

Engineering Education Research: Emergence, Current Status, and Future Directions

Special Session 3: Engineering Education Research Across the World: A Kick Start for Educators



Karl A. Smith

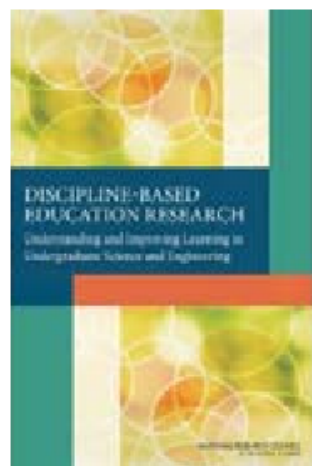
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University of Minnesota

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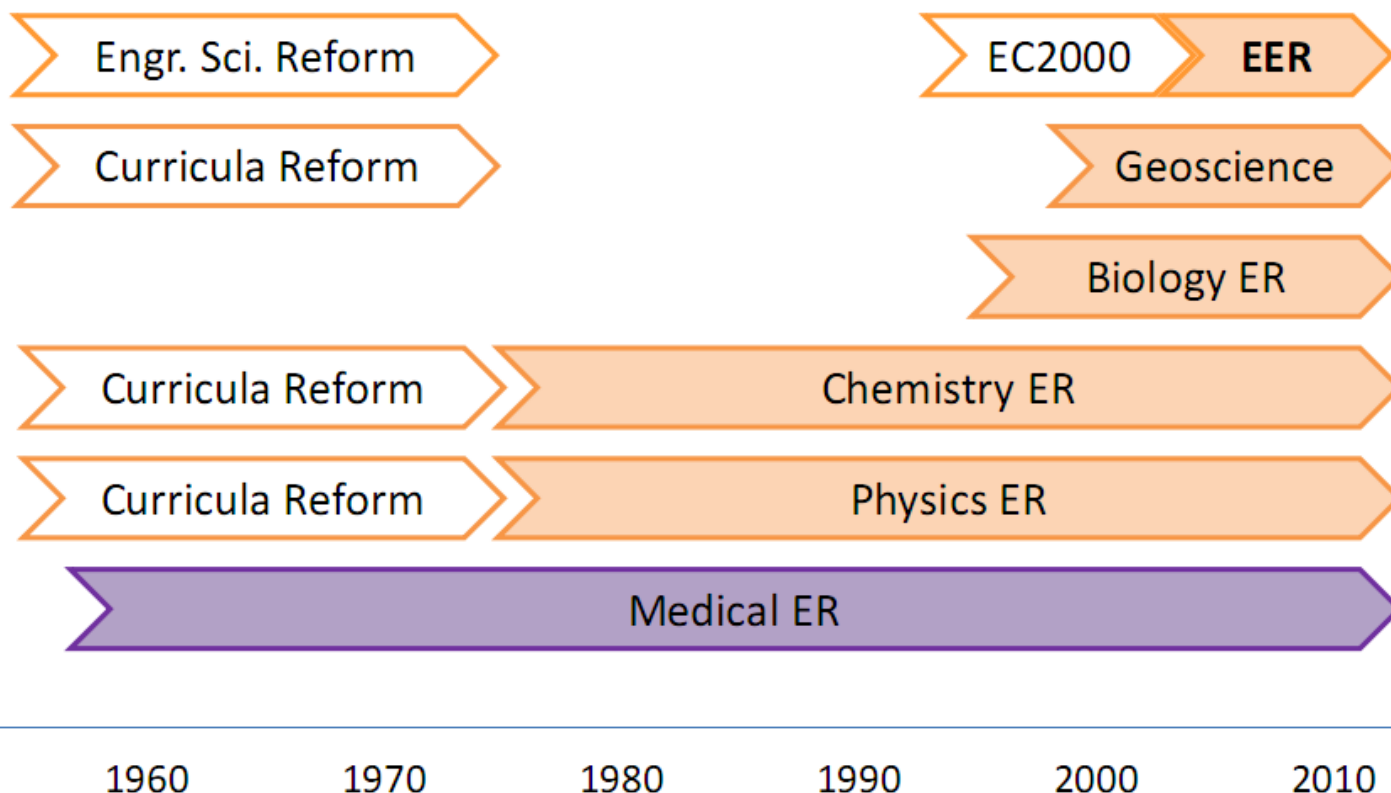
<https://karlsmithmn.org/>

