

Mechanical Engineering Education: *What Should We Teach and How Should We Teach It?*

Al Ferri

March 18, 2011



George W. Woodruff School of Mechanical Engineering



Jack M. Zeigler Woodruff Outstanding Educator Award

Jack Zeigler received his bachelor's degree in mechanical engineering in 1948 after interrupting his education with three and one-half years of service in the U.S. Army. He is the retired president and owner of Fabrication Engineering Service Company, Inc., a made-to-order fabrication business for process engineering equipment. He was a registered professional engineer in five states, and a lifetime member of the American Society of Mechanical Engineers and the American Welding Society. In 1994 Mr. Zeigler was the recipient of the Distinguished Alumnus Award from the Woodruff School, and in 1999 he was inducted into the College of Engineering Alumni Hall of Fame. The Jack M. Zeigler Woodruff Outstanding Educator Award was created in 1999 to recognize an outstanding educator among the academic faculty of the Woodruff School of ME at Georgia Tech. This is a lifetime achievement award that a person can receive one time.



Previous Winners

1999 William Z. Black
2000 Said I. Abdel-Khalik
2001 Farrokh Mistree
2002 Robert Fulton
2003 James G. Hartley

2004 David L. McDowell
2006 Robert M. Nerem
2007 Jonathan S. Colton
2009 David N. Ku

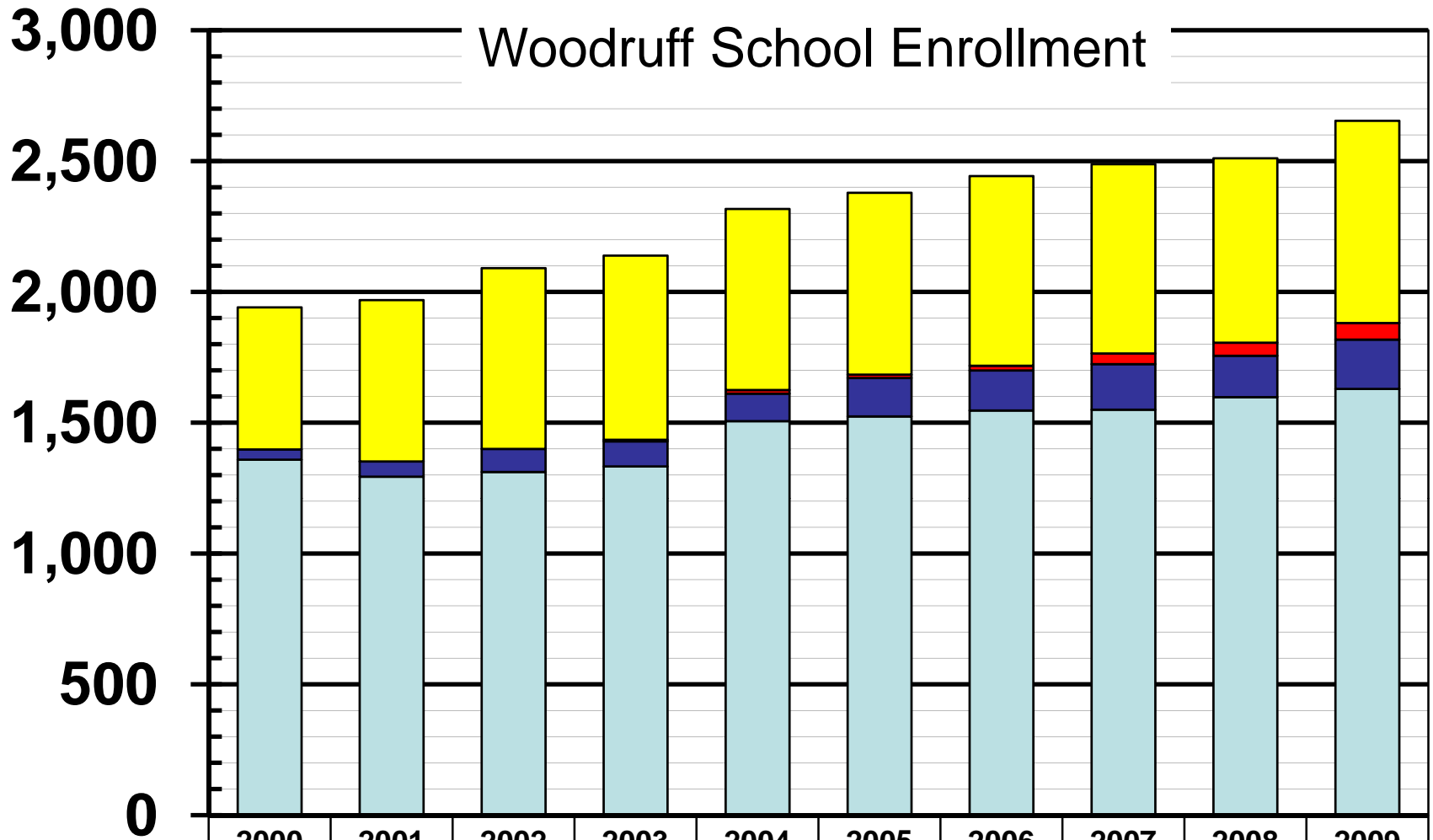
“Mechanical Engineering is the liberal arts degree for the 21st century”

