Implications of Research in Engineering Education
for Practice in Engineering Education

Karl A. Smith

Engineering Education – Purdue University
Civil Engineering - University of Minnesota

ASEE Global Colloquium on Engineering Education

Cape Town, South Africa

October 21, 2008

Implications of Research in Engineering Education
for Practice in Engineering Education

- Research and Practice Models
  - R ↔ P
  - Cycle of Knowledge Production and Improvement of Practice
  - Pasteur's Quadrant
- Research that makes a difference in theory and practice
  - Your Ideas – Think-Pair-Share
  - My Ideas
- Current Activities and Initiatives – International Conferences, NSF, NAE, Departments of Engineering Education
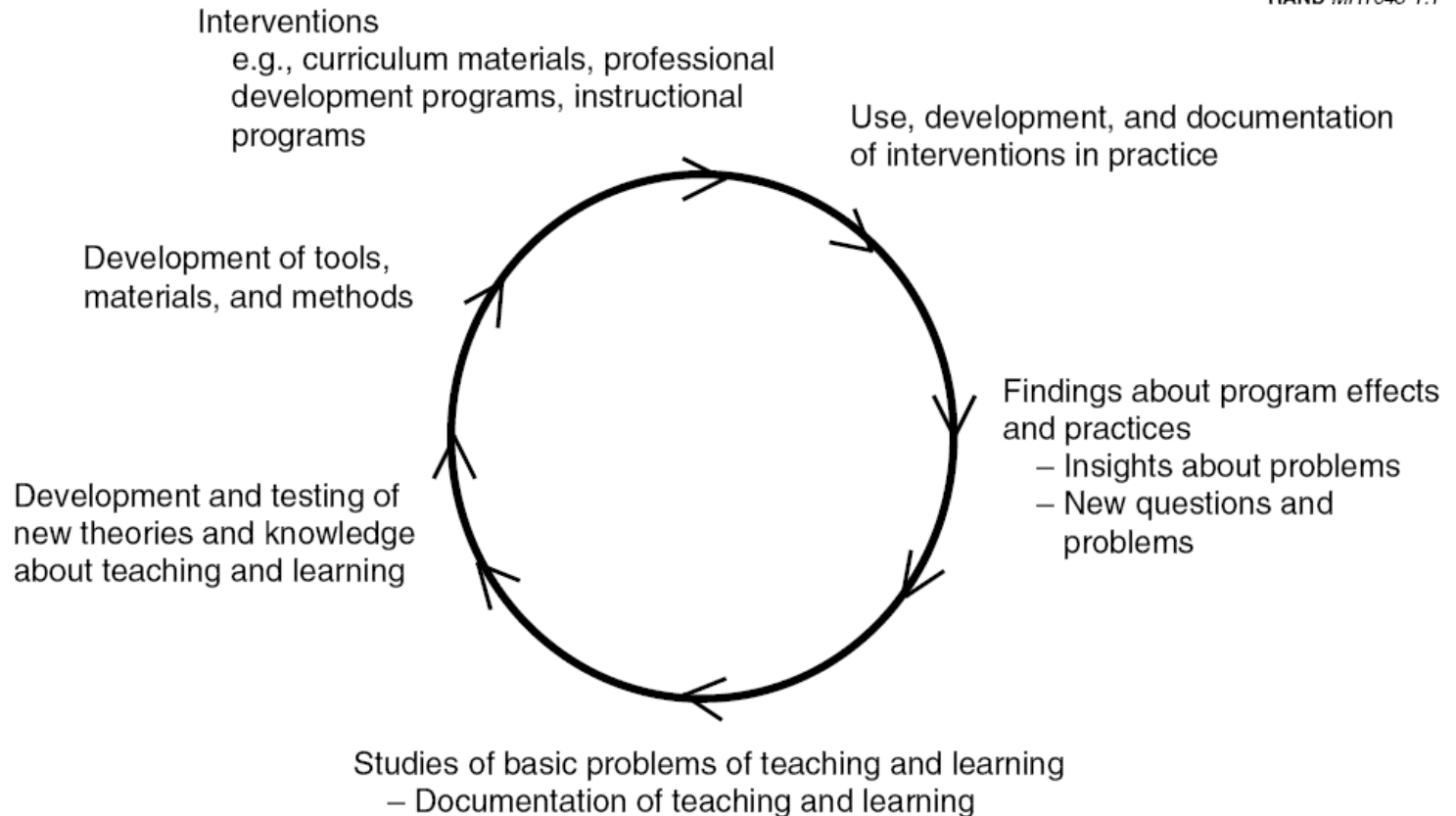
Current Models Linking Research and Practice in Education

- Model 1: Teachers read research and implement it in their classrooms
- Model 2: Summary guides
- Model 3: General professional development
- Model 4: The policy route
- Model 5: The long route
- Model 6: Design experiments

Burkhardt and Schoenfeld (2003)

Engineering Education Research – Closing the Loop

RAND MR1643-1.1

Interventions
e.g., curriculum materials, professional development programs, instructional programs

Use, development, and documentation of interventions in practice

Development of tools, materials, and methods

Findings about program effects and practices
- Insights about problems
- New questions and problems

Development and testing of new theories and knowledge about teaching and learning

Studies of basic problems of teaching and learning
- Documentation of teaching and learning

Mathematical Proficiency for All Students

Toward a Strategic Research and Development Program in Mathematics Education

RAND Mathematics Study Panel
Deborah Loewenberg Ball, Chair

Prepared for the
Office of Educational Research and Improvement (OERI)
U.S. Department of Education

Science & Technology Policy Institute   RAND EDUCATION

Figure 1.1—Cycle of Knowledge Production and Improvement of Practice

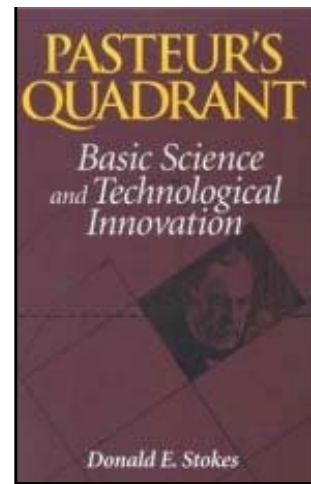# Research Inspired By:

Use (Applied)

PASTEUR'S QUADRANT
Basic Science and Technological Innovation
Donald E. Stokes

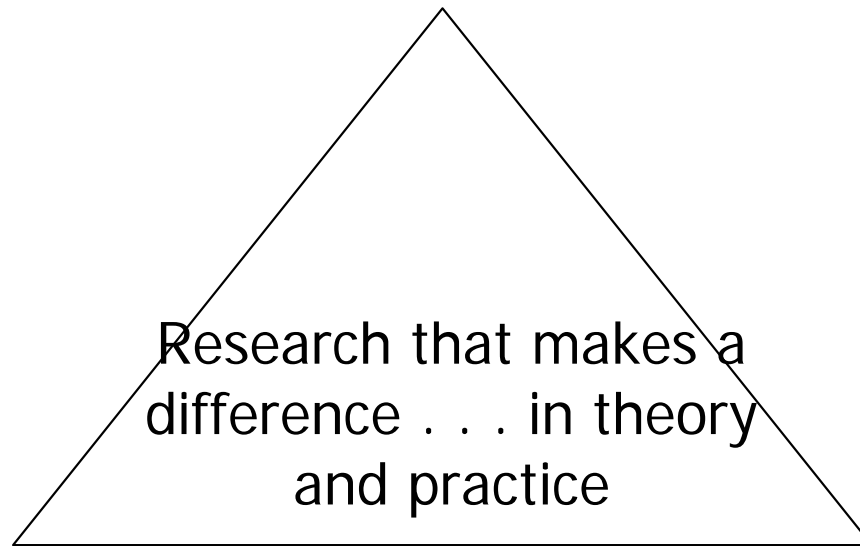|	**No**	**Yes**
Yes	Pure basic research (Bohr)	Use-inspired basic research (Pasteur)
No		Pure applied research (Edison)