Discipline-Based Education Research Timeline

DBER Departments and Graduate Programs



National Research
Council
2012



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

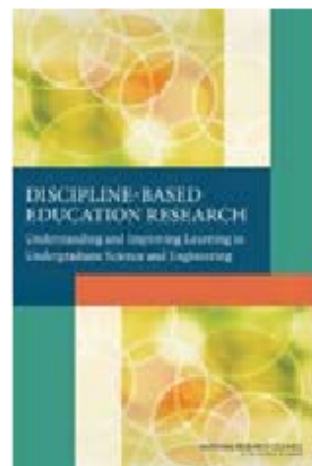
Discipline-Based Education Research (DBER)

Understanding and Improving
Learning in Undergraduate Science
and Engineering



http://www.nap.edu/catalog.php?record_id=13362

Discipline-Based Education Research (DBER)



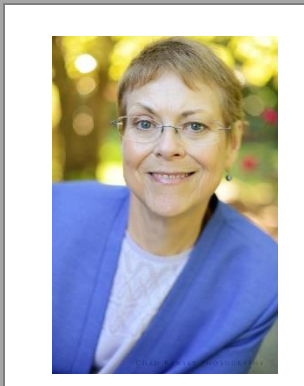
National Research
Council
2012

- 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**.

Fundamentals of Engineering Education Research

Rigorous Research in Engineering Education Initiative
(NSF DUE 0817461)

<https://stemedhub.org/groups/cleerhub>



Ruth A. Streveler
Purdue University



Karl A. Smith
Purdue University and
University of Minnesota

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

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

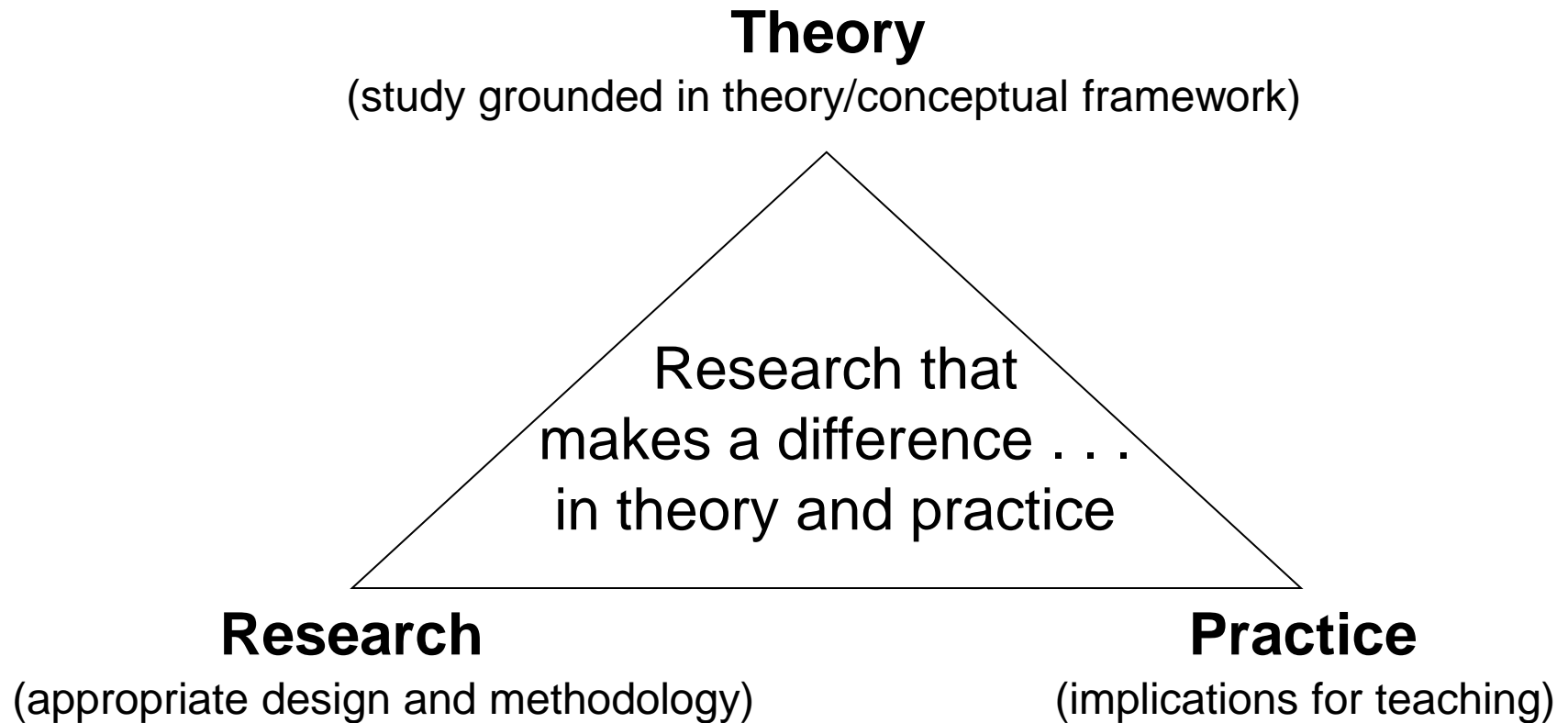
- **Level 0** Teacher
 - Teach as taught
- **Level 1** Effective Teacher
 - Teach using accepted teaching theories and practices
- **Level 2** Scholarly Teacher
 - Assesses performance and makes improvements
- **Level 3** Scholar of Teaching and Learning
 - Engages in educational experimentation, shares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