Ward Winer

- ME is arguably the broadest of all engineering disciplines
- Virtually every product made today has been worked on by a Mechanical Engineer
- According to a recent survey, starting salaries for ME's with just a BS degree was about \$58.7K/yr, ranking 7th out of all university majors
- A Mechanical Engineering undergraduate degree is an excellent launching pad for graduate and professional degree programs in engineering, business, law, and medicine.
- Our graduates go on to work in a myriad of companies and industries

What Industries Hire ME's?

- Automotive & OEM Suppliers
- Construction Equipment
- Construction Companies
- Ship & Railroad Companies
- Airplane Manufacturing
- Power Generation / Nuclear
- Alternative Fuel / Energy
- Utility Companies
- Oil and Gas Companies
- Chemical Companies
- Pharmaceutical & Health Care
- Biomedical
- Sports Equipment Mfg.
- Computer-Aided Design
- Automation & Robotics
- Electronics Industries
- Appliance Manufacturers
- HVAC & Refrigeration
- Toy Manufacturing
- Furniture Manufacturing
- Paper Industry
- Food & Beverage Industry
- Telecommunications
- Amusement Parks
- National Labs
- Aeronautical (NASA, etc.)
- Government Agencies
- Academia (Teaching)
- Financial Companies
- Consulting Companies



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
■ Graduate Students	543	617	691	704	692	695	725	723	705	773
■ ME Undergrads (GTS)	0	0	0	6	14	13	18	41	50	63
■ NRE Undergrads	39	58	88	96	105	147	153	174	158	189
■ ME Undergrads	1,359	1,294	1,312	1,333	1,506	1,524	1,547	1,550	1,598	1,629
Total	1,941	1,969	2,091	2,139	2,317	2,379	2,443	2,488	2,511	2,655

- Sounds like everything is going fine. Why should we change what we're teaching?
- Why should we change how we teach mechanical engineering?

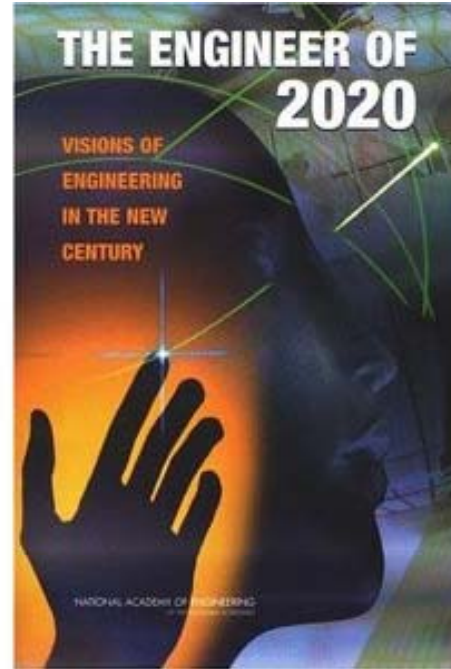
Themes of this talk.....

- With the finalization of the GWW and Institute Strategic Plans, there are tremendous opportunities to change at this time.
- The breadth of the mechanical engineering discipline is its greatest advantage, but also its greatest challenge.
- How can we cover the entire field of mechanical engineering in just ~60 credit hours, and still leave about 15 hours of electives?
- If we move to a curriculum having fewer courses, we will probably have to redesign some of our courses to be more effective.
- There's a ton of material out there on new ways of structuring and delivering courses, much of it grounded in research and/or the science of learning.

Reasons for Change



**Vision 2030 --
Creating the Future of
Mechanical Engineering
Education**

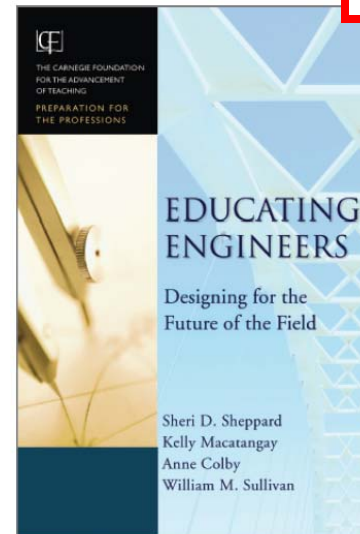


Report of
**The "5XME" Workshop:
Transforming Mechanical
Engineering Education and
Research in the USA**

