, or standards** for **high-quality <u>education</u>** research in your discipline?

☞ Individually, list:

1) Which qualities, characteristics, or standards identified in the previous list DO NOT apply?
2) What qualities, characteristics, or standards can you envision that are DIFFERENT for education research?

☞ As a group, combine your lists.

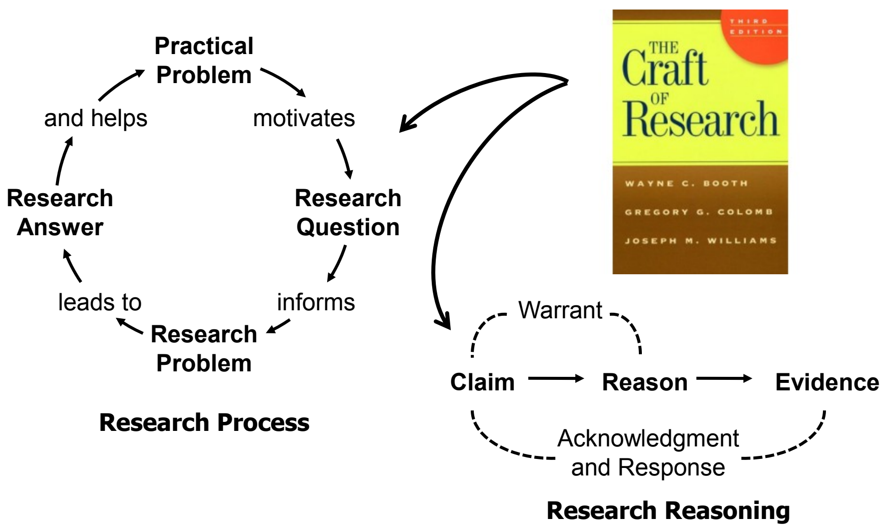
Guiding principles for scientific research in education

1. Pose **significant questions** that can be investigated **empirically**
2. Link research to relevant **theory**
3. Use **methods** that permit **direct investigation** of the question
4. Provide coherent, explicit chain of **reasoning**
5. Replicate and **generalize** across studies
6. Disclose research to encourage professional **scrutiny and critique**

- **How do our lists compare with the NRC six?**
- **Is a global list possible? Do cultural contexts matter?**

Source: Scientific Research in Education, National Research Council, 2002

The research process and reasoning



Most common frameworks in educational research

- **Theories of learning**
- **Theories of motivation**
- **Theories of development**
- **Theories of contextual effects**

See Marilla Svinick's Handbook — A Guidebook On Conceptual Frameworks For Research In Engineering Education. http://cleerhub.org/resources/gb-svinicki

Multiple theoretical frameworks

Which comes first: framework or observation?

Can go in either direction

Multiple theoretical frameworks

Going from framework to research question to research study

Framework

Self-determination framework says - students' motivation for a task is affected by the degree of control they have over it.

Therefore

If we manipulate the degree of student control, we should see variations in motivation levels.

Design

Different groups are given different degrees of control over the topic and process of their project and their motivation for the project is measured at various times throughout the semester.

Multiple theoretical frameworks

Going from observation to framework to research question to research study and back to observation

Observation

Some students in a class participate more than others.

Possible Frameworks

•Learning theory: Prior knowledge differences
•Motivation theory: Goal orientations, task value, self-efficacy
•Contextual variables: Course contingencies; classroom climate

Design possibilities

•Measure and regress level of participation on potential variables.
•Manipulate course contingencies or course practices.

Books, journals, online resources

- The Craft of Research
- Scientific Research in Education
- Journal of Engineering Education (JEE)
- Thomson ISI Citation Index
- Some other journals

What is your experience?