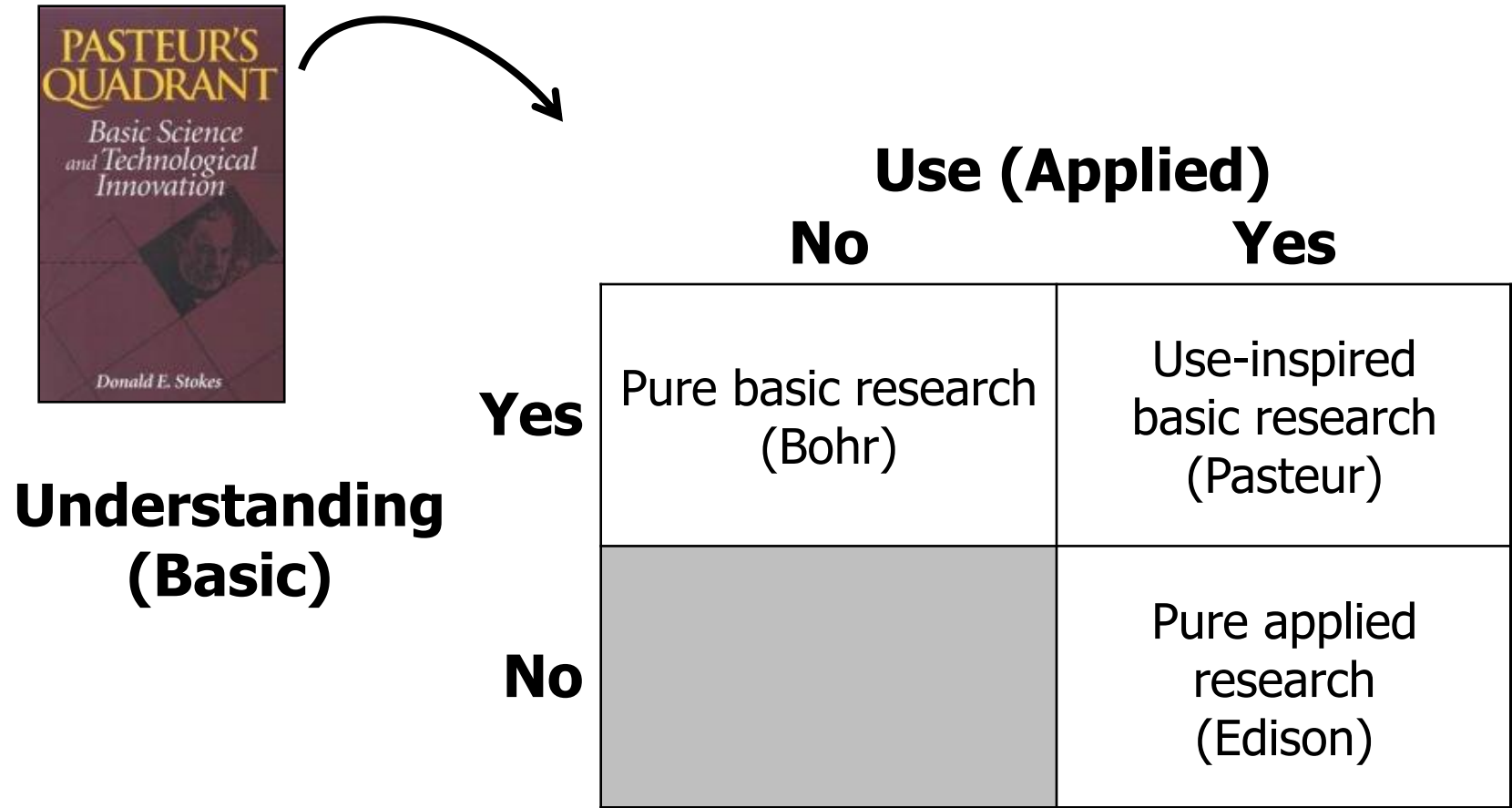
Workshop Intentions / Participant Learning Outcomes

