A Workshop on Building Capability and Communities in Engineering Education Research sponsored by

Overview
What are we going to do?
- Welcome and introductions
- Structure of the workshop
  - 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
- Format of the workshop
  - Interactive and team-based

Who’s here?
- Your workshop leaders
  - Introduce yourself (< 1 minute)
    - Name, institution, discipline
    - Your engineering education research experience and aspirations?
    - What would make this workshop valuable for you?

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
  - 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 have participated
- Presenters, mentors and evaluators representing
  - American Society for Engineering Education
  - American Educational Research Association
  - Professional and Organizational Development Network in Higher Education
- Faculty funded by two NSF projects
  - Conducting Rigorous Research in Engineering Education
  - Strengthening HBCU Engineering Education Research Capacity
    - Council of HBCU Engineering Deans
    - Center for the Advancement of Scholarship in Engineering Education, National Academy of Engineering
RREE1 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 practice

Research Inspired By:

<table>
<thead>
<tr>
<th>Use (Applied)</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pure basic research (Bohr)</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Use-inspired basic research (Pasteur)</td>
<td>No</td>
<td>Pure applied research (Edison)</td>
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RREE2

- Follow-up proposal has been awarded (RREE2)
  - Includes a series of 5 short courses
    1) Fundamentals of Educational Research
    2) Identifying Theoretical Frameworks
    3) Designing Your Research Study
    4) Collaborating with Learning and Social Scientists
    5) Understanding Qualitative Research
  - To be available on rreeHUB.org

Engineering education research

Closing the loop

Figure 1.1—Cycle of Knowledge Production and Improvement of Practice
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

Objective 1
Identify principal features of engineering education research

What does engineering (technical) research look like?

• What are the guiding principles for rigorous technical research in your engineering discipline?
• Technical engineering research can be called rigorous when....
  • Individually, list the qualities and characteristics of rigorous research in your engineering discipline
  • As a group, develop a list of research standards in engineering

What does engineering education research look like?

• What are the guiding principles for rigorous research in engineering education?
• Engineering education research can be called rigorous when....
  • Individually, list the qualities and characteristics of rigorous engineering education research
  • As a group, develop a list of research standards in engineering education
Let’s compare and contrast engineering technical and education research.

Take a few moments to list the differences you see between engineering technical research and engineering education research.

<table>
<thead>
<tr>
<th>Engineering technical vs. education research</th>
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<tbody>
<tr>
<td>Let’s compare and contrast engineering technical and education research.</td>
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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 we compare?

- How do our lists compare with the NRC six?
  - Similarities
  - Differences
- Is a global list possible or is the list dependent on the cultural context and research traditions?

Pose significant questions that can be investigated empirically

Who would care about your results?

What evidence will you need to gather to answer your questions?

- What forms can “evidence” take?

Link research to relevant theory

- **Learning theories**
  - Cognition
  - Novice–expert differences
  - Instructional psychology
  - Psychometrics
- **Motivational theories**
- **Moral and ethical development**
- **Social context of education**
### Use methods that permit direct investigation of the question

- **Quantitative methods**
  - Tests
  - Surveys and questionnaires (defined response)
  - Faculty or peer ratings
- **Qualitative methods**
  - Focus groups
  - Interviews
  - Observations

### Provide coherent, explicit chain of reasoning

- Builds on what others have done before (literature)
- Theoretical foundation — make sense of results within existing frameworks of learning and teaching
- Methodology is explicit and appropriate — instruments are reliable and valid
- Strength of observed relationships
- Elimination of alternative explanations — study design and confounding variables

What else makes for a convincing argument?

### Replicate and generalize across studies

- **Setting the results in a larger context**
  - **Must** know the literature
  - **Strict replication** is rare in educational research
  - Transferable with extension, i.e., to new topic, setting, learners, etc.

### Disclose research to encourage professional scrutiny and critique

- **Scholarly journals**
- **Conference presentations**
- **Peer-review is the core issue**
  - highly-valued means of quality control
  - the more rigorous and independent, the better

### Objective 2

**Frame and situate research questions and methodologies**

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**The Craft of Research, 3rd ed., 2008**

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Which comes first? Framework? Or Observation?

- Going from framework to research question to research study
  - Eg. The experiential learning cycle
- Going from observation to framework to research question to research study and back to observation
  - E.g., Classroom community
  - Please describe observations that have sparked your curiosity

Most common frameworks in educational research

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

Please visit the RREE 2006 Workshop Materials website for details http://www.ce.umn.edu/~smith/ndlinks.html
See Marilla Svinick’s slides – Conceptual frameworks: Finding a conceptual framework that is appropriate for your question. [RREE-D2-Marilla-conceptual1.pdf]

Becoming and 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’ll 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.

