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

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

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

http://inside.mines.edu/research/cee/ND.htm
Research can be inspired by ...

<table>
<thead>
<tr>
<th>Understanding (Basic)</th>
<th>Use (Applied)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Pure basic research (Bohr)</td>
<td>Yes</td>
</tr>
<tr>
<td>Pure applied research (Edison)</td>
<td>No</td>
</tr>
</tbody>
</table>

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

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.

Today's objectives

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

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

(Workshop list)

(Workshop list)

What does education research in your discipline look like?

- What are the qualities, characteristics, or standards for high-quality education 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. 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

- Practical Problem
  - Research Question
    - Research Answer
      - Research Process
        - Warrant
        - Reason
          - Evidence
          - Acknowledgment
          - Response

Multiple theoretical frameworks

Which comes first: framework or observation?
Can go in either direction

Most common frameworks in educational research

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


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

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’s 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 “tinsel” at all times.
8. Use research as an opportunity for reflective practice.

Sources:

Groups, centers, departments...

Engineering education societies...

Forums for dissemination...

Engineering education centers:
- NCECE: National Center for Engineering Education and Centers
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Engineering education societies:
- GCEE: Global Commission on Engineering Education & Society
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Conferences with engineering education research presentations:
- ASEE: Annual Conference, American Society for Engineering Education
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Connecting and Expanding the Engineering Education Research (EER) and Engineering Education Innovation (EEI) Communities

ASEE Headquarters Session T106D in partnership with the Rigorous Research in Engineering Education Initiative (DUE 0817461)

http://CLEERhub.org

ASEE Annual Conference - June 12, 2012 – T106D – 7:00 am – 8:30 am

Facilitated By

Karl A. Smith
Purdue University and University of Minnesota

Ruth A. Streveler
Purdue University

Slides posted - http://www.ce.umn.edu/~smith(links.html

Activity | Time Allotted
--- | ---
Introduction of session and facilitators | 5
Brief report on status of EER & EEI | 5
Update on RREE – CLEERHub.org Collaboratory for Engineering Education Research | 10
Update on EER – NRC DBER report | 5
Update on EEI – ASEE Innovation with Impact EEC report | 10
Participant Networking | 25
Rapid introductions around guided questions – Four to five conversations in groups of 3 – as a way to meet many people | 25
Identification of intellectual neighborhoods around research and innovation questions and opportunities – individual reflection and writing | 5
Brainstorming on strategies to connect, expand, and sustain the emerging EER and EEI communities | 10
Summary of ideas for (1) local, (2) national – conferences, etc. and (3) virtual community | 5
Individuals share reflections with the large group, facilitators sum up the session and participants complete feedback forms | 10

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

CLEERhub.org
What’s Available Now

Some of our most popular resources:
- Fundamentals of Engineering Education Research
- Qualitative and Quantitative Research Methods
- Exploring How People Learn Engineering

Recent Reports/Initiatives

- National Research Council Discipline-Based Education Research (DBER)
- ASEE Innovation with Impact report
- NAE Engineering Education Research and Innovation Activities

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 BEICHERNER, North Carolina State University
- STACEY LOWERY BRETZ, Miami University
- MELANIE COOPER, Clemson University
- SEAN DECATUR, Oberlin College
- JAMES FAIRWEATHER, Michigan State University
- KENNETH HILLER, University of Minnesota
- KIM RASTENS, Columbia University
- MICHAEL MARTINEZ, University of California, Irvine
- DAVID MOOG, 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

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. (Paraphrased)

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, and
  - 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

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  - 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)

Emphasis on Innovation

- ASEE Innovation with Impact report
  - Excerpt from Presentation by Leah Jamieson, Dean, College of Engineering, Purdue
- NAE Engineering Education Research and Innovation Activities
  - Briefing by Beth Cady, Program Officer, Engineering Education, National Academy of Engineering

ASEE Reports - A Path Forward
Seven Recommendations for Innovation with Impact

Who
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.
6. Conduct periodic self-assessments in our individual institutions.

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

Seven Recommendations for Innovation with Impact (continued)

Real-World Engineering Education
- Sponsored by AMD
- Innovative programs infusing real-world experiences
- Final publication to be released over the summer
- Includes program description and discussion of barriers/solutions

Frontiers of Engineering Education (FOEE)
- Catalyze a vibrant community of emerging engineering education leaders
- Recognize faculty accomplishment, facilitate learning, broaden collaboration, and promote dissemination of innovative practice in engineering education

Center for the Advancement of Scholarship on Engineering Education
- Created to foster continuous improvement
- Extensive set of resources at www.nae.edu/casee
- Research-to-Practice documents
- Meeting agendas and reports of CASEE projects
- Equity-related resources
- Videos
- Summaries
- Please help us organize the site!
  - Search terms, categories

National Academy of Engineering
Engineering Education Research and Innovation Activities
Beth Cady
Program Officer, Engineering Education
cady@nae.edu
FOEE (continued)

- Attendees share their work with peers
- Speakers on topics of interest to attendees
- Speakers/Coaches provide mentoring advice
- Opportunities to network with peers and coaches

- 150 alums
- Nominations for 2012 currently open
- Nominations from dean or NAE member
- Applications due in July
- Symposium will be October 14-17 in Irvine, CA

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 social behavioral 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

Facilitated By

Karl A. Smith
Purdue University and University of Minnesota
ksmith@umn.edu

Ruth A. Streveler
Purdue University
streveler@purdue.edu