(Left vertical axis label: Understanding (Basic))

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

Engineering Education Research

Theory

Research that makes a
difference . . . in theory
and practice

Research   Practice

# Formulate-Share-Listen-Create (Think-Pair-Share)

- Individually reflect on engineering education research that has informed/influenced practice

- Turn to the person next to you, introduce yourself, and share individual lists

- Develop one list and prepare to discuss

Research that Makes a Difference in Theory and Practice

- Evident in Practice
  - Outcomes/Mastery
  - Inquiry
  - Student Engagement
- Emerging in Practice
  - Cognitive model of the learner
  - Integrated approach to course/program design
  - Broader range of knowledge, skills and attributes
  - Scholarly approach to engineering education

Educational Objectives and Mastery, and Student Learning Outcomes

1. What educational purposes should the school seek to attain?
2. What educational experiences can be provided that are likely to attain these purposes?
3. How can these educational experiences be effectively organized?
4. How can we determine whether these purposes are being attained?
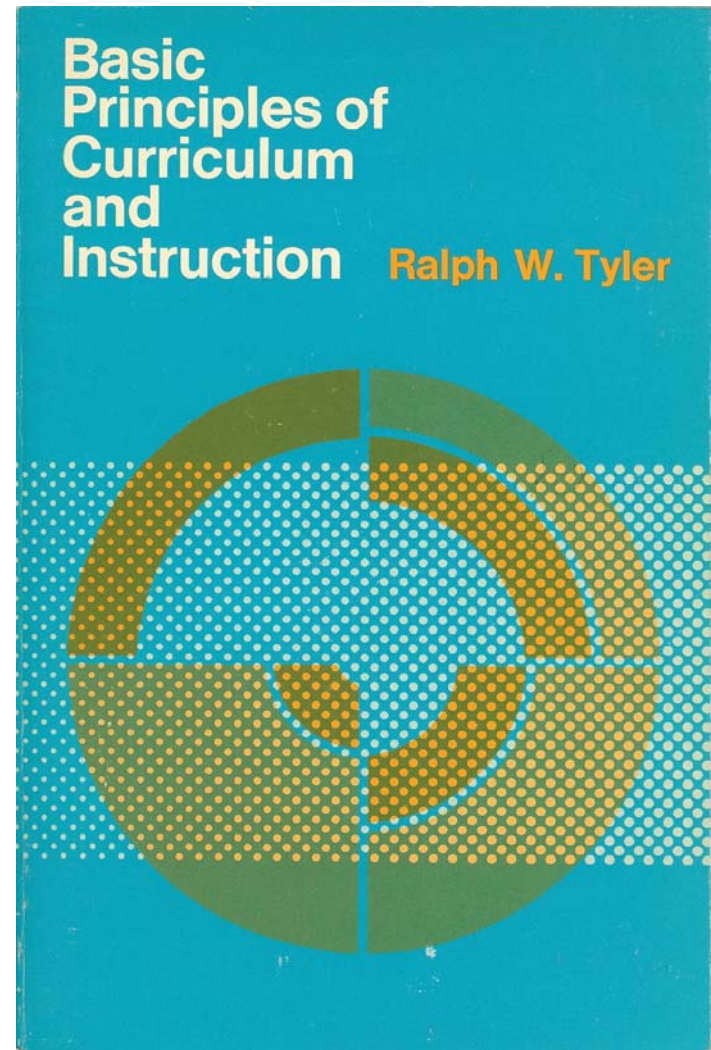
Tyler, R.W. 1949. *Basic principles of curriculum and instruction.* Chicago: University of Chicago Press

Taxonomies

Bloom's taxonomy of educational objectives: Cognitive Domain (Bloom & Krathwohl, 1956)

A taxonomy for learning, teaching, and assessing: A revision of Bloom's taxonomy of educational objectives (Anderson & Krathwohl, 2001).

Evaluating the quality of learning: The SOLO taxonomy (Biggs & Collis, 1982; Biggs, 1999)

Facets of understanding (Wiggins & McTighe, 1998)

Taxonomy of significant learning (Fink, 2003)

A taxonomic trek: From student learning to faculty scholarship (Shulman, 2002)

The Six Major Levels of Bloom's Taxonomy of the Cognitive Domain
(with representative behaviors and sample objectives)

Knowledge. Remembering information *Define, identify, label, state, list, match*

   Identify the standard peripheral components of a computer
   Write the equation for the Ideal Gas Law

Comprehension. Explaining the meaning of information *Describe, generalize, paraphrase, summarize, estimate*

   In one sentence explain the main idea of a written passage
   Describe in prose what is shown in graph form

Application. Using abstractions in concrete situations *Determine, chart, implement, prepare, solve, use, develop*

   Using principles of operant conditioning, train a rate to press a bar

   Derive a kinetic model from experimental data

Analysis. Breaking down a whole into component parts *Points out, differentiate, distinguish, discriminate, compare*

   Identify supporting evidence to support the interpretation of a literary passage
   Analyze an oscillator circuit and determine the frequency of oscillation

Synthesis. Putting parts together to form a new and integrated whole *Create, design, plan, organize, generate, write*

   Write a logically organized essay in favor of euthanasia
   Develop an individualized nutrition program for a diabetic patient

Evaluation. Making judgments about the merits of ideas, materials, or phenomena *Appraise, critique, judge, weigh, evaluate, select*

   Assess the appropriateness of an author's conclusions based on the evidence given
   Select the best proposal for a proposed water treatment plant

3.1 THE TAXONOMY TABLE

THE KNOWLEDGE DIMENSION	THE COGNITIVE PROCESS DIMENSION					
	1. REMEMBER	2. UNDERSTAND	3. APPLY	4. ANALYZE	5. EVALUATE	6. CREATE
A. FACTUAL KNOWLEDGE						
B. CONCEPTUAL KNOWLEDGE						
C. PROCEDURAL KNOWLEDGE						
D. META-COGNITIVE KNOWLEDGE						

(Anderson & Krathwohl, 2001).

SOLO Taxonomy - Structure of Observed Learning Outcome

Levels of Understanding:

- **Pre-structural** - The task is not attacked appropriately; the student hasn't really understood the point and uses too simple a way of going about it.

- **Uni-structural** - The students response only focus on one relevant aspect

- **Multi-structural** - The students response focus on several relevant aspects but they are treated independently and additively. Assessment of this level is primarily quantitative.

- **Relational** - The different aspects have become integrated into a coherent whole. This level is what is normally meant by an adequate understanding of some topic.

- **Extended abstract** - The previous integrated whole may be conceptualised at a higher level of abstraction and generalised to a new topic or area.

Biggs, J.B., and Collis, K.F. 1982. *Evaluating the Quality of Learning – the SOLO Taxonomy.* New York: Academic Press.

Biggs, J. 1999. *Teaching for Quality Learning at University.* Buckingham: SRHE and Open University Press

Inquiry Foundations - John Dewey

John Dewey - "productive inquiry" - the process of seeking the knowledge when it is needed in order to carry out a particular situated task.

John Dewey's ideal school:

- a "thinking" curriculum aimed at deep understanding
- cooperative learning within communities of learners
- interdisciplinary and multidisciplinary curricula
- projects, portfolios, and other "alternative assessments" that challenged students to integrate ideas and demonstrate their capabilities.

