Seminar on

Engineering Education Research (EER): Status of Global Efforts and Opportunities

sponsored by the

Universiti Teknologi Malaysia

in partnership with

Annals of Research in Engineering Education

Journal of Engineering Education

Rigorous Research in Engineering Education Initiative

Skudai, Malaysia – March 12, 2009



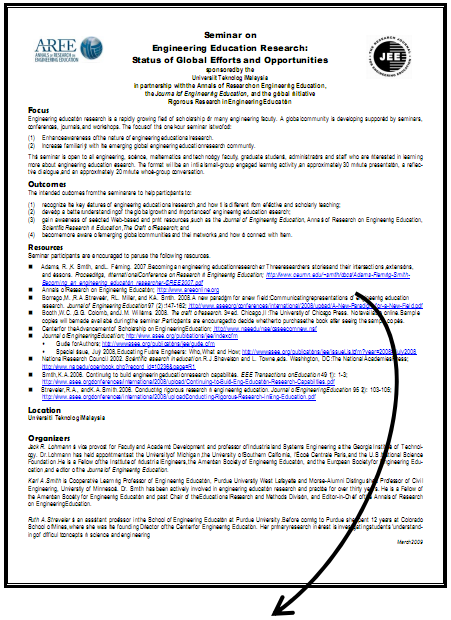
Karl A. Smith
Purdue University and
University of Minnesota

Overview

What are we going to do?

We assume you are here because either you are…

- engaged in EER and already have a strong interest in the topic, or
- interested in EER and want to be more personally engaged or encourage and support others to be engaged



Seminar on
Engineering Education Research:
Status of Global Efforts and Opportunities

sponsored by the
Universiti Teknologi Malaysia
in partnership with the Annals of Research on Engineering Education,
the Journal of Engineering Education, and the global initiative
Rigorous Research in Engineering Education

Focus
Engineering education research is a rapidly growing field of scholarship for many engineering faculty. A global community is developing supported by seminars, conferences, journals, and workshops. The focus of this one-hour seminar is twofold:

(1) Enhance awareness of the nature of engineering educational research.
(2) Increase familiarity with the emerging global engineering education research community.

This seminar is open to all engineering, science, mathematics and technology faculty, graduate students, administrators and staff who are interested in learning more about engineering education research. The format will be an initial small-group engaged learning activity an approximately 50 minute presentation, a reflective dialogue and an approximately 20 minute whole-group conversation.

Outcomes
The intended outcomes from the seminar are to help participants to:

(1) recognize the key features of engineering educational research and how it is different from effective and scholarly teaching;
(2) develop a better understanding of the global growth and importance of engineering education research;
(3) gain awareness of selected Web-based and print resources such as the Journal of Engineering Education, Annals of Research on Engineering Education, Scientific Research in Education, The Craft of Research; and
(4) become more aware of emerging global communities and their networks and how to connect with them.

Resources
Seminar participants are encouraged to peruse the following resources.

- Adams, R. K. Smith, and L. Fleming. 2007. Becoming a engineering education researcher: Three researchers' stories and their interactions, extensions, and lessons. Proceedings, International Conference on Research in Engineering Education. http://www.caunix.edu/~smithjoy/4-adams-Family-Smith-Becoming-an-engineering_education_researcher-CREE2007.pdf
- Annals of Research on Engineering Education. http://www.aree01.org/
- Borrego, M., R. A. Streveler, R.L. Miller, and K.A. Smith. 2008. A new paradigm for a new field: Communicating representations of engineering education research. Journal of Engineering Education 97 (2):147-162. http://www3.interscience.wiley.com/journal/117980601/abstract?CRETRY=1&SRETRY=0
- Booth, W., G. Colomb, and M. Williams. 2008. The craft of research. 3rd ed. Chicago // The University of Chicago Press. No book in the Library's collection will be made available during the summer. Participants are encouraged to decide whether to purchase the book after seeing the seminar materials.
- Carnegie Initiative on the Formation of Engineering Educators. http://www.carnegiefoundation.org/
- Journal of Engineering Education. http://www.asee.org/publications/jee/index.cfm
  - Guide for Authors. http://www.asee.org/publications/jee/guide.cfm
  - Special issue, July 2005, Educating Future Engineers: Who, What, and How. http://www3.interscience.wiley.com/journal/112624966/issue?CRETRY=1&SRETRY=0
- National Research Council. 2002. Scientific research in education. R. J. Shavelson and L. Towne, eds. Washington, DC: The National Academies Press. http://www.nap.edu/catalog.php?record_id=10236#toc
- Smith, K. A. 2008. Continuing to build engineering education research capabilities. IEEE Transactions on Education (43) 1): 1-3. http://www.asee.org/portal/searchresults/literature/2008-Impact-Continuing-to-Build-Eng-Education-Research-Capabilities.pdf
- Streveler, R. A., and K. A. Smith. 2006. Conducting rigorous research in engineering education. Journal of Engineering Education 95 2): 103-105. http://www.asee.org/portal/searchresults/literature/2006-Conducting-Rigorous-Research-in-Eng-Education.pdf