May 10-11, 2007

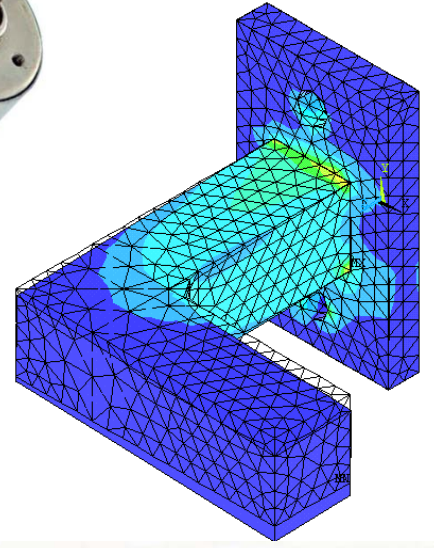
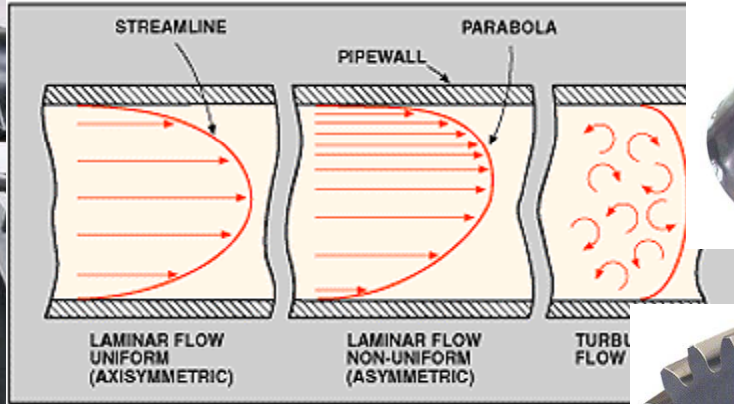
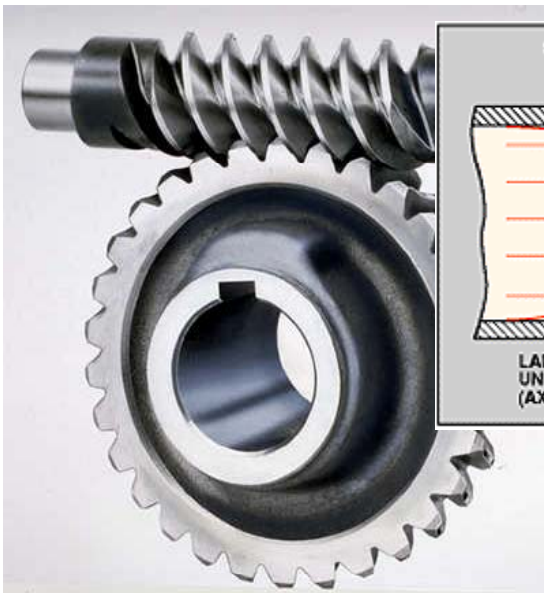
National Science Foundation, Arlington,
VA

Edited by A.G. Ulsoy

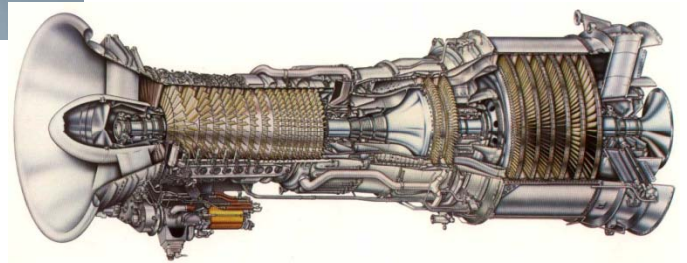
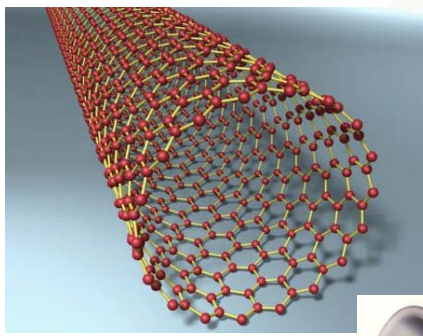
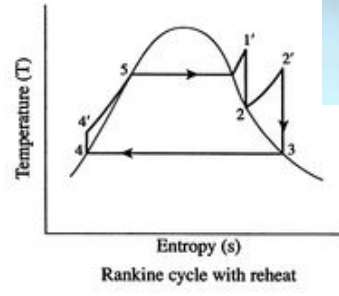
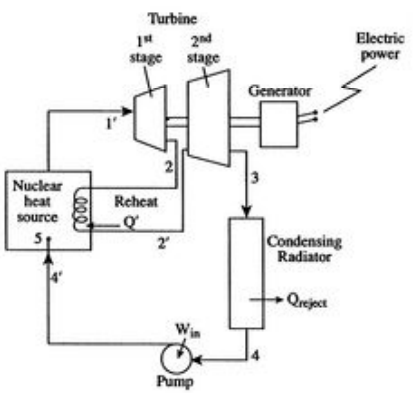


"We are currently preparing students for jobs that don't yet exist, using technologies that haven't been invented, in order to solve problems we don't even know are problems yet."