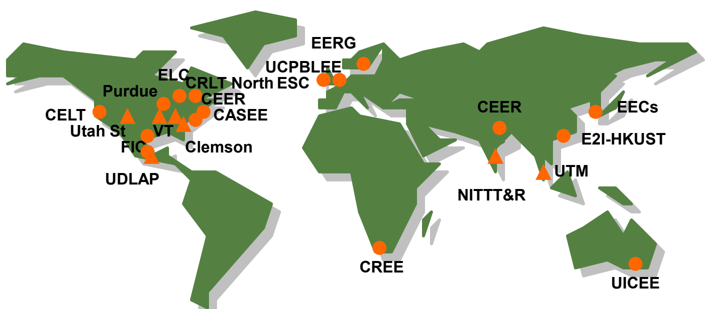
- Silently reflect on your experience with engineering education research
- Jot down
  - What has been the most exciting opportunity for you in this area?
  - What has been the most difficult challenge you have faced?
- Share with the person next to you

Becoming an Engineering Education Researcher—Adams, Fleming & Smith

1. Find and follow your dream.
2. Find and build community.
3. Do your homework. Become familiar with engineering education research.
4. Remember what it is like to be a student—be open to learning and the associated rewards and challenges.
5. Find balance. You will feel like you have multiple identities.
6. Be an architect of your own career.
7. Wear your researcher "lenses" at all times.
8. Use research as an opportunity for reflective practice.

Adams, R., L. Fleming, and K. Smith. 2007. Becoming an engineering education researcher: Three researchers stories and their intersections, extensions, and lessons. Proceedings, International Conference on Research in Engineering Education; http://www.ce.umn.edu/%7Esmith/docs/Adams-Fleming-Smith-Becoming_an_engineering_education_researcher-ICREE2007.pdf

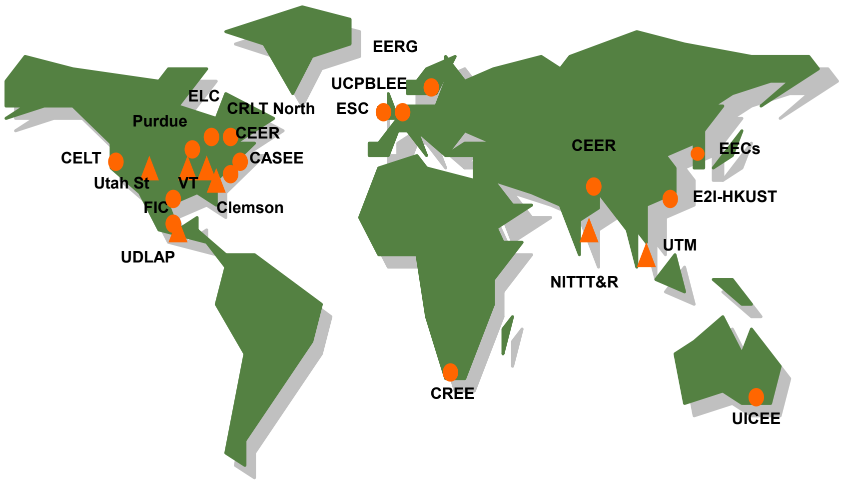
Groups, centers, departments…



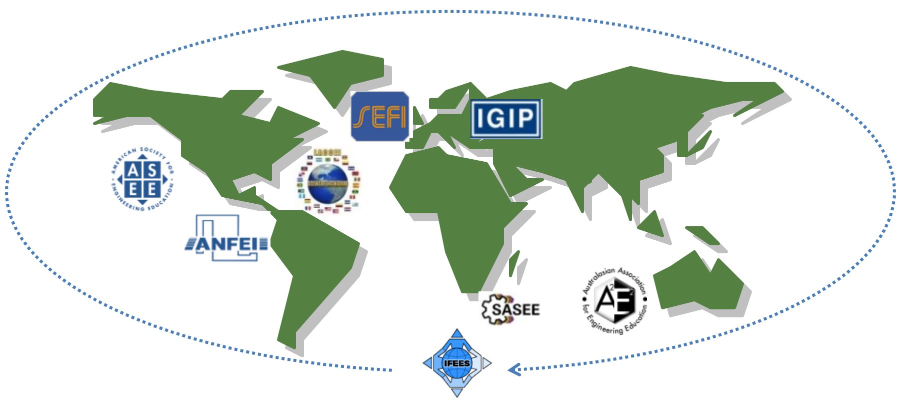
● **Engineering Education Centers** — Australia: UICEE, UNESCO International Centre for Engineering Education; Denmark: UCPBLEE, UNESCO Chair in Problem Based Learning in Engineering Education; Hong Kong: E2I, Engineering Education Innovation Center, Hong Kong University of Science and Technology; Pakistan: Center for Engineering Education Research, NUST, National University for Science and Technology; South Africa: CREE, Centre for Research in Engineering Education, U of Cape Town; Sweden: Engineering Education Research Group, Linköping U; UK: ESC, Engineering Subject Centre, Higher Education Academy; USA: CELT, Center for Engineering Learning and Teaching, U of Washington; CRLT North, Center for Research on Learning and Teaching, U of Michigan; Faculty Innovation Center, U of Texas-Austin; Engineering Learning Center, U of Wisconsin-Madison; CASEE, Center for the Advancement of Scholarship in Engineering Education, National Academy of Engineering; EEIC, Engineering Education Innovation Center, Ohio State University; CEER, Center for Engineering Education Research, Michigan State University.