Location
Universiti Teknologi Malaysia

Organizers
Jack R. Lohmann is vice provost for Faculty and Academic Development and professor of Industrial and Systems Engineering at the Georgia Institute of Technology. Dr. Lohmann has held appointments at the University of Michigan, the University of Southern California, Ecole Centrale Paris and the U.S. National Science Foundation. He is a Fellow of the Institute of Industrial Engineers, the American Society of Engineering Education, and the European Society for Engineering Education and editor of the Journal of Engineering Education.

Karl A. Smith is Cooperative Learning Professor of Engineering Education, Purdue University. West Lafayette and Morse-Alumni Distinguished Professor of Civil Engineering, University of Minnesota. Dr. Smith has been actively involved in engineering education research and practice for over thirty years. He is a Fellow of the American Society for Engineering Education and past Chair of the Educational Research and Methods Division, and Editor-in-Chief of the Annals of Research on Engineering Education.

Ruth A. Streveler is an assistant professor in the School of Engineering Education at Purdue University. Before coming to Purdue she spent 12 years at Colorado School of Mines, where she was the founding Director of the Center for Engineering Education. Her primary research interest is in understanding students' understanding of difficult concepts in science and engineering.

March 2009

Resources

Focus of the seminar

- Enhance awareness of the nature of engineering educational research
- Increase familiarity with the emerging global engineering education research community

Format of the seminar

- Reflection and small-group dialogue
- Presentation
- Reflection and whole group conversation

Introduction and reflective dialogue

- Your seminar speakers
- ☞ Individually, reflect on your engineering education research experience and interest, and reasons for your interest (~ 1 minute)
- ☞ Introduce yourself to a person nearby and share your thoughts (~2 minutes)

Why should we care about research in engineering education?

At M.I.T., Large Lectures Are Going the Way of the Blackboard



Jodi Hilton for The New York Times

The Massachusetts Institute of Technology has changed the way it offers some introductory classes. Prof. Gabriella Sciolla at a class on electricity and magnetism.

By SARA RIMER
Published: January 12, 2009

COMMENTS (66)
E-MAIL
PRINT
SINGLE PAGE

CAMBRIDGE, Mass. — For as long as anyone can remember, introductory physics at the Massachusetts Institute of Technology was taught in a vast windowless amphitheater known by its number,

January 13, 2009—New York Times
http://www.nytimes.com/2009/01/13/us/13physics.html?em

EDUCATION

Farewell, Lecture?

A physics professor describes his evolution from lecturing to dynamically engaging students during class and improving how they learn.

Eric Mazur

Discussions of education are generally predicated on the assumption that we know what education is. I hope to convince you otherwise by recounting some of my own experiences. When I started teaching introductory physics to undergraduates at Harvard University, I never asked myself how I would educate my students. I did what my teachers had done—I lectured. I thought that was how one learns. Look around anywhere in the world and you'll find lecture halls filled with students and, at the front, an instructor. This approach to education has not changed since before the Renaissance and the birth of scientific inquiry. Early in my career I received the first hints that something was wrong with teaching in this manner, but I had ignored it. Sometimes it's hard to face reality.