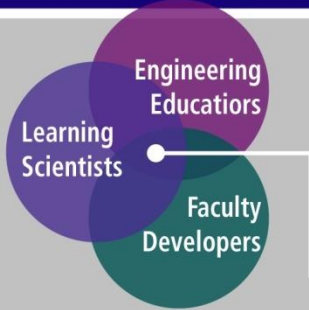
1. Describe key features of engineering education research
2. Explain emergence of engineering education research as a discipline
3. Describe recent reports and their relevance for and relationship with engineering education research
4. Summarize growth of engineering education research
5. Speculate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

RREE Approach



Research can be inspired by ...





Conducting Rigorous Research in Engineering Education

The Community of Practice



What *IS* Rigorous Research in Engineering Education?

ASEE Global
Colloquium
Cape Town,
South Africa
2008


Ruth Streveler


Karl Smith

**School of Engineering Education
Purdue University, US**

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 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. 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?**



**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*

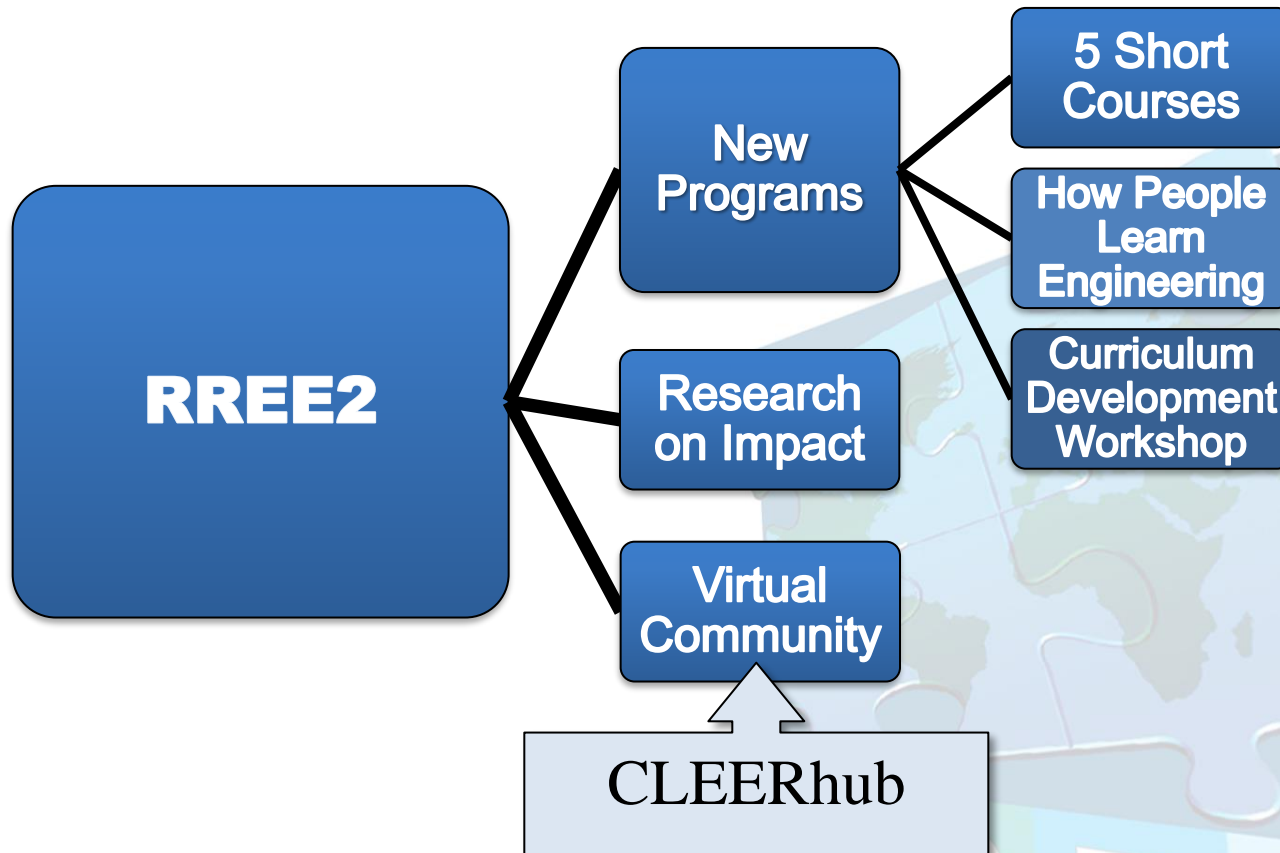
RREE2

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

<https://stemedhub.org/groups/cleerhub>



RIGOROUS RESEARCH
in
ENGINEERING EDUCATION

Centrality of Community of Practice (CoP)

- [Streveler, R.A., Smith, K.A., and Miller, R.L. 2005. Enhancing Engineering Education Research Capacity through Building a Community of Practice.](#)
- [Streveler, R.A., Magana, A.J., Smith, K.A. and Douglas, T.C. 2010. CLEERHub.org: Creating a digital habitat for engineering education researchers. American Society for Engineering Education Annual Conference](#)
