Essential Elements of Effective Teaching

Karl A. Smith
Engineering Education – Purdue University
Civil Engineering - University of Minnesota
ksmith@umn.edu
http://www.ce.umn.edu/~smith

Effective Teaching: Moving Away from a Teacher-Centered Paradigm

Plenary for the Associated Colleges of the St. Lawrence Valley

November 6, 2010
Reflection and Dialogue

• Individually reflect on your mental image of effective teaching. Write for about 1 minute.
  – Jot down words or phrases
  – Construct a figure or diagram

• Discuss with your neighbor for about 3 minutes
  – Describe your mental image and talk about similarities and differences
  – Select one Element, Image, Comment, Story, etc. that you would like to present to the whole group if you are randomly selected

• Whole group discussion
## Teacher Mental Images About Teaching - Axelrod (1973)

<table>
<thead>
<tr>
<th>Mental Image</th>
<th>Motto</th>
<th>Characteristics</th>
<th>Disciplines</th>
</tr>
</thead>
<tbody>
<tr>
<td>Content</td>
<td>I teach what I know</td>
<td>Pour it in, Lecture</td>
<td>Science, Math</td>
</tr>
<tr>
<td>Instructor</td>
<td>I teach what I am</td>
<td>Modeling, Demonstration</td>
<td>Many</td>
</tr>
<tr>
<td>Student – Cognitive Development</td>
<td>I train minds</td>
<td>Active Learning, Discussion</td>
<td>English, Humanities</td>
</tr>
<tr>
<td>Student – Development of Whole Person</td>
<td>I work with students as people</td>
<td>Motivation, Self-esteem</td>
<td>Basic Skills Teachers</td>
</tr>
</tbody>
</table>

Pedago-pathologies

Amnesia

Fantasia

Inertia

Lee Shulman – MSU Med School – PBL Approach (late 60s – early 70s), President Emeritus of the Carnegie Foundation for the Advancement of College Teaching

What do we do about these pathologies?

- **Activity** – Engage learners in meaningful and purposeful activities
- **Reflection** – Provide opportunities
- **Collaboration** – Design interaction
- **Passion** – Connect with things learners care about

Seven Principles for Good Practice in Undergraduate Education

• Good practice in undergraduate education:
  – Encourages student-faculty contact
  – Encourages cooperation among students
  – Encourages active learning
  – Gives prompt feedback
  – Emphasizes time on task
  – Communicates high expectations
  – Respects diverse talents and ways of learning

Chickering & Gamson, June, 1987
Formulate-Share-Listen-Create (Think-Pair-Share)

• Individually read the quote “To teach is to engage students in learning. . .”
• Underline/Highlight words and/or phrases that stand out for you
• Turn to the person next to you and talk about words and/or phrases that stood out
• Report out
To teach is to engage students in learning; thus teaching consists of getting students involved in the active construction of knowledge. . . The aim of teaching is not only to transmit information, but also to transform students from passive recipients of other people's knowledge into active constructors of their own and others' knowledge. . . Teaching is fundamentally about creating the pedagogical, social, and ethical conditions under which students agree to take charge of their own learning, individually and collectively.

Comparison of Old and New Paradigm of Teaching (Johnson, Johnson & Smith, 1991)

<table>
<thead>
<tr>
<th></th>
<th><strong>Old Paradigm</strong></th>
<th><strong>New Paradigm</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge</td>
<td>Transferred from Faculty to Students</td>
<td>Jointly Constructed by Students and Faculty</td>
</tr>
<tr>
<td>Students</td>
<td>Passive Vessel to be Filled by Faculty's Knowledge</td>
<td>Active Constructor, Discoverer, Transformer of Knowledge</td>
</tr>
<tr>
<td>Faculty Purpose</td>
<td>Classify and Sort Students</td>
<td>Develop Students' Competencies and Talents</td>
</tr>
<tr>
<td>Relationships</td>
<td>Impersonal Relationship Among Students and Between Faculty and Students</td>
<td>Personal Transaction Among Students and Between Faculty and Students</td>
</tr>
<tr>
<td>Context</td>
<td>Competitive/Individualistic</td>
<td>Cooperative Learning in Classroom and Cooperative Teams Among Faculty</td>
</tr>
<tr>
<td>Teaching Assumption</td>
<td>Any Expert can Teach</td>
<td>Teaching is Complex and Requires Considerable Training</td>
</tr>
</tbody>
</table>