When I started teaching, I prepared lecture notes and then taught from them. Because my lectures deviated from the textbook, I provided students with copies of these lecture notes. The infuriating result was that on my end-of-semester evaluations—which were quite good otherwise—a number of students complained that I was "lecturing straight from (his) lecture notes." What was I supposed to do? Develop a set of lecture notes different from the ones I handed out? I decided to ignore the students' complaints.



Click here. Students continually discuss concepts among themselves and with the instructor during class. Discussions are spurred by multiple-choice conceptual questions that students answer using a clicker device. See supporting online text for examples of such "clicker questions."

A few years later, I discovered that the students were right. My lecturing was ineffective, despite the high evaluations. Early on in the physics curriculum—in week 2 of a typical introductory physics course—the Laws of Newton are presented. Every student in such a course can recite Newton's third law of motion, which states that the force of object A on object B in an interaction between two objects is equal in magnitude to the force of B on A—it sometimes is known as "action is reaction." One day, when the course had progressed to more complicated material, I decided to test my students' understanding of this concept not by doing traditional problems, but by asking them a set of basic conceptual questions (*1*, *2*). One of the questions, for example, requires students to compare the forces that a heavy truck and a light car exert on one another when they collide. I expected that the students would have no trouble tackling such questions, but much to my surprise, hardly a minute after the test began, one student asked, "How should I answer these questions? According to what you taught me or according to the way I usually think about these things?" To my dismay, students had great difficulty with the conceptual questions. That was when it began to dawn on me that something was amiss.

In hindsight, the reason for my students' poor performance is simple. The traditional approach to teaching reduces education to a transfer of information. Before the industrial revolution, when books were not yet mass commodities, the lecture method was the only way to transfer information from one generation to the next. However, education is so

Department of Physics, Harvard University, Cambridge, MA 02138, USA. E-mail: mazur@physics.harvard.edu

CREDIT (BOTTOM): JON CHASE/HARVARD UNIVERSITY

January 2, 2009—Science, Vol. 323
www.sciencemag.org

Reason one — Calls for evidence-based teaching practices

Reason Two: Faculty interest in higher levels of inquiry in engineering education

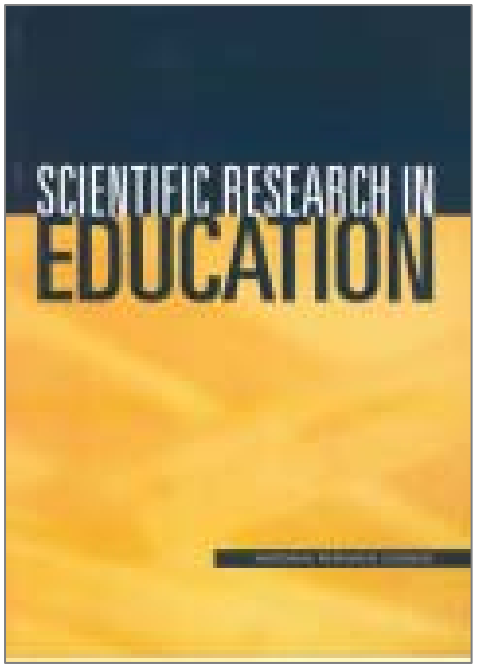
- **Level 0** Teacher
  - Teach as taught
- **Level 1** Effective Teacher
  - Teach using accepted teaching theories and practices
- **Level 2** Scholarly Teacher
  - Assesses performance and makes improvements
- **Level 3** Scholar of Teaching and Learning
  - Engages in educational experimentation, 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.