▲ **Engineering Education Degree-granting Departments** — USA: School of Engineering Education, Purdue U; Department of Engineering Education, Virginia Tech; Department of Engineering and Science Education, Clemson U; Department of Engineering and Technology Education, Utah State U; Malaysia: Engineering Education PhD program, Universiti Teknologi Malaysia; India: National Institute for Technical Teacher Training and Research; Mexico: Universidad de las Americas, Puebla

Groups, centers, departments…



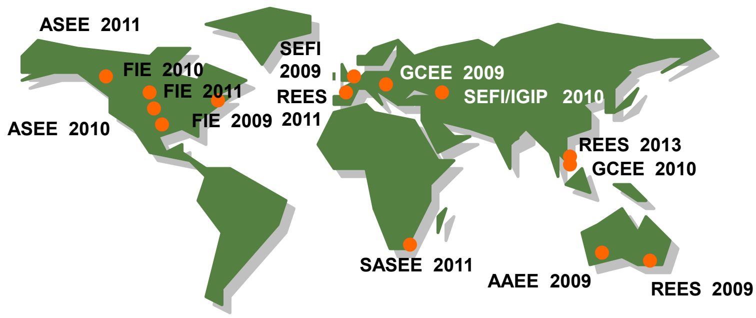
Engineering education societies…



Societies with Engineering Education Research Groups — ASEE, American Society for Engineering Education, Educational Research Methods Division; SEFI, Société Européenne pour la Formation des Ingénieurs (European Society for Engineering Education), Engineering Education Research Working Group; Australasian Association for Engineering Education, Engineering Education Research Working Group; Community of Engineering Education Research Scholars, Latin America and Caribbean Consortium for Engineering Institutions

Societies with Engineering Education Research Interests — Indian Society for Technical Education, Latin American and Caribbean Consortium of Engineering Institutions, Asociación Nacional de Facultades y Escuelas de Ingeniería (National Association of Engineering Colleges and Schools in Mexico), Internationale Gesellschaft für Ingenieurpädagogik (International Society for Engineering Education), International Federation of Engineering Education Societies, South African Engineering Education Association (SASEE)

Forums for dissemination…



Conferences with engineering education research presentations:

- **ASEE** — Annual Conference, American Society for Engineering Education, see www.asee.org
- **AAEE** — Annual Conference, Australasian Association for Engineering Education, see www.aaee.com.au
- **FIE** — Frontiers in Education, sponsored by ERM/ASEE, IEEE Education Society and Computer Society, /fie-conference.org/erm
- **GCEE** — Global Colloquium on Engineering Education, sponsored by ASEE and local partners where the meeting is held, see www.asee.org
- **SEFI** — Annual Conference, Société Européenne pour la Formation des Ingénieurs , see www.sefi.be
- **REES** — Research on Engineering Education Symposium, rees2009.pbwiki.com/
- **SASEE** – South African Society for Engineering Education,

VIEW EDIT

Engineering Education Departments and Programs (Graduate)

(redirected from Engineering-Education-Degree-and-Certificate-Programs)

last edited by Elliot Douglas 2 months, 3 weeks ago Page history

1. Engineering/STEM Education Graduate Programs
2. Engineering Education-Related Certificate Programs
3. Innovative Engineering and Inter/Cross-Disciplinary Programs