Karl Fisch, "Did You Know"



What Should We Teach?



General Electric LM2500 Gas Turbine

ASME Vision 2030, Survey of 31 dept. heads:

What 5 ME subjects are central to an ME education?

Materials
Mechanics (solid and fluid)
Design
Manufacturing
Dynamics and controls

What are five subjects outside of ME that should be in the curriculum?

Electrical circuits
Communication
Business
Economics
Life Sciences

What are five key professional skills that should be in the curriculum?

Teamwork
Communication
Product design and fabrication
Systems integration
Modern software

5xME Workshop:

What 5 ME subjects are central to an ME education?

Materials
Mechanics
Thermo Fluids
Design and manufacturing
Systems

What are five subjects outside of ME that should be in the curriculum?

Art
Electronics
Social Science
Biology
Ethics
Business

What are five key professional skills that should be in the curriculum?

Information technology
Problem formulating and solving
Communication skills
Experimental skills
Teamwork and leadership

As said previously, the 5xME participants were also asked what 5 subjects would they leave out: "Anything beyond 1st core ME classes"

Alternate Approach: Form a ME Body-of-Knowledge (BOK)

2006 study by Jarosz and Busch-Vishniac surveyed the course syllabi of all required classes for the BS degree at 9 universities: Cal State University at LA, Howard University, Johns Hopkins University, MIT, Michigan State University, Smith College¹, and Stevens Institute of Technology.

- The 9 sets yielded a total of 2,151 topics
- Reduced it down to 1,392
- Looked for topics common to all curricula

How many topics were common to at least 5 schools?

- (a) Zero
- (b) Less than 100
- (c) Between 100 and 500
- (d) Between 500 and 1000
- (e) 1392



¹ Smith has a engineering science program with specialization in mechanics

Mechanical Engineering Body of Knowledge (BOK)

Required by 9:

conduction, convection, design methodologies, economics, first law of thermodynamics, gases, harmonic motion, 2nd-law of thermodynamics, vector operations

Required by 8:

CAD/CAM, circuits, conservation laws, integration methods, linear differential equations

Required by 7:

electromagnetism/electricity, ethics, friction, kinematics and dynamics of rigid bodies, Laplace transforms, optimization, radiant heat transfer, refrigeration, stress and strain of deformable bodies, Taylor series

Required by 6:

atomic physics, beam theory, bonding, capstone design project, ceramics, communication, data analysis, derivatives, entropy, the environment and industrial ecology, Fourier series and integrals, frequency response. Impulse and momentum, kinematics and dynamics of particles, limits, metals, Newton's laws, optics, polymers, sketching, torsion

Required by 5:

combustion, control volume analysis, creep, dimensional analysis, equilibrium, fluid properties, gears, geometry (solid analytic), ideal and real gases/vapors, internal combustion engines, multiple integration, operational amplifiers, periodic table and the elements, polar coordinates, project management, stability analysis, statistics, stoichiometry, transfer functions, waves, writing

Forms the consensus list of topics: 64 topics, just 4.5% of the total 1,392 !

Mechanical Engineering (BOK) continued

Required by 4:

bearings, boundary layer flow, columns, conservation of energy, continuity, costs, debugging, equilibrium of rigid body systems and subsystems, feedback control, flexure, fluid mechanics, free-body diagrams, fundamental theorem of calculus, gas laws, gas turbines, heat exchangers, infinite series, Kirchoff's laws, lab practices/safety, laminar flow, line integrals, linkages, matrix operations, mechanics, modal analysis, Mohr's circle, probability, pure substance, rotational motion, semiconductors, series, shafts, similtude, mechanical springs, thermochemistry, tolerances, trusses, turbulent flow

Required by 3:

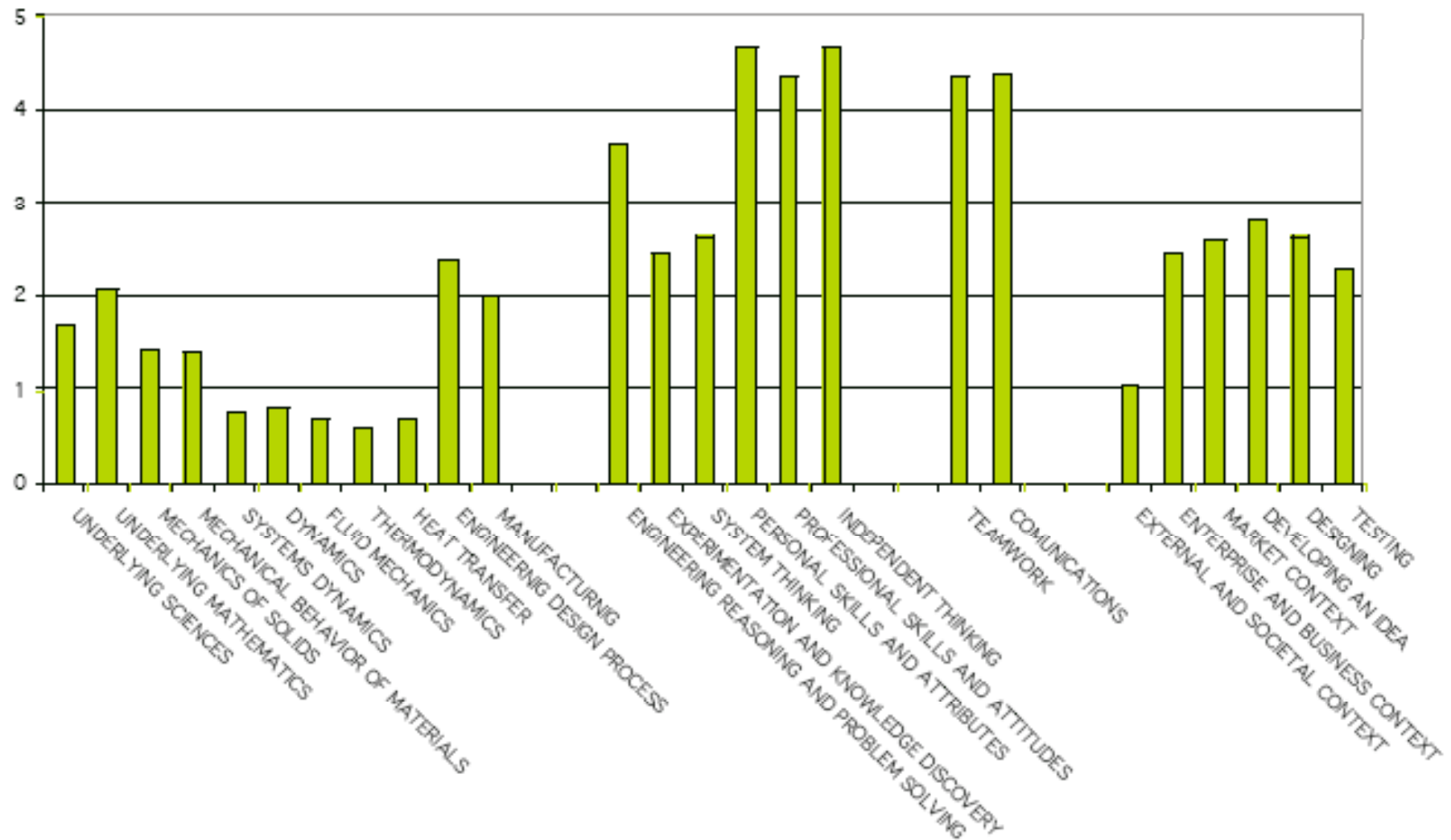
aesthetics, angular momentum, arrays and lists, atomic properties of materials, bending, Bernoulli equations, Bode plots, boiling, brakes, buckling, cams, casting, chemical reactions, combined loading, complex numbers, compounds, condensation, control systems, Coulomb friction, crystalline materials, decision making, design for manufacture, design of mechanical systems and mechanical elements, dimensioning, eigenvalues, eigenvectors, electrical and electronic components, electrochemical cells, energy, error analysis, fastener design, fatigue, finite element analysis, fins, fluid flow equations, force analysis, functions of several variables, Green's theorem, harmonically excited systems, hydrostatics, improper integrals, internal forces, irreversibility, joining, lift and drag, linear momentum, Navier-Stokes equations, numerical analysis, oxidation, phase equilibrium, profession of engineering, quantum mechanics, Rankine cycles, root locus, second-order systems, sensitivity analysis, solid modeling, sound, Stokes; theorem, strengthening mechanics and processes, stress concentrations, stresses from shearing forces, surface integrals, teamwork, tension, time domain analysis, viscous flow, visualization, welded joints, work and energy.