Rigorous Research in Engineering Education (RREE) – Streveler & Smith

- **RREE-1**
  - Funded by National Science Foundation (NSF), 2004-2006
  - One-week summer workshop, year-long research project
  - About 150 engineering faculty participated
- **RREE-2**
  - Funded by NSF, 2008-2011, Expanding and Sustaining Research Capacity in Engineering and Technology Education
  - Five short courses, WWW enabled learning environment
- **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

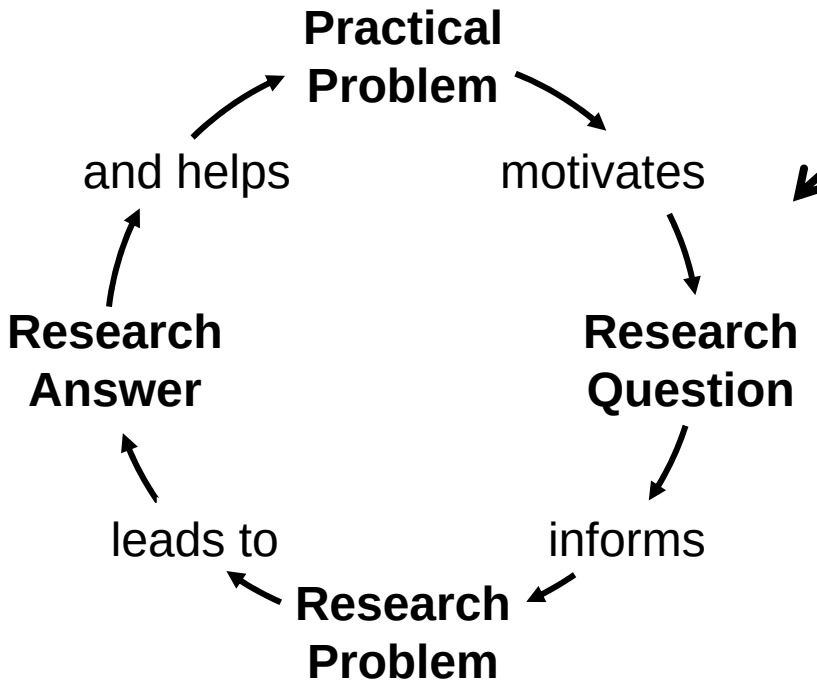
Guiding principles for scientific research in education



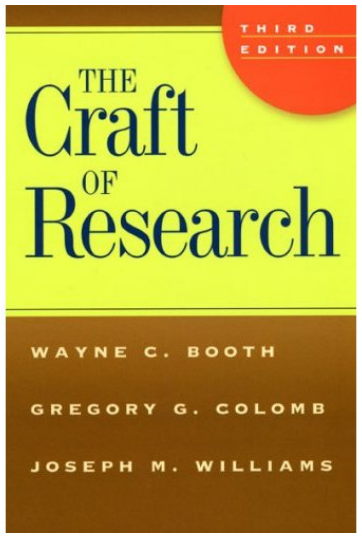
1. Pose **significant questions** that can be investigated **empirically**
2. Link research to relevant **theory**
3. Use **methods** that permit **direct investigation** of the question
4. Provide coherent, explicit chain of **reasoning**
5. Replicate and **generalize** across studies
6. Disclose research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

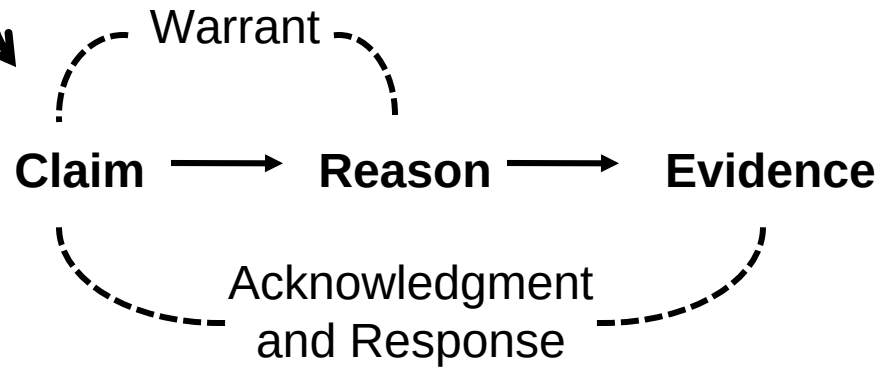
Source: Scientific Research in Education, National Research Council, 2002