Dewey, John. 1915. The school and society, 2nd ed. Chicago: University of Chicago Press.

Inquiry – Jerome Bruner

- Bruner (1960) "Mastery of the fundamental ideas of a field involves not only the grasping of general principles, but also the **development of an attitude toward learning and inquiry**, toward guessing and hunches, toward the possibility of solving problems on one's own."
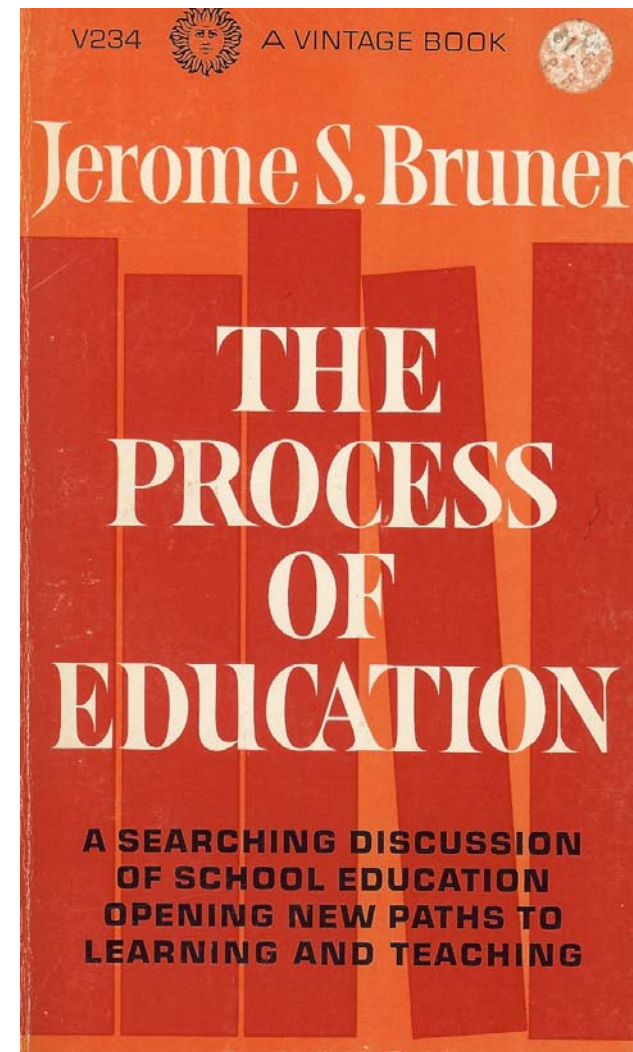
TABLE 1

Instructional demands imposed by inductive teaching methods.

Method	Required resources	Planning time and instructor involvement	Student resistance
Inquiry	None	Small	Minimal
Cases (individual)	Cases	Small (existing cases); considerable (original cases)	Minimal
Project-based (individual)	Facilities for experimental projects	Small (same project, no facilities maintenance); moderate (different projects, facilities maintenance[a]	Minimal
Just-in-time teaching	Web-based course management system	Moderate (continual need to adjust lesson plans to reflect student answers to pre-class questions)	Moderate
Cases (teams)	Cases	Considerable (team management[b])	Considerable[b]
Project-based (teams)	Facilities for experimental projects	Considerable (team management, facilities maintenancea)	Considerable[a,b]
Problem-based	Problems	Considerable (existing problems), extensive (original problems)[b]	Major[c]
Hybrid (problem/project-based)	Problems, facilities for experimental projects	Considerable (existing problems), extensive (original problems)[a,b]	Major[c]

[a] Assuming that experimental facilities are required for student projects and that the instructor (as opposed to a technician) is involved in maintaining them.

[b] Assuming that cooperative learning principles are followed for team projects. If, for example, students can self-select teams and the instructor makes no effort to assess individual knowledge and performance or to intervene in team conflicts, the demands on the instructor are the same as for individual assignments using the same method.

[c] Resistance follows both from the burden of responsibility for their own learning placed on students and the additional demands imposed by cooperative learning. Hybrid methods may also involve problems of facilities maintenance.

Prince, Michael J. & Felder, Richard M. 2007. The many faces of inductive teaching and learning. *Journal of College Science Teaching, 36(5),* 14–20.

Student Engagement

- *Involvement in learning: Realizing the potential of American higher education* 1984
- Research - Astin, Light, Pascarella & Terrenzini
- Student-Student Interaction – Cooperative Learning
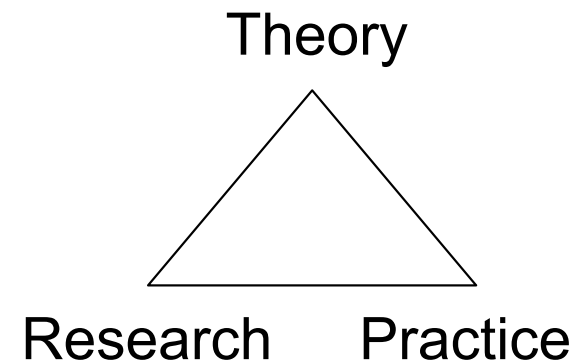- National Survey of Student Engagement (NSSE)

Student – Student Interaction Kurt Lewin's Contributions

- Founded field of social psychology
- Action Research
- Force-Field analysis
- B = f(P,E)
- Social Interdependence Theory
- "There is nothing so practical as a good theory"

Cooperative Learning

- Theory – Social Interdependence – Lewin – Deutsch – Johnson & Johnson
- Research – Randomized Design Field Experiments
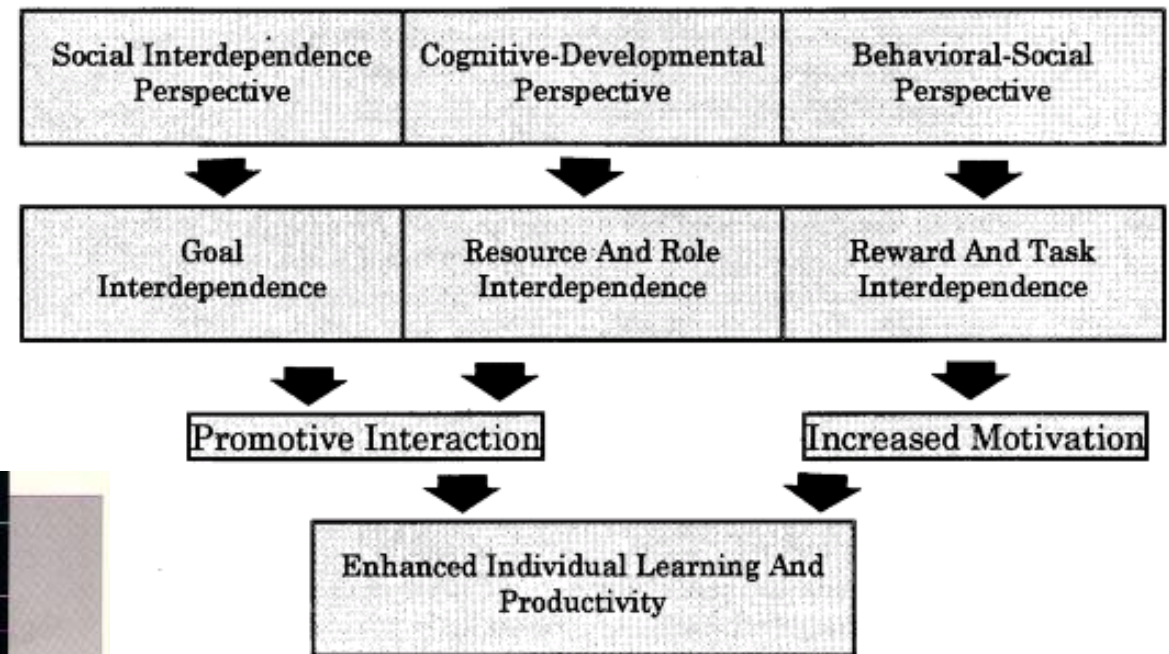- Practice – Formal Teams/Professor's Role