<table>
<thead>
<tr>
<th></th>
<th><strong>Old Paradigm</strong></th>
<th><strong>New Paradigm</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge</td>
<td>Transferred from Faculty to Students</td>
<td>Jointly Constructed by Students and Faculty</td>
</tr>
<tr>
<td>Students</td>
<td>Passive Vessel to be Filled by Faculty's Knowledge</td>
<td>Active Constructor, Discoverer, Transformer of Knowledge</td>
</tr>
<tr>
<td>Mode of Learning</td>
<td>Memorizing</td>
<td>Relating</td>
</tr>
<tr>
<td>Faculty Purpose</td>
<td>Classify and Sort Students</td>
<td>Develop Students' Competencies and Talents</td>
</tr>
<tr>
<td>Student Goals</td>
<td>Complete Requirements, Achieve Certification within a Discipline</td>
<td>Grow, Focus on Continual Lifelong Learning within a Broader System</td>
</tr>
<tr>
<td>Relationships</td>
<td>Impersonal Relationship Among Students and Between Faculty and Students</td>
<td>Personal Transaction Among Students and Between Faculty and Students</td>
</tr>
<tr>
<td>Context</td>
<td>Competitive/Individualistic</td>
<td>Cooperative Learning in Classroom and Cooperative Teams Among Faculty</td>
</tr>
<tr>
<td>Climate</td>
<td>Conformity/Cultural Uniformity</td>
<td>Diversity and Personal Esteem/ Cultural Diversity and Commonality</td>
</tr>
<tr>
<td>Power</td>
<td>Faculty Holds and Exercises Power, Authority, and Control</td>
<td>Students are Empowered; Power is Shared Among Students and Between Students and Faculty</td>
</tr>
<tr>
<td>Assessment</td>
<td>Norm-Referenced (i.e., Graded &quot;On the Curve&quot;); Typically Multiple Choice Items; Student rating of instruction at end of course</td>
<td>Criterion-Referenced; Typically Performances and Portfolios; Continual Assessment of Instruction</td>
</tr>
<tr>
<td>Ways of Knowing</td>
<td>Logico-Scientific</td>
<td>Narrative</td>
</tr>
<tr>
<td>Technology Use</td>
<td>Drill and Practice; Textbook Substitute; Chalk and Talk Substitute</td>
<td>Problem Solving, Communication, Collaboration, Information Access, Expression</td>
</tr>
<tr>
<td>Teaching Assumption</td>
<td>Any Expert can Teach</td>
<td>Teaching is Complex and Requires Considerable Training</td>
</tr>
</tbody>
</table>
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]
Integrated Course Design (Fink, 2003)

Initial Design Phase

1. Situational Factors

2. Learning Goals

3. Feedback and Assessment

4. Teaching/Learning Activities

5. Integration
College Teaching: What do we know about it?

• Five assertions about what we know about college teaching
  – Good teaching makes a difference
  – Teachers vary markedly
  – Some characteristics/methods are present in all good teaching
  – Teaching can be evaluated and rewarded
  – There is ample room for improvement.

• K. Patricia Cross, 1991 ASEE ERM Distinguished Lecture
• Four factors in good teaching, based on student ratings*:
  – Skill. Communicates in an exciting way.
  – Rapport. Understands and emphasizes with students.
  – Structure. Provides guidance to course and material.
  – Load. Requires moderate work load.
• *Student ratings of teaching are consistent (with other measures), unbiased, and useful. Students agree on good teaching and their views are consistent with faculty.
Student Engagement Research Evidence

• Perhaps the strongest conclusion that can be made is the least surprising. Simply put, the greater the student’s involvement or engagement in academic work or in the academic experience of college, the greater his or her level of knowledge acquisition and general cognitive development ...(Pascarella and Terenzini, 2005).