<Home

Engineering/STEM Education Graduate Programs

Institution	Program	Degrees Awarded
Arizona State University	Mary Lou Fulton Teachers College	M.Ed. Educational Technology Ph.D. in Curriculum and Instruction with concentration in Engineering Education (more info) Ph.D. in Educational Technology Ph.D. in Educational Technology with concentration in Arts, Media, and Engineering
	Ira A. Fulton School of Engineering	Ph.D. Aerospace Engineering with concentration in Engineering Education Ph.D. Mechanical Engineering with concentration in Engineering Education
University of California - Berkeley	Studies in Engineering, Science, and Mathematics (SESAME) Education	M.A. Technology, Science, or Math Education, Ph.D. Technology, Science, or Math Education
Chalmers University of Technology (Sweden)	Department of Applied Information Technology	Licentiate Engineering Education Research Ph.D. Engineering Education Research
University of Cincinnati	School of Engineering Education (SEE)	
Clemson University	Department of Engineering and Science Education	Ph.D. Engineering or Science Education
University of Kentucky	College of Education - Department of Science, Technology, Engineering and Mathematics	Ph.D. Science, Technology, Engineering and Mathematics Education
Linköping University (Sweden)	Engineering Education Research Group	Ph.D. Engineering Education Research
The College of New Jersey	School of Engineering - Department of Technological Studies	M.A.T. in Secondary Education - Technology Education
Niagara University	College of Education	M.S. Ed. Math, Science, and Technology Education
North Carolina State University	College of Education - Department of Science, Technology, Engineering, and Mathematics Education	M.S. and M.Ed. Program in Technology Education Ed.D. Program in Technology Education
Old Dominion University	Darden College of Education - Department of STEM Education & Professional Studies	M.S. Engineering - Modeling and Simulation

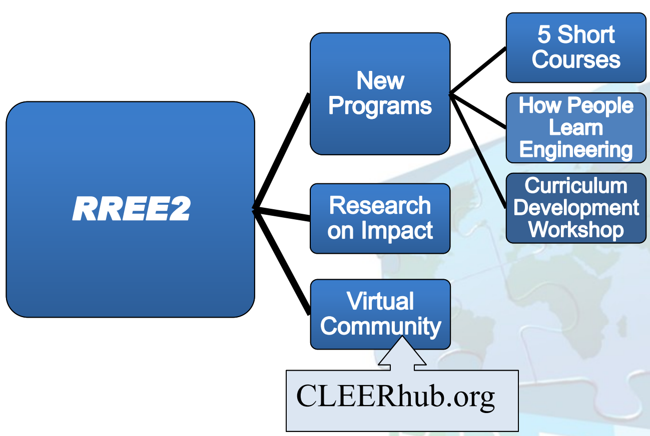
http://tinyurl.com/engredu

RIGOROUS RESEARCH in ENGINEERING EDUCATION

Funded by the National Science Foundation through awards DUE 0341127 and DUE 0817461

Expanding and sustaining research capacity in engineering and technology education: Building on successful programs for faculty and graduate students

Collaborative partners: Purdue (lead), Alverno College, Colorado School of Mines, Howard University, Madison Area Technical College, National Academy of Engineering