Theory

Research   Practice
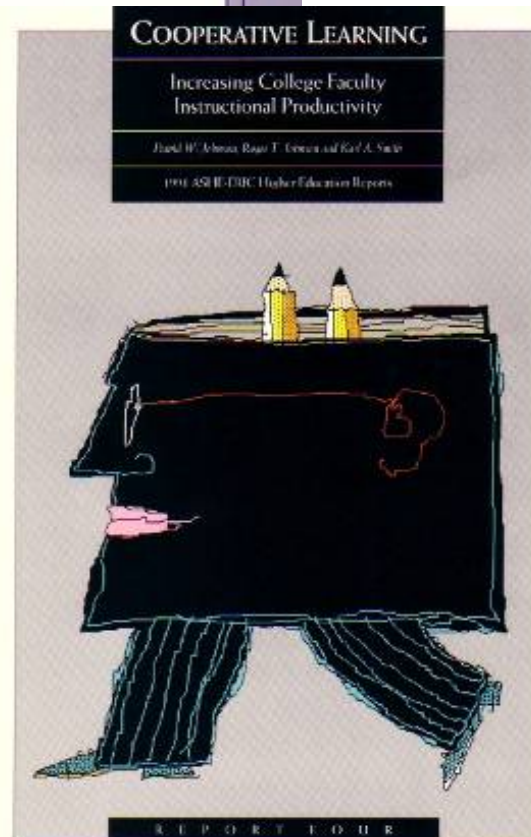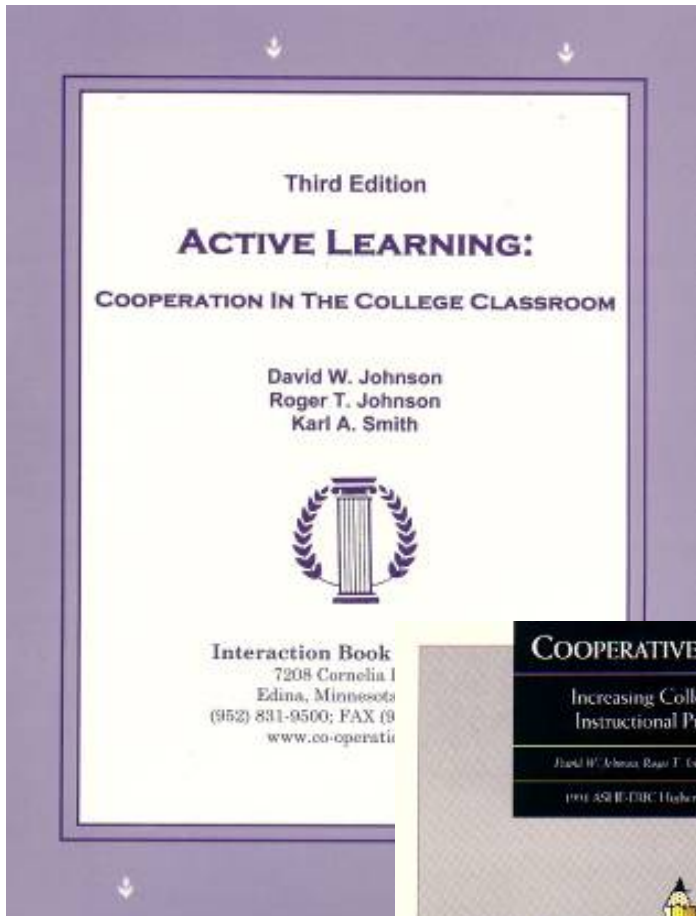
Figure A.1 A General Theoretical Framework

Social Interdependence Perspective	Cognitive-Developmental Perspective	Behavioral-Social Perspective

⬇ ⬇ ⬇

Goal Interdependence	Resource And Role Interdependence	Reward And Task Interdependence

⬇ ⬇

Promotive Interaction   Increased Motivation

⬇ ⬇

Enhanced Individual Learning And Productivity

Third Edition

ACTIVE LEARNING:

COOPERATION IN THE COLLEGE CLASSROOM

David W. Johnson
Roger T. Johnson
Karl A. Smith

Interaction Book
7208 Cornelia
Edina, Minnesota
(952) 831-9500; FAX (9
www.co-operati

COOPERATIVE LEARNING

Increasing College Faculty
Instructional Productivity

David W. Johnson, Roger T. Johnson and Karl A. Smith

1991 ASHE-ERIC Higher Education Reports

REPORT FOUR

Cooperative Learning
- Positive Interdependence
- Individual and Group Accountability
- Face-to-Face Promotive Interaction
- Teamwork Skills
- Group Processing

Cooperative Learning Research Support

Johnson, D.W., Johnson, R.T., & Smith, K.A. 1998. Cooperative learning returns to college: What evidence is there that it works? *Change*, *30* (4), 26-35.

- Over 300 Experimental Studies
- First study conducted in 1924
- High Generalizability
- Multiple Outcomes

Outcomes

1. Achievement and retention
2. Critical thinking and higher-level reasoning
3. Differentiated views of others
4. Accurate understanding of others' perspectives
5. Liking for classmates and teacher
6. Liking for subject areas
7. Teamwork skills

January 2005
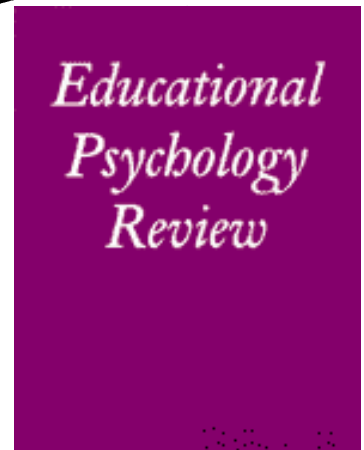
March 2007

Small-Group Learning: Meta-analysis

Springer, L., Stanne, M. E., & Donovan, S. 1999. Effects of small-group learning on undergraduates in science, mathematics, engineering, and technology: A meta-analysis. Review of Educational Research, 69(1), 21-52.

Small-group (predominantly cooperative) learning in postsecondary science, mathematics, engineering, and technology (SMET). 383 reports from 1980 or later, 39 of which met the rigorous inclusion criteria for meta-analysis.

The main effect of small-group learning on achievement, persistence, and attitudes among undergraduates in SMET was significant and positive. Mean effect sizes for achievement, persistence, and attitudes were 0.51, 0.46, and 0.55, respectively.

National Survey of Student Engagement

1. **Level of academic challenge**: Schools encourage achievement by setting high expectations and emphasizing importance of student effort.

2. **Active and collaborative learning**: Students learn more when intensely involved in educational process and are encouraged to apply their knowledge in many situations.

3. **Student-faculty interaction**: Students able to learn from experts and faculty serve as role models and mentors.

4. **Enriching educational experiences**: Learning opportunities inside and outside classroom (diversity, technology, collaboration, internships, community service, capstones) enhance learning.

5. **Supportive campus environment**: Students are motivated and satisfied at schools that actively promote learning and stimulate social interaction.