- Pitterson, N., Allendoerfer, C., Streveler, R., Ortega-Alvarez, J., & Smith, K. (2020). The Importance of Community in Fostering Change: A Qualitative Case Study of the Rigorous Research in Engineering Education (RREE) Program. *Studies in Engineering Education*, 1(1), 20–37.
DOI: <http://doi.org/10.21061/see.7>
<https://www.seejournal.org/articles/10.21061/see.7/>

Engineering Education Research Networking Session

Connecting Engineering Education

Research Programs from Around the World

sponsored by the
ASEE International Division

in partnership with
Rigorous Research in
Engineering Education Initiative
CLEERhub.org
And the Journal of Engineering Education

ASEE Annual Conference – June 22, 2010 – Session 2123

Facilitated By

Karl A. Smith

Purdue University and
University of Minnesota

Jack Lohmann

Georgia Tech

Hans Hoyer

ASEE

Ruth A. Streveler

Purdue University

Satish Udpa

Michigan State University

Stephanie Eng

ASEE

EER PhD Program Briefings

- **Utah State University – Kurt Becker**
- **Purdue University – David Radcliffe & Robin Adams**
- **Universidad de las Americas, Puebla, Mexico – Enrique Palou**
- **Virginia Tech – Maura Borrego**
- **Universiti Teknologi Malaysia – Zaini Ujang**
- **Clemson University – Lisa Benson**
- **NITTTRs – India – R. Natarajan**
- **Arizona State University – Tirupalavanam Ganesh & Chell Roberts**
- **University of Washington – Cindy Atman**
- **Ohio State University – Lisa Abrams**
- **Carnegie Mellon University – Paul Steif**
- **University of Michigan – Cindy Finelli**
- **Washington State University – Denny Davis**
- **University of Georgia – Nadia Kellam & Joachim Walther**
- **Michigan State University – Jon Sticklen**
- **University of Colorado – Boulder – Daria Kotys-Schwartz**