Objective 3
Gain familiarity with several print and online resources

Books, journals, online resources

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

Brief history of JEE
From society communications to education research

Journal of Engineering Education
1910-1991

Society communications & educational innovations
1992-Present

1993-2002

Educational innovations (R&D)

2003-Present

“R&D in society communications & educational innovations”

2007-Present

Development

2008-Present

Since 1992 the same title
Where you can find articles on research in engineering and technology

*Source: Students in Transition

- Sociology of Education
- Mind, Culture, and Activity
- Journal of Research in Science Teaching
- Education Researcher
- Journal of Engineering Education
- Journal of the Learning Sciences
- Journal of the First-Year Experience
- Chronicle of Higher Education
- International Journal of Science and Mathematics Education
- International Journal of Problem-Based Learning
- International Journal of Computer-Supported Collaborative Learning
- Cognitive Science
- Design Studies
- Cultural Studies in Science Education
- College Teaching
- International Journal for the Scholarship of Teaching and Learning

Increase discussion of research
Increase awareness and use of
Increase progress toward
Link journals related to

Some more journals
- Technology Teacher
- Research in Engineering Design
- Journal of Women and Minorities in Science and Engineering
- Journal of Science Education and Technology
- Social Science Citation Index
- Thomson ISI (relevant for Scientific Information)

Review Criteria – Manuscripts are expected to:
1) situate the research within relevant bodies of knowledge and describe how it contributes to new knowledge;
2) explain the research design, methods, theories, and practices as appropriate;
3) present original ideas or results of general significance supported by clear reasoning and compelling evidence;
4) exhibit clear, concise, and precise exposition of the research findings and conclusions;
5) identify, evaluate, and synthesize empirical or empirical-like evidence that addresses a broad question or problem;
6) identify and incorporate relevant literature and literature gaps, including those found within the engineering education research, and

Manuscripts are expected to:

- state clearly the questions or propositions addressed and the significance of the research performed;
- explain the research design, methods, theories, and practices as appropriate;
- present original ideas or results of general significance supported by clear reasoning and compelling evidence;
- exhibit clear, concise, and precise exposition of the research findings and conclusions;
- identify, evaluate, and synthesize empirical or empirical-like evidence that addresses a broad question or problem;
- identify and incorporate relevant literature and literature gaps, including those found within the engineering education research, and

ARTEE

www.seeonlin.org

Some more journals

- with engineering or technology in their titles

- 105 journals, including education (52), social sciences (28), natural science (9), medicine (6), other (9)

- Category: Education and Educational Research

www.iteaconnect.org/Publications/t&c.htm

www.begellhouse.com/journals/00551c876cc2f027.html


http://www.cs.cmu.edu/~sfinger/red/red.html

www.asee.org/jee

http://logon.jstor.org/journals/00221546.html

http://www.jstor.org/journals/07370008.html

http://www.georgiasouthern.edu/ijsotl/

http://www.isteonline.in/index.php?q=node/43


http://www.asee.org/jee

http://www.press.jhu.edu/journals/review_of_higher_education/

http://www.cognitivesciencesociety.org/about.html

http://www3.interscience.wiley.com/cgibin/jhome/31817?CRETRY=1&SRETRY=0

http://www3.interscience.wiley.com/cgibin/jhome/31817?CRETRY=1&SRETRY=0

http://www.cognitivesciencesociety.org/about.html

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Objective 4
Become aware of global communities and their networks

An emerging global community

- First, a joint journal effort, then...
- Groups, centers, departments
- Engineering education societies
- Forums for dissemination

What follows is a sample — it is NOT an exhaustive list!

A joint journal effort
“Advancing the Global Capacity for Engineering Education Research” (AGCEER)

- Why? Engineering education research is an emerging field; there is a need to better understand global perspectives
- Goal — Identify the critical issues to advancing the global capacity for engineering education research
- Approach — A global series of interactive sessions at key international conferences (July 2007 – December 2008)

AGCEER
Preliminary findings — Paper to appear jointly in JEE and EJEE in 2009

- Widespread agreement on
  - Need to bridge education research and teaching practice
  - Importance of multi-disciplinary collaboration (engineering and social sciences/education)
  - Desire to improve recognition and legitimacy of engineering education research
- Challenges
  - Contextual variations and emphases (national and regional)
  - Clarify and improve relations with non-engineering fields
  - Develop shared language, culture, and agenda for the field

Groups, centers, departments...

Engineering education societies...

Groups, centers, departments...

Engineering education societies...

Any in India?

Why not ISTE?
Forums for dissemination...

Conferences with engineering education research presentations:

- ASEE — Annual Conference, American Society for Engineering Education, see www.asee.org
- SEFI — Annual Conference, Société Européenne pour la Formation des Ingénieurs, see www.sefi.be
- GCEE — Global Colloquium on Engineering Education, sponsored by ASEE and local partners where the meeting is held, see www.asee.org
- REES — Research on Engineering Education Symposium, see rees2009.pbwiki.com
- ASEE 2009
- SEFI 2009
- GCEE 2009
- FIE 2009
- REES 2009
- ASEE 2010

How about ISTE?

Conferences with engineering education research presentations:

- ISTE — The International Society for Technology in Education

New!

REES 2009

Not just another engineering education conference

**Vision — to create:**

- A community-owned meeting for scholarly reflection on engineering education research
- A high-quality forum to shape and define the future of the field
- A supportive space to leverage seasoned wisdom and nurture emerging talent
- An affordable, accessible, and welcoming global gathering

**REES 2009**

- Roger Hadgraft, U of Melbourne, General Chair
- “Publish to attend” (peer-reviewed abstracts)
- 20-23 July 2009, Queensland, Australia

Thank you!

An e-copy of this presentation may be found at:


38th ISTE Annual Convention—Bhubaneswar 20 December 2008

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