Emerging Support

- Cognitive Model of the Learner
- Integrated Approach to Course and Program Design
  - Content, Assessment and Pedagogy
- Broader Range of Knowledge, Skills and Attributes

Models of the Learner

The Cognitive Model

- Students build their knowledge by processing the information they receive (constructivism).
- What students construct depends on the context—including the students' mental states.
- Producing significant conceptual change is difficult and can be facilitated through a variety of known mechanisms.
- Individuals show a significant variation in their style of learning along a number of dimensions.
- For most individuals, learning is most effectively carried out via social interactions.

The Broadcast Model

- Previous knowledge is not relevant. (Students are blank slates.)
- Knowledge is binary. (You either know it or you don't.)
- The student is idealized. (Students possess good motivation, independence, a knowledge of what to do, and a willingness to do it.) If the student differs from this ideal image, it's their fault.
- The student is assumed to be metacognitive. (Students learn from their mistakes.)
- Scientific thought and rational thinking are taken to be natural—even obvious.

Redish, E.F. 2000. Discipline-based education and education research: The case of physics. *Journal of Applied Developmental Psychology, 21*(1), 85-96.
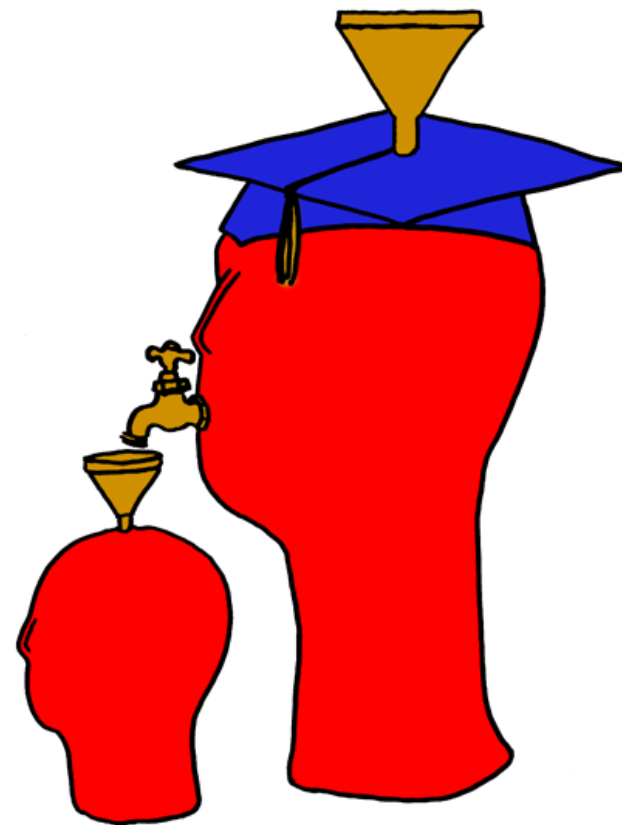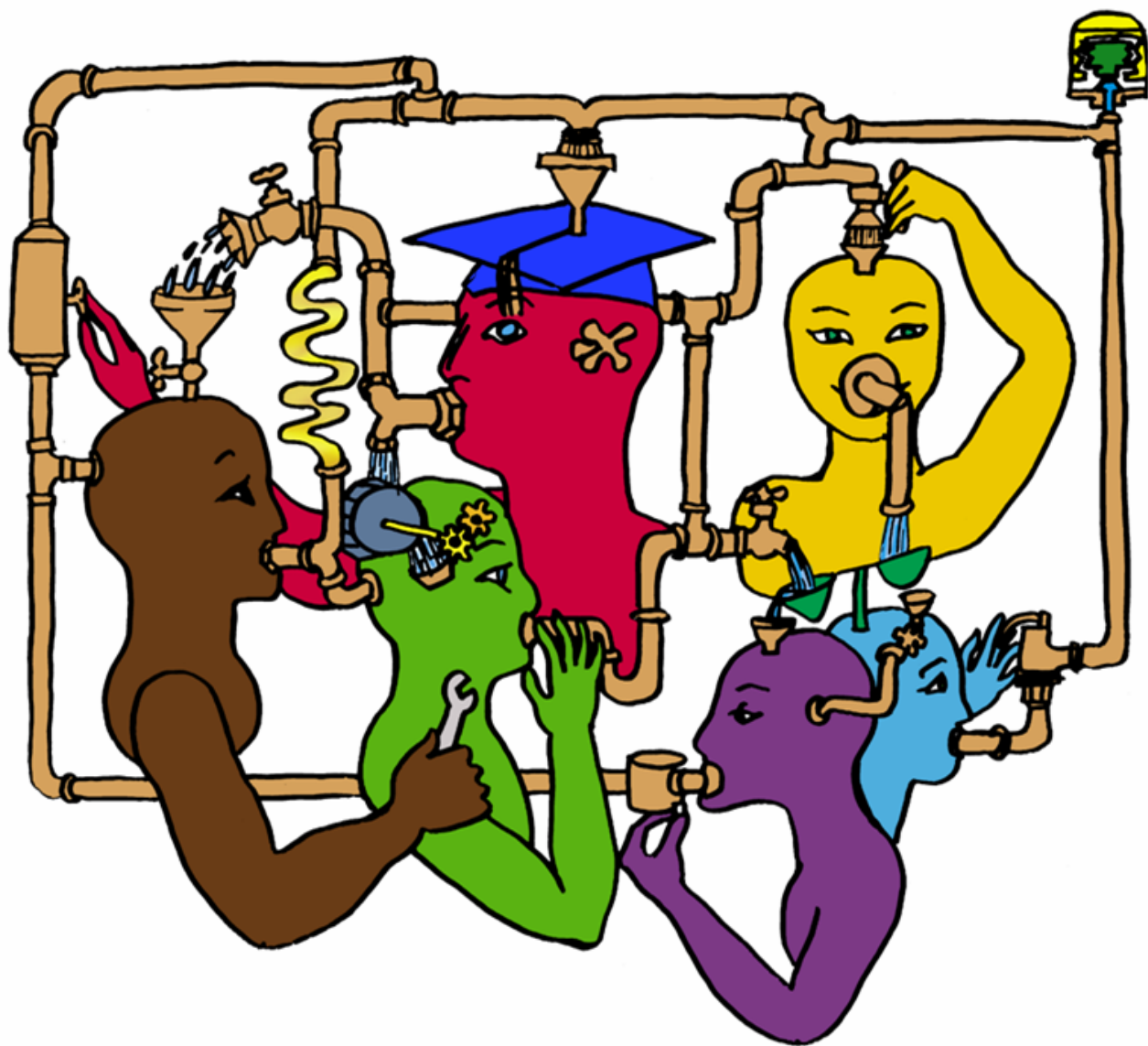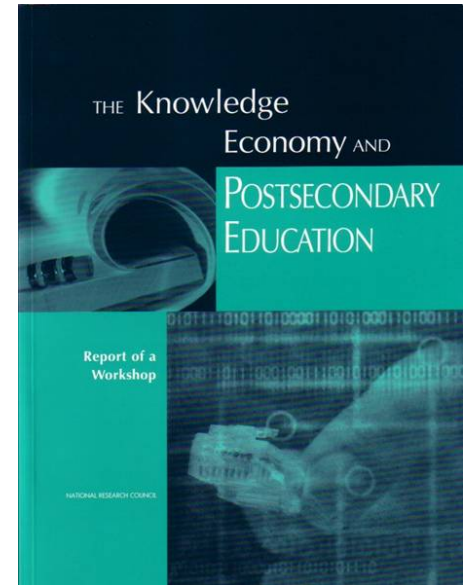
Lila M. Smith