The MIT Study by Warren Seering

Survey of MIT ME alumni ('92 - '96) eight years after graduation

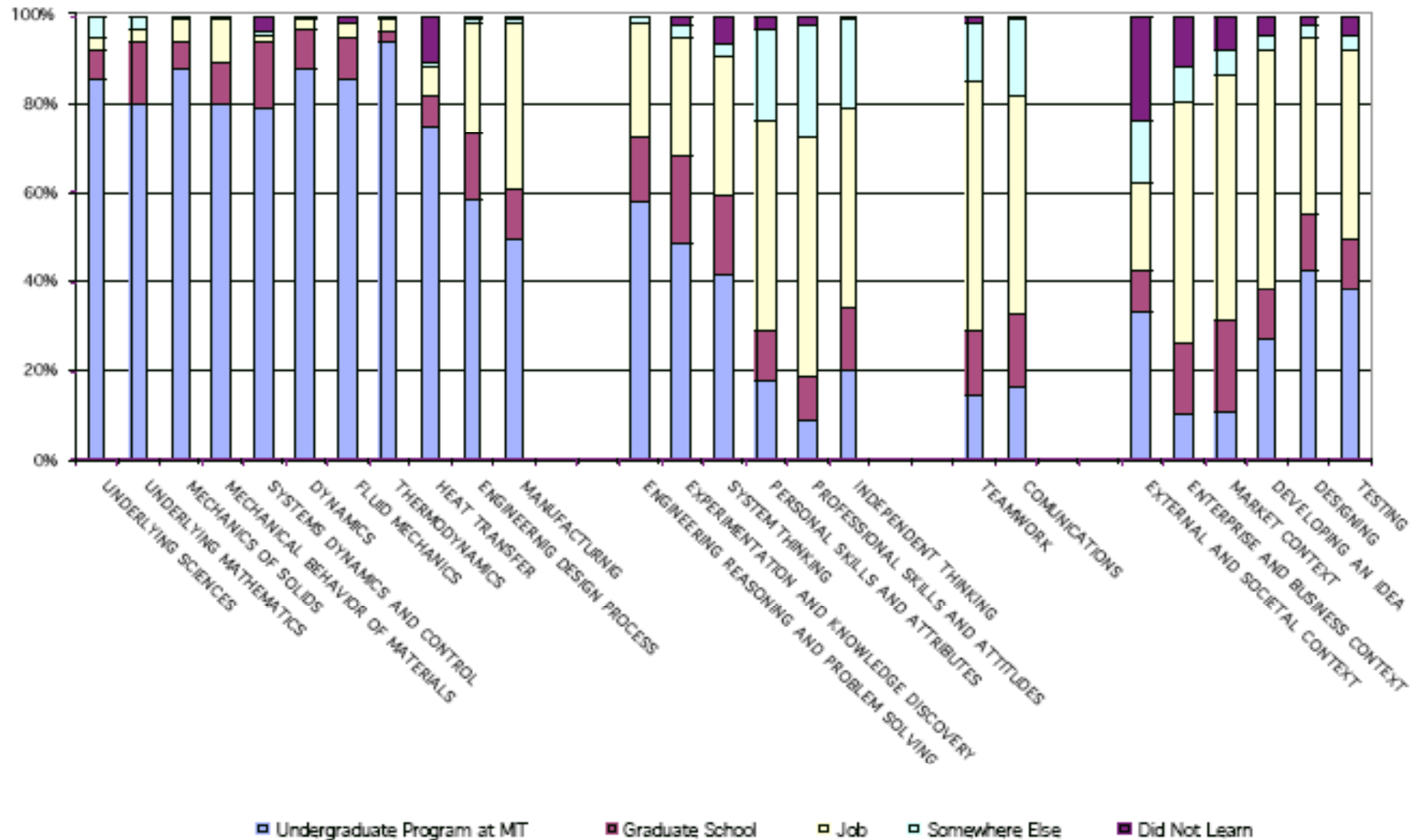
- *“How much of the knowledge covered in your classes did you learn?”*
Mean 70%
- *“How much of the knowledge that you learned do you remember now?”*
Mean 50%
- Their conclusion was that the MIT students graduated knowing and remembering about 35% of the material that was presented to them, and they had no control over what 35%.

Mean frequency of use



Frequency of Use: 0 Never, 1 Hardly ever - a few times a year, 2 Occasionally - at least once a month, 3 Regularly - at least weekly, 4 Frequently - on most days, 5 Pervasively - for most everything I do

Source



Industry survey (2009) – Q. *What are the strengths and weaknesses of recent BS mechanical engineering hires ?*

Category	%Strength	%Weakness	Net
Information processing – electronic communication	27	1	+26
Technical fundamentals – traditional ME disciplines	22	13	+9
Interpersonal/teamwork	19	10	+9
Computer modeling and analysis – software tools	17	2	+15
Communication – oral, written	3	14	-11
Practical experience - how devices are made and work	2	24	-22
Problem solving & critical thinking - analysis	2	9	-7
Design – product creation	1	5	-4
Business processes - entrepreneurship	1	6	-5
Project management -	1	3	-2
Overall systems perspective	1	1	
Technical fundamentals – new ME applications (bio, nano, info, multi..)	0	0	
Leadership	0	0	
Experiments - laboratory procedures	0	0	

For industry, the top three negatives were “practical experience, communication, and problem solving.”

‘Q. What’s missing..... ?’