• Active and collaborative instruction coupled with various means to encourage student engagement invariably lead to better student learning outcomes irrespective of academic discipline (Kuh et al., 2005, 2007).

Pedagogies of Engagement
“Throughout the whole enterprise, the core issue, in my view, is the mode of teaching and learning that is practiced. Learning ‘about’ things does not enable students to acquire the abilities and understanding they will need for the twenty-first century. We need new pedagogies of engagement that will turn out the kinds of resourceful, engaged workers and citizens that America now requires.”

Russ Edgerton (reflecting on higher education projects funded by the Pew Memorial Trust)

Pedagogies of Engagement:
Classroom-Based Practices

Karl A. Smith
Department of Civil Engineering
University of Minnesota

Sheri D. Shepard
Department of Mechanical Engineering
Syracuse University

David W. Johnson
Department of Educational Psychology
University of Minnesota

Roger T. Johnson
Department of Curriculum and Instruction
University of Minnesota

Abstract

Educators, researchers, and policy makers have advocated student involvement for some time as an essential aspect of meaningful learning. In the past twenty years engineering educators have implemented several means of better engaging their undergraduate students, including active and cooperative learning, learning communities, service learning, cooperative education, inquiry and problem-based learning, and team projects. This paper focuses on classroom-based pedagogies of engagement, particularly cooperative and problem-based learning. It includes a brief history, theoretical roots, research support, summary of practice, and suggestions for redesigning engineering classes and programs to include more student engagement. The paper also lays out the research needed for advancing pedagogies aimed at more fully enhancing students’ involvement in their learning.

Keywords: cooperative learning, problem-based learning, student engagement

I. Introduction to the Pedagogies of Engagement

Russ Edgerton introduced the term “pedagogies of engagement” in his 2001 paper [1], in which he reflected on the projects on higher education funded by the Pew Charitable Trusts [2].

“Pedagogies of engagement” are needed to engage the whole enterprise of higher education in meaningful ways. In my view, the mode of teaching and learning that is practiced ‘about’ things does not enable students to acquire the abilities and understanding they will need for the twenty-first century. We need new pedagogies of engagement that turn out the kinds of resourceful, engaged workers and citizens that America now requires.”

Russ Edgerton (reflecting on higher education projects funded by the Pew Memorial Trust)
Cooperative Learning

- Research – Randomized Design Field Experiments
- Practice – Formal Teams/Professor’s Role
Cooperative Learning
- Positive Interdependence
- Individual and Group Accountability
- Face-to-Face Promotive Interaction
- Teamwork Skills
- Group Processing

Figure A.1 A General Theoretical Framework

Cooperative Learning
Cooperative Learning is instruction that involves people working in teams to accomplish a common goal, under conditions that involve both positive interdependence (all members must cooperate to complete the task) and individual and group accountability (each member is accountable for the complete final outcome).

Key Concepts

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

- 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
Active and Cooperative Learning

Farewell, Lecture?
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—lectured. I thought that was how one learns. Look 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 evaluation—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

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

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."

From the ones I handed out? I decided to ignore the students' complaints.

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—sometimes 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 last 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
Book Ends on a Class Session

Thinking Together: Collaborative Learning in the Sciences – Harvard University – Derek Bok Center – www.fas.harvard.edu/~bok_cen/
At M.I.T., Large Lectures Are Going the Way of the Blackboard

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

By SARA RIMER
Published: January 12, 2009

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,

http://web.mit.edu/edtech/casestudies/teal.html#video
The primary goal of the Student-Centered Activities for Large Enrollment Undergraduate Programs (SCALE-UP) Project is to establish a highly collaborative, hands-on, computer-rich, interactive learning environment for large-enrollment courses.