Backward Design
Wiggins & McTighe

Stage 1. Identify Desired Results

Stage 2. Determine Acceptable Evidence

Stage 3. Plan Learning Experiences and Instruction

- Bransford, Vye and Bateman – Creating High Quality Learning Environments
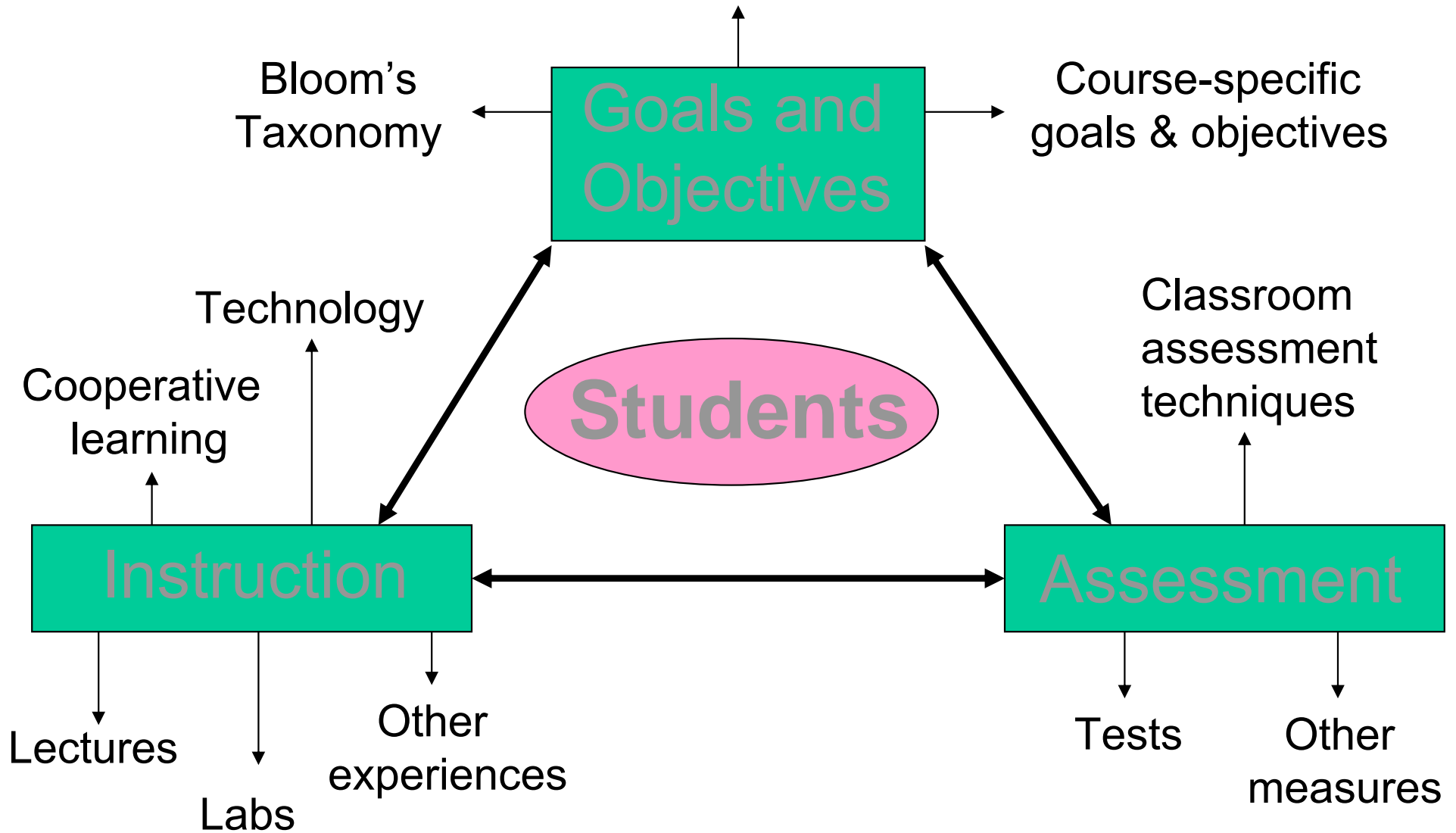
Wiggins, Grant and McTighe, Jay. 1998. *Understanding by Design*. Alexandria, VA: ASCD

Effective Course Design

(Felder & Brent, 1999)

ABET EC 2000

Bloom's
Taxonomy

Goals and
Objectives

Course-specific
goals & objectives

Technology

Cooperative
learning

Students

Classroom
assessment
techniques

Instruction

Assessment

Lectures

Labs

Other
experiences

Tests

Other
measures

ABET Engineering Criteria 2000

To maintain **ABET** accreditation, Engineering Departments must demonstrate
that all of their graduates have the following eleven general skills and abilities:

a. an ability to apply knowledge of mathematics, science, and engineering
b. an ability to design and conduct experiments, as well as to analyze and interpret data
c. an ability to design a system, component, or process to meet desired needs
d. an ability to function on multi-disciplinary teams
e. an ability to identify, formulate, and solve engineering problems
f. an understanding of professional and ethical responsibility
g. an ability to communicate effectively
h. the broad education necessary to understand the impact of engineering solutions in a global and societal context
i. a recognition of the need for, and an ability to engage in life-long learning
j. a knowledge of contemporary issues
k. an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

Desired Attributes of a Global Engineer*

- A good grasp of these engineering science fundamentals, including:
  - Mechanics and dynamics
  - Mathematics (including statistics)
  - Physical and life sciences
  - Information science/technology
- A good understanding of the design and manufacturing process (i.e., understands engineering and industrial perspective)
- A multidisciplinary, systems perspective, along with a product focus
- A basic understanding of the context in which engineering is practiced, including:
  - Customer and societal needs and concerns
  - Economics and finance
  - The environment and its protection
  - The history of technology and society
- An awareness of the boundaries of one's knowledge, along with an appreciation for other areas of knowledge and their interrelatedness with one's own expertise
- An awareness of and strong appreciation for other cultures and their diversity, their distinctiveness, and their inherent value
- A strong commitment to team work, including extensive experience with and understanding of team dynamics
- Good communication skills, including written, verbal, graphic, and listening
- High ethical standards (honesty, sense of personal and social responsibility, fairness, etc)
- An ability to think both critically and creatively, in both independent and cooperative modes
- Flexibility: the ability and willingness to adapt to rapid and/or major change
- Curiosity and the accompanying drive to learn continuously throughout one's career
- An ability to impart knowledge to others

*A Manifesto for Global Engineering Education, Summary Report of the Engineering Futures Conference, January 22-23, 1997. The Boeing Company & Rensselaer Polytechnic Institute.

Desired Attributes of a Global Engineer*

- A multidisciplinary, systems perspective, along with a product focus

- An awareness of the boundaries of one's knowledge, along with an appreciation for other areas of knowledge and their interrelatedness with one's own expertise

- An awareness of and strong appreciation for other cultures and their diversity, their distinctiveness, and their inherent value

- High ethical standards (honesty, sense of personal and social responsibility, fairness, etc)

- An ability to think both critically and creatively, in both independent and cooperative modes

*A Manifesto for Global Engineering Education, Summary Report of the Engineering Futures Conference, January 22-23, 1997. The Boeing Company & Rensselaer Polytechnic Institute.

Purdue's Future Engineer

Vision: Purdue Engineers will be prepared for leadership roles in responding to the global technological, economic, and societal challenges of the 21st century.

Strategy: We will provide educational experiences that develop students' knowledge areas, abilities, and qualities to enable them to identify needs and construct effective solutions in an economically, socially, and culturally relevant manner.