EER&I Networking Session

Connecting and Expanding the Engineering Education Research & Innovation (EER&I) Communities

ASEE Annual Conference – June 18, 2019– T474 – 1:30 pm – 3:00 pm

Facilitated By



Karl A. Smith

Purdue University and
University of Minnesota



Ruth A. Streveler

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Rocio Chavela Guerra

American Society for
Engineering Education

UNIVERSITI TEKNOLOGI MALAYSIA CENTRE FOR ENGINEERING EDUCATION: LOCAL & GLOBAL ACTIVITIES

Scholarly Innovations, Research & PhD in Engineering



More than 20 PhD graduates since 2011
Current students: 16

Translating research into practice



JICA-funded PBL for Low Carbon Society with Kyoto Environ. Activities Assoc. & Johor State Edu. Dept



Training, Mentoring, & Recognition

4 international & 8 national awards



Research & knowledge implementation & dissemination



Active Learning



Team Based Learning



Cooperative Problem Based Learning (CPBL)



Training: Effective SCL implementation for Engaging Millennials

Community of practice – enable and support

Champions & Communities of change agents



International Innovative Practices in Higher Education Expo (I-PHEX)



International Engineering Service Learning with Korea & Malaysia



Champions and trainers (TOT) – World Bank-funded project with MOHE Afghanistan

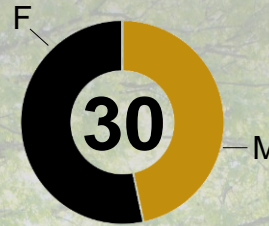
Contact: khairiyah@utm.my

UNDERGRADUATE ENROLLMENT AY 2018-19

First-Year Engineering ~**2800**

Multidisciplinary Engineering **88**

FACULTY GENDER RATIO

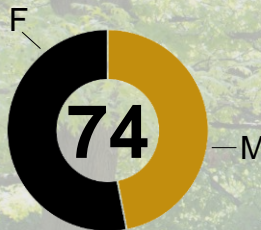


30 Faculty
26 AP Staff
7 Admin Assistants

CURRENT PHD STUDENTS

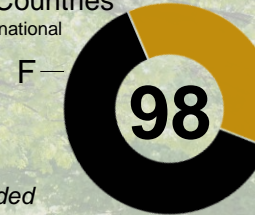
Representing 14 Countries

2 or more
Brazil
Canada
China
Colombia
India
Iran
Pakistan
United States



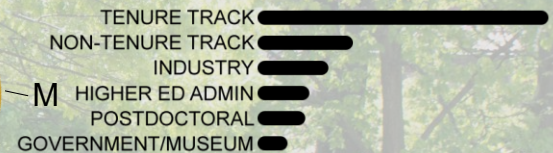
PHD ALUMNI*

Representing 15 Countries
and 54 Domestic and International
Universities and Colleges



**Successfully Defended*

PHD ALUMNI CAREERS



Others: P-12 Education, Higher Ed Research, Unknown

PROGRAMS and OPERATIONS

First-Year Engineering Program
Graduate Program (MS and PhD)
Multidisciplinary Engineering Degree Program
INSPIRE Pre-College Engineering Research
Student Advising
Graduate Certificate (New 2016; Online New 2018)
Integrated Research Labs
Ideas To Innovation Learning Labs

CAMPUS COLLABORATIONS

Biomedical Engineering
Chemical Engineering
Electrical and Computer
Engineering
Environmental and Ecological
Engineering
Materials Engineering
Mechanical Engineering

Honors College
Purdue Polytechnic Institute
Krannert School of Management
College of Education
College of Health and Human
Services
College of Liberal Arts
Purdue Athletics

INTEGRATING RESEARCH AND PRACTICE



131

centers &
groups

48

graduate
programs

75

conferences &
workshops

60

journals

...and more

engineering education community resource

<http://bit.ly/engredu>

Thank you!

An e-copy of this presentation will be posted to:
<https://karlsmithmn.org/engineering-education-research-and-innovation/>



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