The research process and reasoning



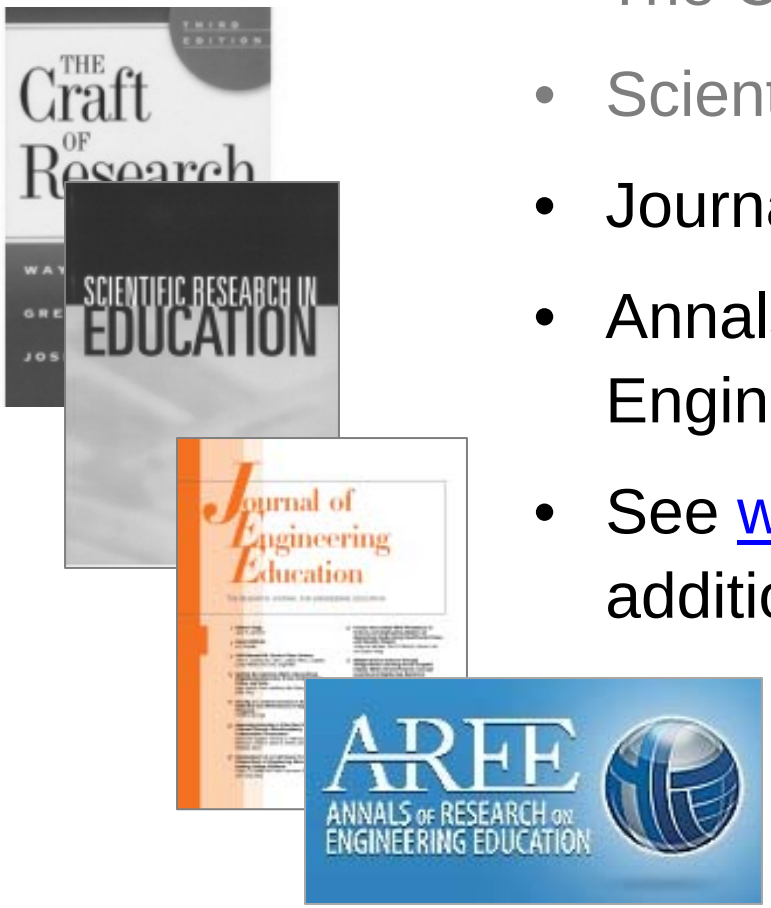
Research Process





Research Reasoning

Books, journals, online resources



- The Craft of Research
- Scientific Research in Education
- Journal of Engineering Education (JEE)
- Annals of Research on Engineering Education (AREE)
- See workshop presentation for additional resources



A growing global journal

8,500 subscribers, 70 countries, 5 partners

- **Founded in 1910**
  - "technical" journal/magazine for 80 years
  - mission refined in 1993 and again in 2003
- **Mission**

  "...serve as an archival record of scholarly research in engineering education"
- **Manuscript types**
  - Research investigations
  - Research reviews
- **Six review criteria**

www.asee.org/jee

NOTE! "The Relationships Between Students' Conceptions of Learning and Their Preferences for Classroom and Laboratory Learning Environments," by Chia-Ching Ling and Chin-Chung Tsai, National Taiwan University of Science and Technology, to appear in the *Journal of Engineering Education*, April 2009