Abilities

- leadership
- teamwork
- communication
- decision-making
- recognize & manage change
- work effectively in diverse & multicultural environments
- work effectively in the global engineering profession
- synthesize engineering, business, and societal perspectives

Knowledge Areas

- science & math
- engineering fundamentals
- analytical skills
- open-ended design & problem solving skills
- multidisciplinarity within and beyond engineering
- integration of analytical, problem solving, and design skills

Qualities

- innovative
- strong work ethic
- ethically responsible in a global, social, intellectual, and technological context
- adaptable in a changing environment
- entrepreneurial and intrapreneurial
- curious and persistent continuous learners

The Three Pillars of the Purdue Engineering Undergraduate Education

Scholarship Reconsidered: Priorities of the Professoriate Ernest L. Boyer

- The **Scholarship of Discovery**, research that increases the storehouse of new knowledge within the disciplines;

- The **Scholarship of Integration**, including efforts by faculty to explore the connectedness of knowledge within and across disciplines, and thereby bring new insights to original research;

- The **Scholarship of Application**, which leads faculty to explore how knowledge can be applied to consequential problems in service to the community and society; and

- The **Scholarship of Teaching**, which views teaching not as a routine task, but as perhaps the highest form of scholarly enterprise, involving the constant interplay of teaching and learning.

A SPECIAL REPORT

Scholarship Reconsidered
PRIORITIES OF THE PROFESSORIATE

ERNEST L. BOYER

THE CARNEGIE FOUNDATION
FOR THE ADVANCEMENT OF TEACHING
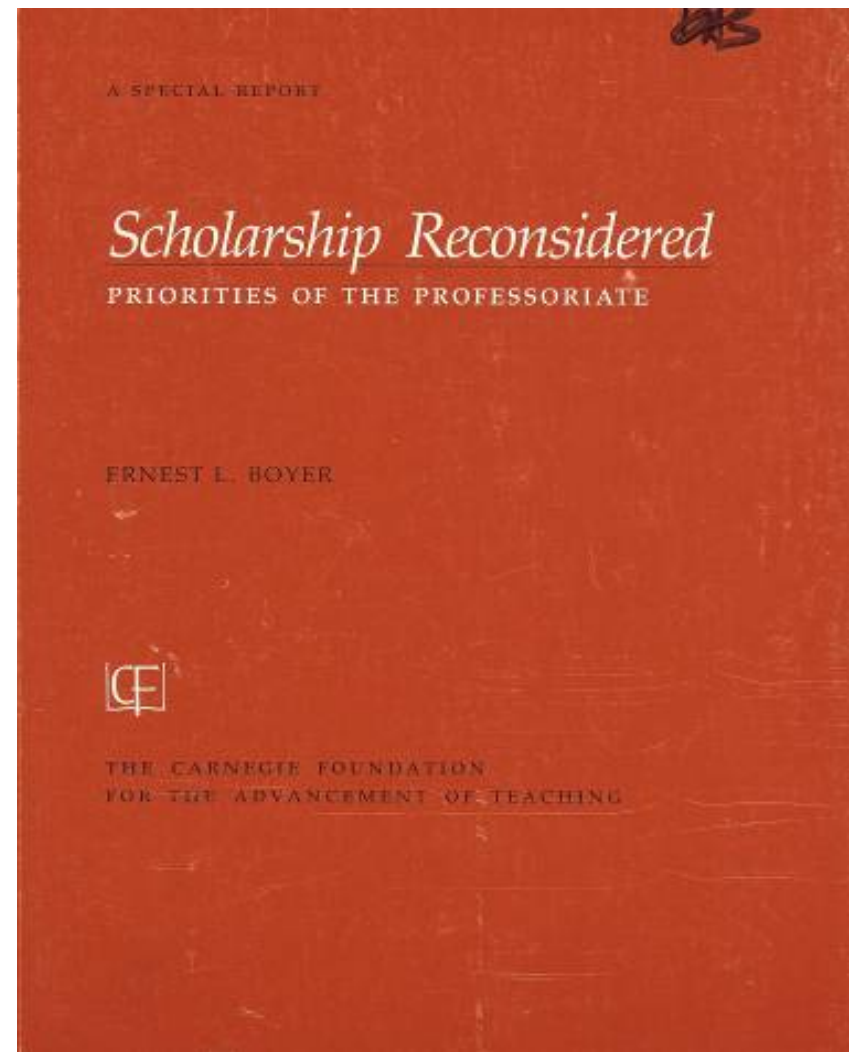
Engineering Education Levels of Inquiry

- Teach as Taught ("distal pedagogy")
- Level 1: Effective Teacher
- Level 2: Scholarly Teacher
- Level 3: Scholarship of Teaching and Learning (SoTL)
- Level 4: Engineering Education Research

Streveler, R., Borrego, M. and Smith, K.A. 2007. Moving from the "Scholarship of Teaching and Learning" to "Educational Research:" An Example from Engineering. Silver Anniversary Edition of *To Improve the Academy,* Vol. 25, 139-149.

Level of inquiry	Attributes of that level
Level 1: Excellent teaching	Involves the use of good content and teaching methods
Level 2: Scholarly Teaching	Good content and methods *and* classroom assessment and evidence gathering, informed by best practice and best knowledge, inviting of collaboration and review.
Level 3: Scholarship of Teaching	Is public and open to critique and evaluation, is in a form that others can build on, involves question-asking, inquiry and investigation, particularly about student learning.
Level 4: Rigorous Research in Engineering Education	Also is public, open to critique, and involves asking questions about student learning, but it includes a few unique components. (1) Begin with a *research* question not an *assessment* question. Assessment questions often deal with the "what" or "how much" of learning, while research questions more often focus on the "why" or "how" of learning (Paulsen, 2001). (2) Tying the question to learning, pedagogical, or social theory and interpreting the results of the research in light of theory. This will allow for the research to build theory and can increase the significance of the findings. For example, studies about teaching thermodynamics can be redesigned to become studies, based on cognitive theory, which can help explain why certain concepts in thermodynamics are so difficult to learn. (3) Paying careful attention to design of the study and the methods used. This will enable the study to hold up to scrutiny by a broad audience, again creating a potential for greater impact of results.

Table 7. Levels of rigor in inquiry representation. Reproduced from Streveler, Borrego, and Smith (2007). The authors credit Hutchings and Shulman (1999) for levels 1–3.
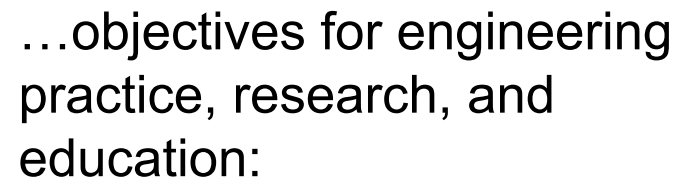
Borrego, M., Streveler, R.A., Miller, R.L. and Smith, K.A. 2008. A new paradigm for a new field: Communicating representations of engineering education research. *Journal of Engineering Education*, 97(2), 147-162.

