A Workshop on

Building Capability and Communities in Engineering Education Research

sponsored by

38th ISTE Annual Convention—Bhubaneswar 20 December 2008

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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

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.

Some history about this workshop

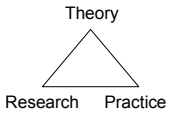
- **Rigorous Research in Engineering Education (RREE1)**
  - One-week summer workshop, year-long research project
  - Funded by National Science Foundation (NSF), 2004-2006
  - About 150 engineering faculty have participated
- **Presenters, mentors and evaluators representing**
  - American Society for 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

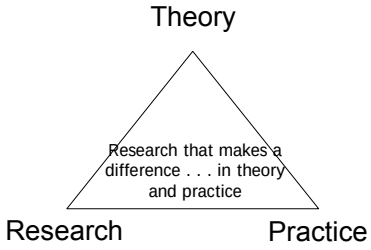
- Identify engineering faculty interested in conducting engineering education research
- Develop faculty knowledge and skills for conducting engineering education research (especially in theory and research methodology)
- Cultivate the development of a Community of Practice of faculty conducting engineering education research

RREE Approach

- Theory – Study grounded in theory/conceptual framework
- Research – Appropriate design and methodology
- Practice – Implications for practice

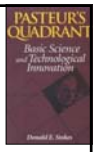


RREE Approach



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

Research Inspired By:



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

Stokes, Donald. 1997. Pasteur's quadrant: Basic science and technological innovation. Wash, D.C., Brookings.

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

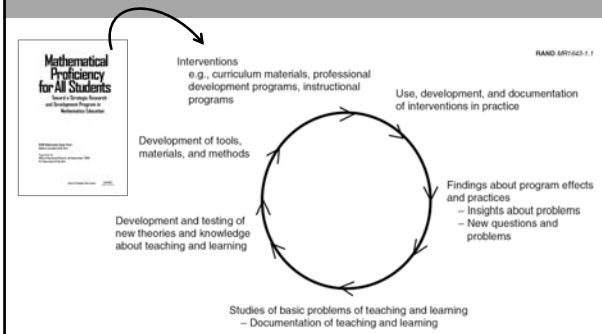


Figure 1.1—Cycle of Knowledge Production and Improvement of Practice

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 (technical) research look like?

- (Workshop list)
- (Workshop list)

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

What does engineering education research look like?

- (Workshop list)
- (Workshop list)

Engineering technical vs. education research

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**

Differences in engineering technical and education research

- (Workshop list)
- (Workshop list)

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**

National Research Council (NRC), 2002

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

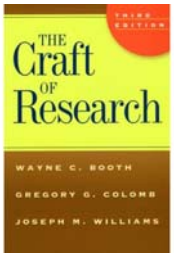
Setting the results in a larger context

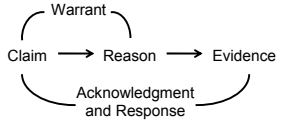
- **Must** know the literature
- Strict replication is rare in educational research
- Transferable with extension, i.e., to new topic, setting, learners, etc.

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

The Craft of Research, 3rd ed., 2008





Objective 2

Frame and situate research questions and methodologies

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.ppt]

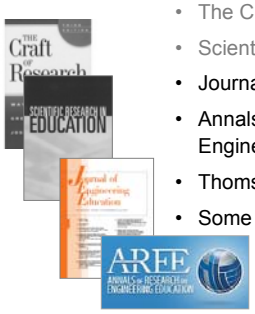
Becoming and Engineering Education Researcher – Adams, Fleming & Smith