RIGOROUS RESEARCH in ENGINEERING EDUCATION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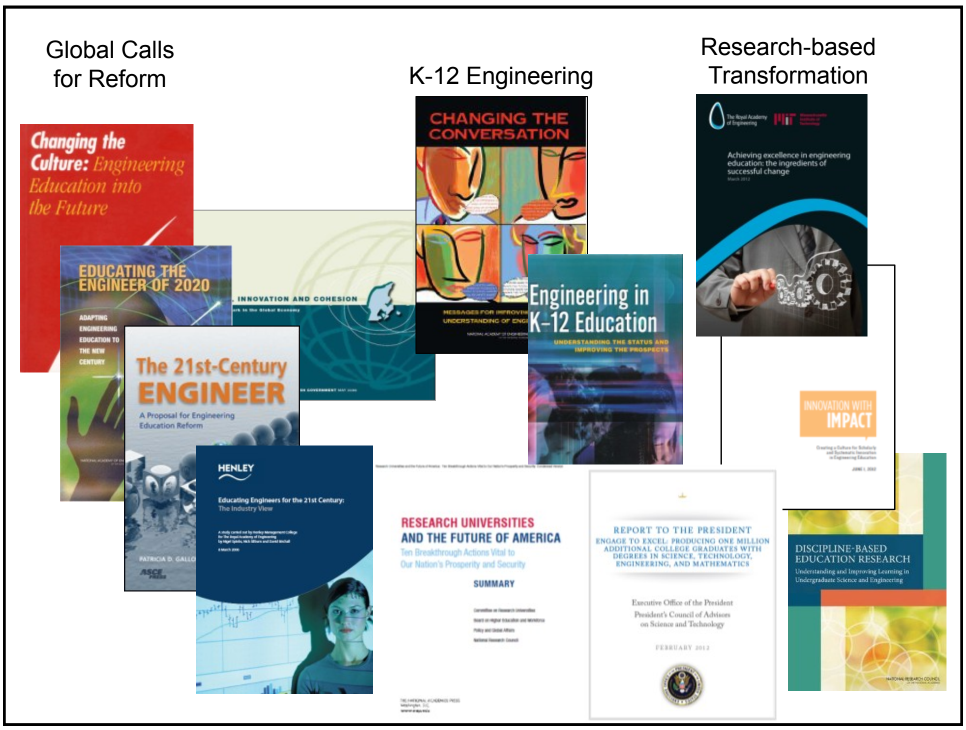
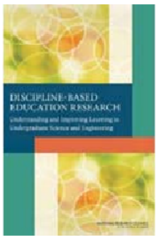
Getting Started in Educational Research
Guide Books
Building a Network of Mentors
Quantitative Research in Education
Conceptual Frameworks For Research
Rigorous Research in Engineering Education
Creating a Community of Practice (PPT)
Workshops
Malaysia 2010: Qualitative Research
Collaborate
Upload Content
Share your materials on this site
Form a user group
Share things in private with your colleagues


Global Calls for Reform
K-12 Engineering
Research-based Transformation
Changing the Culture: Engineering Education into the Future
EDUCATING THE ENGINEER OF 2020
The 21st-Century ENGINEER
A Proposal for Engineering Education Reform
HENLEY
Educating Engineers for the 21st Century: The Industry View
CHANGING THE CONVERSATION
Engineering in K-12 Education
UNDERSTANDING THE STATUS AND IMPROVING THE PROSPECTS
Achieving excellence in engineering education: the ingredients of successful change
INNOVATION WITH IMPACT
RESEARCH UNIVERSITIES AND THE FUTURE OF AMERICA
Ten Breakthrough Actions Vital to Our Nation's Prosperity and Security
SUMMARY
REPORT TO THE PRESIDENT
ENGAGE TO EXCEL: PRODUCING ONE MILLION ADDITIONAL COLLEGE GRADUATES WITH DEGREES IN SCIENCE, TECHNOLOGY, ENGINEERING, AND MATHEMATICS
Executive Office of the President
President's Council of Advisors on Science and Technology
FEBRUARY 2012
DISCIPLINE-BASED EDUCATION RESEARCH
Understanding and Improving Learning in Undergraduate Science and Engineering

Discipline-Based Education Research (DBER)