Engineering Education Research
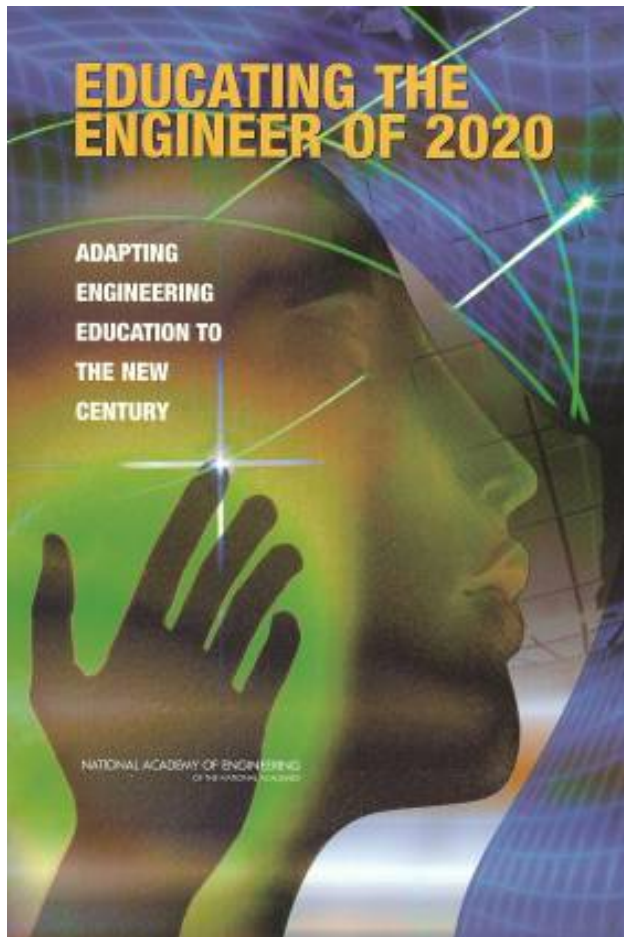
Colleges and universities should endorse research in engineering education as a valued and rewarded activity for engineering faculty and should develop new standards for faculty qualifications.

Engineering for a Changing World

A Roadmap to the Future of Engineering Practice, Research, and Education

The Millennium Project
The University of Michigan

…objectives for engineering practice, research, and education:

To adopt a systemic, research-based approach to innovation and continuous improvement of engineering education, recognizing the importance of diverse approaches–albeit characterized by quality and rigor–to serve the highly diverse technology needs of our society

http://milproj.ummu.umich.edu/publications/EngFlex%20report/download/EngFlex%20Report.pdf

Guiding Principles for Scientific Research in Education

1. **Question**: pose *significant* question that can be investigated *empirically*
2. **Theory**: link research to relevant theory
3. **Methods**: use methods that permit direct investigation of the question
4. **Reasoning**: provide coherent, explicit chain of reasoning
5. **Replicate and generalize** across studies
6. **Disclose** research to encourage professional scrutiny and critique

National Research Council, 2002

The Basic Features of Scholarly and Professional Work

1. Requires a high level of discipline-related expertise;
2. Is conducted in a scholarly manner with clear goals, adequate preparation, and appropriate methodology;
3. Has significance beyond the setting in which the research is conducted;
4. Is innovative;
5. Can be replicated or elaborated on;
6. Is appropriately and effectively documented, including a thorough description of the research process and detailed summaries of the outcomes and their significance;
7. Is judged to be meritorious and significant by a rigorous peer review process.

Adapted from: Diamond and Adam (1993) and Diamond (2002).

Engineering Education as a Field of Research

Journal of Engineering Education:
Guest Editorials

- Felder, R.M., S.D. Sheppard, and K.A. Smith, "A New Journal for a Field in Transition," *Journal of Engineering Education*, Vol. 93, No. 1, 2005, pp. 7–12.
- Kerns, S.E., "Keeping Us on the Same Page," *Journal of Engineering Education*, Vol. 93, No. 2, 2005, p. 205.
- Gabriele, G., "Advancing Engineering Education in a Flattened World," *Journal of Engineering Education*, Vol. 94, No. 3, 2005, pp. 285–286.
- Haghighi, K., "Quiet No Longer: Birth of a New Discipline," *Journal of Engineering Education*, Vol. 94, No. 4, 2005, pp. 351–353.
- Fortenberry, N.L., "An Extensive Agenda for Engineering Education Research," *Journal of Engineering Education*, Vol. 95, No. 1, 2006,pp. 3–5.
- Streveler, R. A. and K.A. Smith, "Conducting Rigorous Research in Engineering Education, *Journal of Engineering Education*, Vol. 95, No. 2, 2006.
- Wormley, D.N. "A Year of Dialogue Focused on Engineering Education Research," *Journal of Engineering Education*, Vol. 95, No. 3, 2006.

CRITERIA FOR A FIELD

1. **Structural Criteria**
   1. Academic recognition
   2. Research journals
   3. Professional associations
   4. Research conferences
   5. Research centers
   6. Research training
2. **Intra-Research Criteria**
   1. Scientific knowledge
   2. Asking questions
   3. Conceptual and theoretical development
   4. Research methodologies
   5. Progression
   6. Model publications
   7. Seminal publications
3. **Outcome Criteria**
   1. Implications for practice

Fensham, P.J. 2004. *Defining an identity.* The Netherlands: Kluwer

Building Engineering Education Research Capabilities:

- NSF Initiated Engineering Education Scholars Program (EESP)
- NSF – Centers for Learning and Teaching (CLT)
  - Center for the Advancement of Engineering Education (CAEE)
  - Center for the Integration of Research, Teaching, and Learning (CIRTL)
  - National Center for Engineering and Technology Education (NCETE)
- NAE: Center for the Advancement of Scholarship on Engineering Education (CASEE)
  - AREE: Annals of Research on Engineering Education
- NSF CCLI ND: Rigorous Research in Engineering Education (RREE)
- NSF CCLI Phase III project, Collaborative research: Expanding and sustaining research capacity in engineering and technology education: Building on successful programs for faculty and graduate students
- Engineering Education Research Colloquies (EERC)

Departments of Engineering Education

- Purdue University - https://engineering.purdue.edu/ENE/

- Virginia Tech - http://www.enge.vt.edu/main/index.php

- Utah State University - http://www.engineering.usu.edu/ete/

Annals of Research on Engineering Education (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
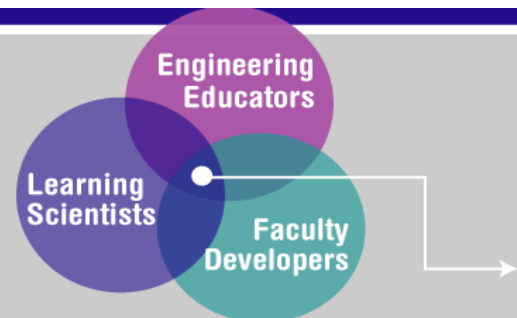
www.areeonline.org

Conducting Rigorous Research in Engineering Education: Creating a Community of Practice (RREE)

NSF-CCLI-ND
American Society for Engineering Education
Karl Smith & Ruth Streveler
University of Minnesota/Purdue University &
Colorado School of Mines/Purdue University

Rigorous Research in Engineering Education

➢ Summer Workshop - Initial Event for year-long project

➢ Presenters and evaluators representing

  – American Society for Engineering Education (ASEE)

  – American Educational Research Association (AERA)

  – Professional and Organizational Development Network in Higher Education (POD)

➢ Faculty funded by two NSF projects:

  – Conducting Rigorous Research in Engineering Education (NSF DUE-0341127)

  – Strengthening HBCU Engineering Education Research Capacity (NSF HRDF-041194)

    • Council of HBCU Engineering Deans

    • Center for the Advancement of Scholarship in Engineering Education (CASEE)

    • National Academy of Engineering (NAE)

It could well be that faculty members of the twenty-first century college or university will find it necessary to set aside their roles as teachers and instead become designers of learning experiences, processes, and environments.

James Duderstadt, 1999 [Nuclear Engineering Professor; Dean, Provost and President of the University of Michigan]