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

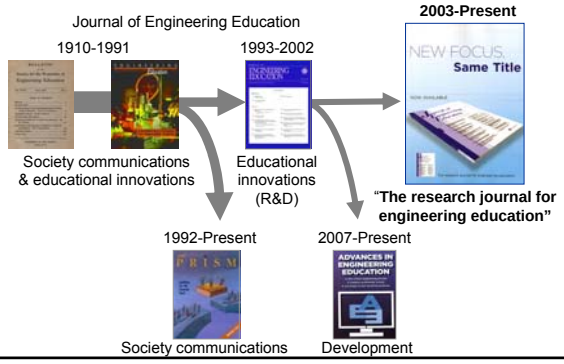
Books, journals, online resources



- 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



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since 4 June 2008

since 24 June 2008

since 10 September 2008

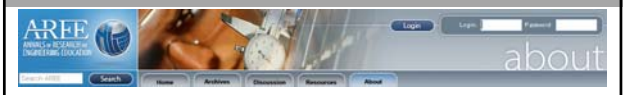
Guide for Authors

www.asee.org/jee

Review Criteria — Manuscripts are expected to:

1) state clearly the questions or propositions addressed and the significance of the research to engineering education research or practice;
2) situate the research within relevant bodies of knowledge and describe how it contributes to new knowledge;
3) employ research designs, methods, theories, and/or practices appropriate to the research performed;
4) present original ideas or results of general significance supported by clear reasoning and compelling evidence;
5) exhibit clear, concise, and precise exposition that appeals to a broad international readership interested in engineering education research; and
6) provide tables and figures, as needed, that meaningfully add to the narrative.

AREE



- Link journals related to engineering education
- Increase progress toward shared consensus on quality research
- Increase awareness and use of engineering education research
- Increase discussion of research and its implications

- Resources – community recommended
  - Annotated bibliography
  - Acronyms explained
  - Conferences, Professional Societies, etc.
- Articles – education research
  - Structured summaries
  - Reflective essays
  - Reader comments

www.areeonline.org

Thomson ISI Citation Index

- **Thomson ISI** (Institute for Scientific Information)
- **Science Citation Index**
  - Category: Education, Scientific Disciplines
  - 23 journals in medicine (10), engineering (7), and science (6)
- **Social Science Citation Index**
  - Category: Education and Educational Research
  - 105 journals, including education (52), social sciences (28), natural science (9), medicine (6), **engineering (1, JEE)**, other (9)

Some more journals

Where you can find articles on research in engineering and technology*

- **Chronicle of Higher Education** (http://chronicle.com/)
- **Cognitive Science** (http://www.cognitivesciencesociety.org/about.html)
- **Cognition and Instruction** (http://www.jstor.org/journals/07370008.html)
- **College Teaching**
- **Cultural Studies in Science Education**
- **Design Studies** (http://www.sciencedirect.com/science/journal/0142694X)
- **Education Researcher** (http://www.jstor.org/journals/0013189X.html)
- **Journal of Higher Education** (http://logon.jstor.org/journals/00221546.html)
- **Interdisciplinary Journal of Knowledge and Learning Objects** (http://ijklo.org/)
- **International Journal for the Scholarship of Teaching and Learning** (http://www.georgiasouthern.edu/ijsotl/)
- **International Journal of Computer-Supported Collaborative Learning** (http://ijcscl.org)
- **International Journal of Problem-Based Learning** (http://docs.lib.purdue.edu/ijpbl/)
- **International Journal of Science and Mathematics Education** (link: Int'l Journal of Science and Mathematics Education)
- **Journal of the First-Year Experience**
- **Journal of the Learning Sciences** (http://www-static.cc.gatech.edu/computing/lst/jls/)
- **Journal of Engineering Education** (http://www.asee.org/jee)
- **Journal of Higher Education** (http://www.jstor.org/journals/00221546.html)
- **Journal of Research in Science Teaching** (http://www3.interscience.wiley.com/cgibin/jhome/31817?CRETRY=1&SRETRY=0)
- **Mind, Culture, and Activity** (http://lchc.ucsd.edu/MCA/Journal/index.html)
- **Review of Higher Education** (http://www.press.jhu.edu/journals/review_of_higher_education/)
- **Sociology of Education** (http://www.asanet.org/cs/root/leftnav/publications/journals/sociology_of_education/homepage)
- **Science & Education**
- **Students in Transition**

*Source: Noemi Mendoza-Diaz & James Cawthorne, School of Engineering Education, Purdue University, 9 December 2008

Some more journals

…with engineering or technology in their titles*

(mostly focused on curriculum development and position papers)