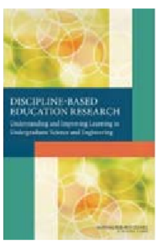


National Research Council 2012

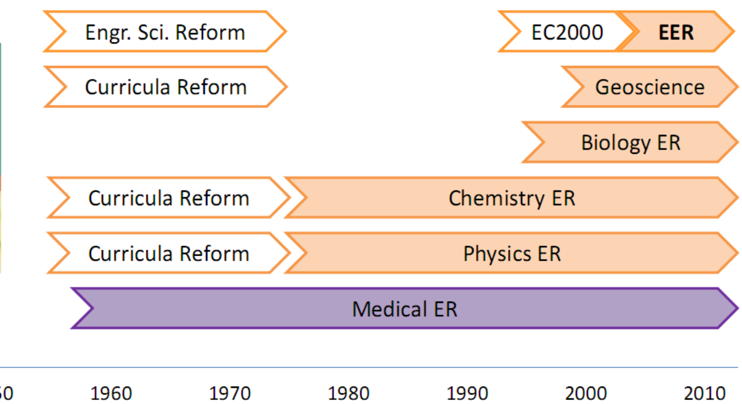
- Discipline-based education research (DBER) is a **small but growing field of inquiry**.
- **Conducting DBER** and **using DBER** findings are **distinct but interdependent** pursuits.
- DBER is **inherently interdisciplinary.**
- Individual fields of DBER have made **notable inroads** in terms of establishing their fields **but still face challenges in doing so**.
- **Blending** a scientific/engineering discipline with education research poses **unique professional challenges for DBER scholars.**
- There are **many pathways to becoming a discipline-based education researcher**.

PURDUE ENGINEERING EDUCATION

Discipline-Based Education Research Timeline



National Research Council 2012



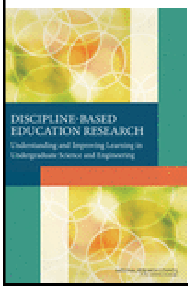
PURDUE ENGINEERING EDUCATION

DBER is **located** in the relevant disciplinary school, e.g. medicine, physics.

SCIENCE EDUCATION AT THE NATIONAL RESEARCH COUNCIL
www.nationalacademies.org/bose

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

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Undergraduate Science and Engineering Education: Challenges and Opportunities

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

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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

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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.

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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

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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)

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Section II. Contributions of Discipline-Based Education Research

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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.

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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.

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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)

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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)

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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

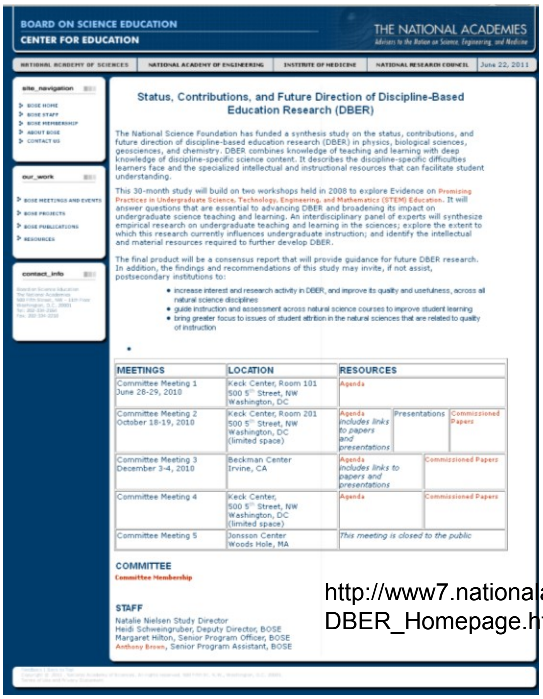
- Advancing DBER requires a robust infrastructure for research. (Conclusion 16)
- **RECOMMENDATION**: Science and engineering departments, professional societies, journal editors, funding agencies, and institutional leaders should:
  - clarify expectations for DBER faculty positions,
  - emphasize high-quality 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)



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Status, Contributions, and Future Direction of Discipline-Based Education Research (DBER)

The National Science Foundation has funded a synthesis study on the status, contributions, and future direction of discipline-based education research (DBER) in physics, biological sciences, geosciences, and chemistry. DBER combines knowledge of teaching and learning with deep knowledge of discipline-specific science content. It describes the discipline-specific difficulties learners face and the specialized intellectual and instructional resources that can facilitate student understanding.

This 30-month study will build on two workshops held in 2008 to explore Evidence on Promising Practices in Undergraduate Science, Technology, Engineering, and Mathematics (STEM) Education. It will answer questions that are essential to advancing DBER and broadening its impact on undergraduate science teaching and learning. An interdisciplinary panel of experts will synthesize empirical research on undergraduate teaching and learning in the sciences; explore the extent to which this research currently influences undergraduate instruction; and identify the intellectual and material resources required to further develop DBER.