Results

Category	% Educator	% Industry	Diff
Technical fundamentals – new ME applications (bio, nano, info, multi..)	27	0	+27
Interpersonal/teamwork	10	13	-3
Overall systems perspective	10	4	+6
Business processes - entrepreneurship	10	8	+2
Practical experience - how devices are made and work	8	22	-14
Design –product creation	6	2	+4
Communication – oral, written	6	16	-10
Problem solving & critical thinking - analysis	4	3	+1
Leadership	4	3	+1
Experiments - laboratory procedures	2	1	+1
Computer modeling and analysis – software tools	2	5	-3
Project management -	2	8	-6
Technical fundamentals – traditional ME disciplines	1	13	-12
Information processing – electronic communication	0	0	

Educator emphasis was on “new ME applications (bio, nano, info...)”, and the Industry emphasis was on “practical experience.”

Remarks

- Relates to the discussions ongoing in the GWW UG Committee
- Depth in several mechanical engineering topics is desirable since it gives students some idea of how “deep the well goes.” It gives them confidence to tackle other subjects later on.
- But depth in too many topics just discourages students and promotes cynicism about what an undergraduate engineering degree means.
- As we look at the sheer number of “topics” that are currently in our required ME classes, should we relegate some of them to elective classes and focus on real understanding in fundamental principles?





How Should We Teach?



problem
based
learning



"sage on the stage"



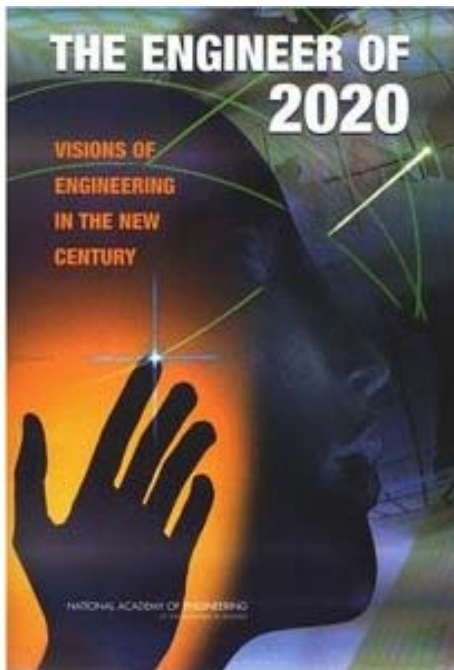
"guide on the side"

*“As we think of the challenges ahead, it is important to remember that students are driven by passion, curiosity, engagement, and dreams. **Although we cannot know exactly what they should be taught, we can focus on the environment in which they learn and the forces, ideas, inspirations, and empowering situations to which they are exposed.** In the long run, making universities and engineering schools exciting, creative, adventurous, rigorous, demanding, and empowering milieus is more important than specifying curricular details.”*



Charles Vest, 2008

*“Past attempts toward reforming engineering education—whether in individual courses or programs or on individual campuses—have been informed primarily by the opinions and experiences of those leading these efforts. **What “works” has been intuitively felt, rather than based on a body of carefully gathered data that provide evidence of which approaches work for which students in which learning environments.** Without such data, engineers, and their colleagues in the scientific community, have found it difficult to evaluate claims, for example, about the effectiveness of emerging pedagogies or the impact of information technologies on strengthening student learning. Unlike the technical community, wherein data-driven results from one lab have widespread impact on the work of peers, many educational reformers have not incorporated research on learning into their work.”*



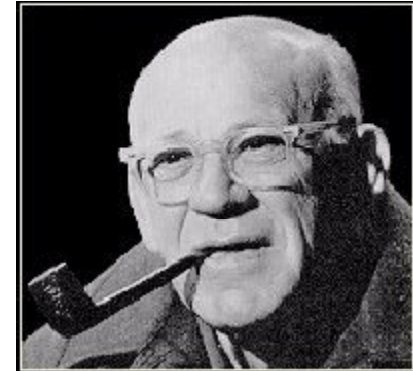
Educating the Engineer of 2020, NAE, 2005



Much discussion on **HOW** we should teach. Generally speaking, the shift in emphasis has been from *teaching* to *learning*.

In times of profound change, the learners inherit the earth, while the learned find themselves beautifully equipped to deal with a world that no longer exists.

Eric Hoffer, *Reflections on the Human Condition* (1973)



"To Teach is to Learn Twice"

Creating a Culture for Scholarly and Systematic Innovation In Engineering Education (CCSSIEE)

L. Jamieson and J. Lohmann, 2009

How do we create an environment in which many exciting, engaging, and empowering engineering educational innovations can flourish and make a significant difference in educating future engineers?

The purpose of this report, therefore, is to catalyze a conversation within the U.S. engineering community on creating and sustaining a vibrant engineering academic culture for scholarly and systematic educational innovation—just as we have for technological innovation—to ensure that the U.S. engineering profession has the right people with the right talent for a global society.