Educational research indicates that students should collaborate on interesting tasks and be deeply involved with the material they are studying. We promote active learning in a redesigned classroom of 80 students or more. (Of course, smaller classes can also benefit.) We believe the SCALE-UP Project has the potential to radically change the way large classes are taught at colleges and universities. The social interactions between students and with their teachers appears to be the "active ingredient" that make the approach work. As more and more instruction is handled virtually, the relationship-building capability of both the teacher and the institution become even more important. The pedagogical methods and classroom management techniques we design and disseminate are general enough to be used in a wide variety of classes at many different types of colleges.

Class sizes are temporarily "scalable" and "stretchable." Essentially these are hard-on activities, simulations, or interesting questions and problems. These are also very hands-on, historically, other students have to move around quite a bit (the scenario is more unplanned than most, but shows what the best students are capable of doing.) Students sit in three groups of three students at 6 to 7 foot diameter round tables. Instructors develop and work with teams and individuals, engaging them in Socratic-like dialogues. Each table has at least three networked laptops. The setting is very much like a banquet hall, with lateral interactions nearly all the time. Many other colleges and universities are adopting/adapting the SCALE-UP room design and pedagogy. Engineering schools are especially pleased with the course objectives, which fit in well with the requirements for ABET accreditation.

Materials developed for the course were incorporated into what became the leading introductory physics textbook, used by more than 70% of all science, math, and engineering students in the country.

Impact

Rigorous evaluations of learning have been conducted in parallel with the curriculum development effort. Besides hundreds of hours of classroom video and audio recordings, we have also conducted numerous interviews and focus groups conducted many conceptual learning assessments (using nationally recognized instruments in the present/pastest protocol), and collected portfolios of student work. We have data comparing nearly 16,000 traditional and SCALE-UP students. Our findings can be summarized as follows:

- Ability to solve problems is improved
- Conceptual understanding is increased
- Attitudes are improved
- Failure rates are drastically reduced, especially for women and minorities
- "At risk" students do better in later engineering states classes

Details

A chapter describing the approach and its underpinnings is available. A shorter description is posted on the NCSU website, or you can view an article describing the project from the proceedings of the Sigma Xi Forum on Reforming Undergraduate Education. The Raleigh News & Observer newspaper also has a description of the project. The very successful pilot project was described in the first issue of the Physics Education Research Supplement to Am. J. of Physics. See our publication page for more information.

More than 50 colleges and universities across the US have adapted the SCALE-UP approach to their own institutions. In all cases, the basic idea remains the same: get the students working together to examine something interesting. That leaves the instructor to roam about the room, asking questions and stirring up debate. Classes in physics, chemistry, math, engineering, and even literature have been taught this way. If you want more information, please contact Orna Katchir.
## The American College Teacher: National Norms for 2007-2008

<table>
<thead>
<tr>
<th>Methods Used in “All” or “Most”</th>
<th>All – 2005</th>
<th>All – 2008</th>
<th>Assistant - 2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cooperative Learning</td>
<td>48</td>
<td>59</td>
<td>66</td>
</tr>
<tr>
<td>Group Projects</td>
<td>33</td>
<td>36</td>
<td>61</td>
</tr>
<tr>
<td>Grading on a curve</td>
<td>19</td>
<td>17</td>
<td>14</td>
</tr>
<tr>
<td>Term/research papers</td>
<td>35</td>
<td>44</td>
<td>47</td>
</tr>
</tbody>
</table>

http://www.heri.ucla.edu/index.php
Good teaching comes from the identity and integrity of the teacher.

Good teachers possess a capacity for connectedness.

The biggest and most long-lasting reforms of undergraduate education will come when individual faculty or small groups of instructors adopt the view of themselves as reformers within their immediate sphere of influence, the classes they teach every day.

K. Patricia Cross
Resources

• Design Framework – How People Learn (HPL) & Backward Design Process
  – Creating High Quality Learning Environments (Bransford, Vye & Bateman) -- [http://www.nap.edu/openbook/0309082927/html/]

• Content Resources

• Cooperative Learning - Instructional Format explanation and exercise to model format and to engage workshop participants
  – Cooperative Learning (Johnson, Johnson & Smith)
    • Smith web site – [www.ce.umn.edu/~smith]

• Other Resources
  – University of Delaware PBL web site – [www.udel.edu/pbl]