- **Australasian Journal of Engineering Education** (http://www.aaee.com.au/journal/)
- **Chemical Engineering Education**
- **Engineering Education: Journal of the Higher Education Academy Engineering Subject Centre**
- **European Journal of Engineering Education** (http://www.tandf.co.uk/journals/titles/03043797.asp)
- **Global Journal of Engineering Education** (http://www.eng.monash.edu.au/uicee/gjee/)
- **IEEE Engineering Science and Education Journal** (http://ieeexplore.ieee.org/xpl/RecentIssue.jsp?punumber=2222)
- **IEEE Transactions on Education**
- **Indian Society for Technical Education Journal** (http://www.isteonline.in/index.php?q=node/43)
- **International Journal of Electrical Engineering Education** (http://journals.mup.man.ac.uk/cgi-bin/MUP?COMval=journal&key=IJEEE)
- **International Journal of Continuing Engineering Education and Life-Long Learning** (http://www.inderscience.com/browse/index.php?journalID=6&year=2008&vol=18&issue=1)
- **International Journal of Engineering Education**
- **International Journal of Mechanical Engineering Education** (http://journals.mup.man.ac.uk/cgi-bin/MUP?COMval=journal&key=IJMEE)
- **Journal of Professional Issues in Engineering Education and Practice** (http://scitation.aip.org/epo)
- **Journal of Science Education and Technology**
- **Journal of STEM Education**
- **Journal of Women and Minorities in Science and Engineering** (http://www.begellhouse.com/journals/00551c876cc2f027.html)
- **Research in Engineering Design** (http://www.cs.cmu.edu/~sfinger/red/red.html)
- **Technology and Children** (http://www.iteaconnect.org/Publications/it&c.htm)
- **Technology Teacher** (http://www.iteaconnect.org/Publications/ttt.htm)
- **Transactions on Engineering Education**

Other journals in India?

*Source: Noemi Mendoza-Diaz & James Cawthorne, School of Engineering Education, Purdue University, 9 December 2008

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!

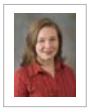
A joint journal effort

"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

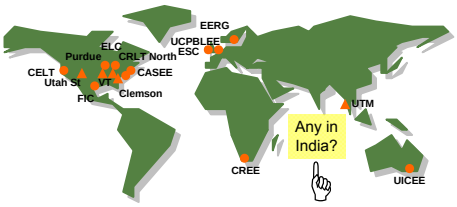


Maura Borrego
Virginia Tech

Brent Jesiek
Purdue

- **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

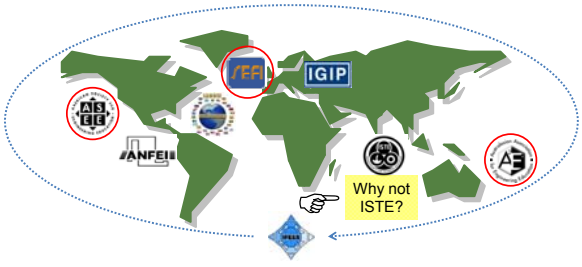
Groups, centers, departments…



Engineering Teaching and Learning Centers — Australia: UICEE, UNESCO International Centre for Engineering Education; Denmark: UCPBLEE, UNESCO Chair in Problem Based Learning in Engineering Education; 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.

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.

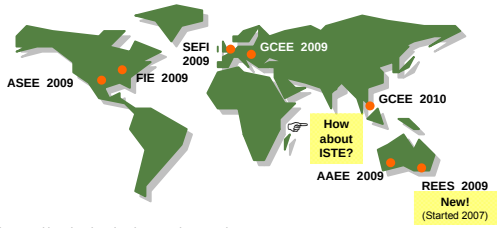
Engineering education societies…



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

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

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/

REES 2009

Not just another engineering education conference

REES 2008
Davos, Switzerland

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
- http://rees2009.pbwiki.com/

Thank you!

An e-copy of this presentation may be found at:
(http://www.ce.umn.edu/~smith/links.html)

38th ISTE Annual Convention—Bhubaneswar 20 December 2008

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