AREE

www.areeonline.org



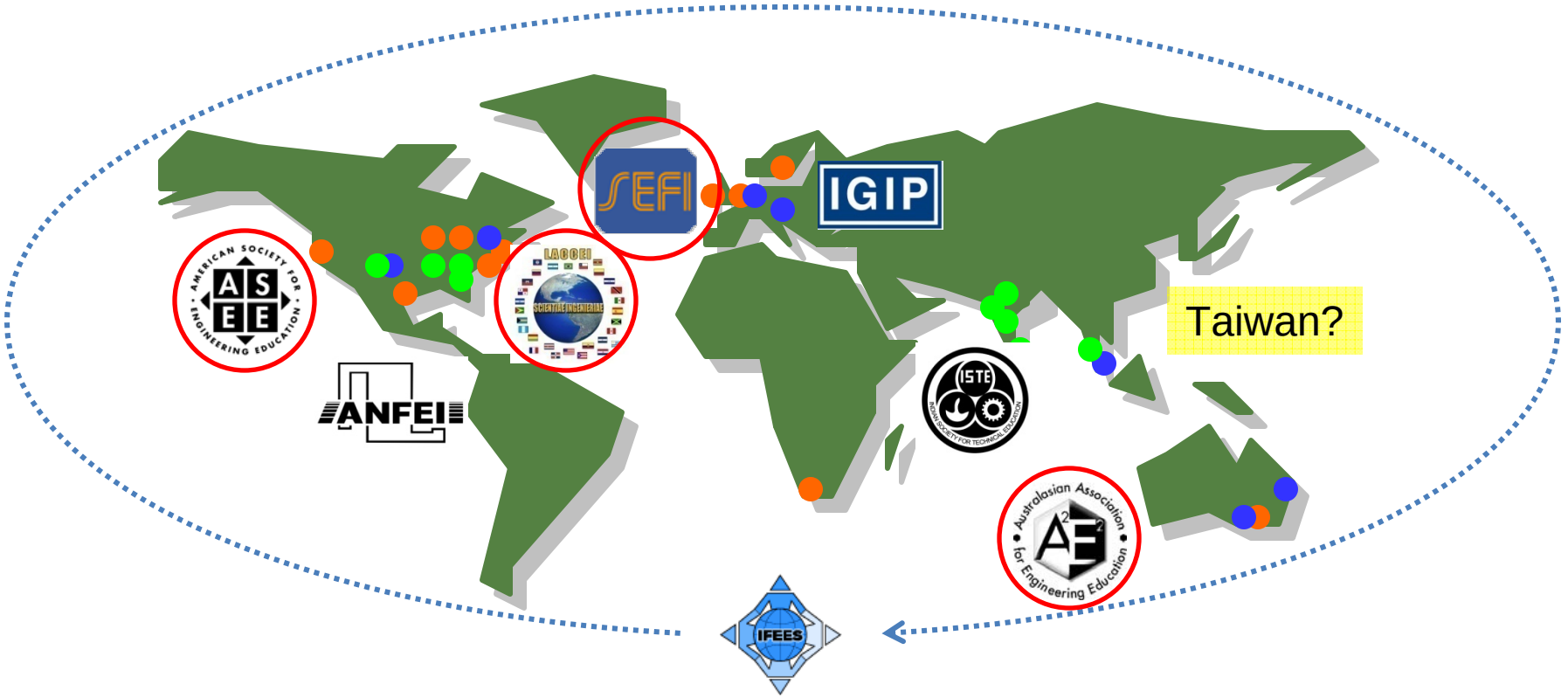
- Link journals related to engineering education
- Increase progress toward shared consensus on quality research
- Increase awareness and use of engineering education research
- Increase discussion of research and its implications

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

Annals of Research on Engineering Education | 500 Fifth Street, NW, Room NAS 225, Washington, DC 20001
Tel: 202-334-1926 Email: awaller@nae.edu ©2005 AREE. All Rights Reserved. Privacy Statement | Site Credits | Contact

An emerging global community

(Examples: Not an exhaustive list!)



- Engineering Teaching and Learning Centers
- Engineering Education Degree-granting Departments

  Engineering Education Societies and Organizations (logos shown)
- Engineering Education Conferences often with EER Sessions

Two special global efforts specifically to build community



- **"Advancing the Global Capacity for Engineering Education Research" (AGCEER)**
  - Joint effort JEE and EJEE
  - 10 sessions at 10 international conferences
- **Research in Engineering Education Symposium (REES)**
  - Retreat-like, research-only symposium
  - 2007, Honolulu, Hawaii; 2008, Davos, Switzerland; 2009, Queensland, Australia

Reflective dialogue and whole group conversation

- Individually, reflect on the presentation and note insights, applications, questions, etc. (~ 1 minute)
- Talk with a person nearby and a develop a brief list of issues and questions (~2 minutes)
- Discussion as a whole group

Thank you!

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

Skudai, Malaysia – March 12, 2009



ksmith@umn.edu