The final product will be a consensus report that will provide guidance for future DBER research. In addition, the findings and recommendations of this study may invite, if not assist, postsecondary institutions to:

- increase interest and research activity in DBER, and improve its quality and usefulness, across all natural science disciplines
- guide instruction and assessment across natural science courses to improve student learning
- bring greater focus to issues of student attrition in the natural sciences that are related to quality of instruction

MEETINGS	LOCATION	RESOURCES		
Committee Meeting 1 June 28-29, 2010	Keck Center, Room 101 500 5th Street, NW Washington, DC	Agenda		
Committee Meeting 2 October 18-19, 2010	Keck Center, Room 201 500 5th Street, NW Washington, DC (limited space)	Agenda *includes links to papers and presentations*	Presentations	Commissioned Papers
Committee Meeting 3 December 3-4, 2010	Beckman Center Irvine, CA	Agenda *includes links to papers and presentations*	Commissioned Papers	
Committee Meeting 4	Keck Center, 500 5th Street, NW Washington, DC (limited space)	Agenda	Commissioned Papers	
Committee Meeting 5	Jonsson Center Woods Hole, MA	*This meeting is closed to the public*		

COMMITTEE
Committee Membership

STAFF
Natalie Nielsen Study Director
Heidi Schweingruber, Deputy Director, BOSE
Margaret Hilton, Senior Program Officer, BOSE
Anthony Brown, Senior Program Assistant, BOSE

http://www7.nationalacademies.org/bose/DBER_Homepage.html

ASEE Reports - A Path Forward

June 2009

June 2012

Seven Recommendations for Innovation with Impact

Who

1. Grow professional development in teaching and learning.
2. Expand collaborations.

What

3. Expand efforts to make engineering more engaging, relevant, and welcoming.

How

4. Increase, leverage, and diversify resources for engineering teaching, learning, and innovation.
5. Raise awareness of proven practices and of scholarship in engineering education.

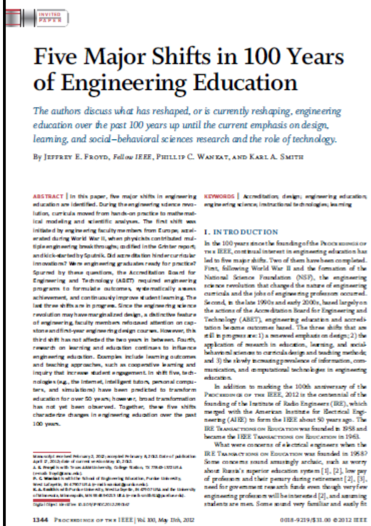
Seven Recommendations for Innovation with Impact *(continued)*

Creating a Better Culture

To measure progress in implementing policies, practices, and infrastructure in support of scholarly and systematic innovation in engineering education:

6. Conduct periodic self-assessments in our individual institutions.
7. Conduct periodic community-wide self-assessments.

http://www.asee.org/about-us/the-organization/advisory-committees/Innovation-with-Impact



INVITED PAPER

Five Major Shifts in 100 Years of Engineering Education

The authors discuss what has reshaped, or is currently reshaping, engineering education over the past 100 years up until the current emphasis on design, learning, and social–behavioral sciences research and the role of technology.

By Jeffrey E. Froyd, *Fellow IEEE*, Phillip C. Wankat, and Karl A. Smith

KEYWORDS | Accreditation; design; engineering education; engineering science; instructional technologies; learning

I. INTRODUCTION

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1. a shift from hands-on and practical emphasis to engineering science and analytical emphasis;
2. a shift to outcomes-based education and accreditation;
3. a shift to emphasizing engineering design;
4. a shift to applying education, learning, and socialbehavioral sciences research;
5. a shift to integrating information, computational, and communications technology in education.

What Are Your Plans?

- Silently reflect on your interests and plans for applying and/or supporting engineering education research, or becoming an engineering education researcher.
- Jot down
  - What do you plan to do next?
  - What are your longer range plans?
- Share with the person next to you

Thank you!

An e-copy of this presentation will be posted to:

http://CLEERhub.org

http://www.ce.umn.edu/~smith/links.html

Faculty Development Workshop (2013) – January 9, 2013 – Jeju Island, South Korea

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