Rigorous Research Methods

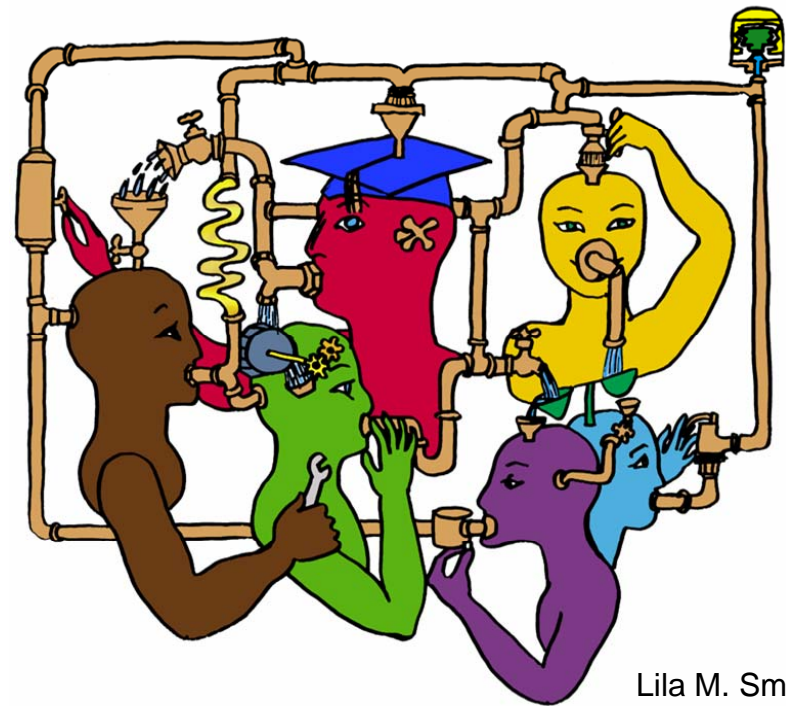
- Methods
 - Hypothesis and Theory (*Behavioral Science*)
 - Control Group vs Experimental Group (students or concepts)
 - IRB Approval
- Measuring Results
 - Quantitative
 - Tests (exams, concept inventories)
 - Surveys (defined responses)
 - Qualitative
 - Observations
 - Interviews and focus groups
- Significance of Findings
 - Small sample size
 - Confounding factors
 - Time spent on task, maturity, prior knowledge and experience, motivation, self-selection, individual abilities

Active Learning

Includes a wide range of paradigms: Elaborative questioning, collaborative learning, cooperative learning, problem-based-learning, experiential/hands-on learning, think-pair-share, etc.



Lila M. Smith



Lila M. Smith

Active Learning

	The Instruction Paradigm	The Learning Paradigm
Objective	Transfer knowledge from the faculty to the student	Promote learning by creating a learning environment- encourage student discovery and construction of knowledge
Learning Theory	Knowledge comes in chunks and bits delivered by the instructor	Knowledge is constructed, created, and "gotten"
	Learning is cumulative and linear	Learning is a nesting and interacting of frameworks
	Learning is teacher-centered	Learning is student-centered
	Talent and ability are rare	Talent and ability are abundant
Nature of Roles	Faculty are primarily lecturers	Faculty are primarily designers of learning methods and environments
	Faculty and students act independently and in isolation	Faculty and students work in teams with each other
	Any expert can teach	Creating learning environments is challenging and complex

Adapted from Joyce Weinsheimer, CETL

Sounds a little “hokey.” Does it work?

Prince, M.J., 2004, “Does active learning work? A review of the research,” *Journal of Engr. Education*.

Clough, M.P. and Kauffman, K.J., 1999, “Improving engineering education: A research based framework for teaching,” *Journal of Engr. Education*.

Wieman, C., 2007, “Why not try a scientific approach to science education,” *Change*.

Ambrose, S.A., et al., 2010, *How Learning Works: 7 Research-Based Principles for Smart Teaching*, John Wiley.

...many, many, others. See, for example, J. of Engineering Education, International J. of Engr. Education, British Journal of Educational Technology, ASEE/IEEE Frontiers in Education Conferences, ASEE Conferences, etc.

In addition to improved learning and improved performance on tests, Active Learning has the potential to help students become *Self-Directed* and *Life-Long Learners*.

Hake Study

Seminal paper by Richard Hake (Am. J. Phys, 1998) performed a 6000-student survey of freshman physics students.

Used pre-test and post-test data from students in 62 different classes.

- 14 Traditional (T) courses using “passive-student lectures, recipe labs, and algorithmic-problem exams
- 48 Interactive Engagement (IE) courses that used a variety of active methods including hands-on activities.

Rated each course using the “Effect Size”

$$\langle g \rangle = \frac{S_f - S_i}{100 - S_i}$$

S_i = initial (pre) test average (%)

S_f = final (post) test average (%)

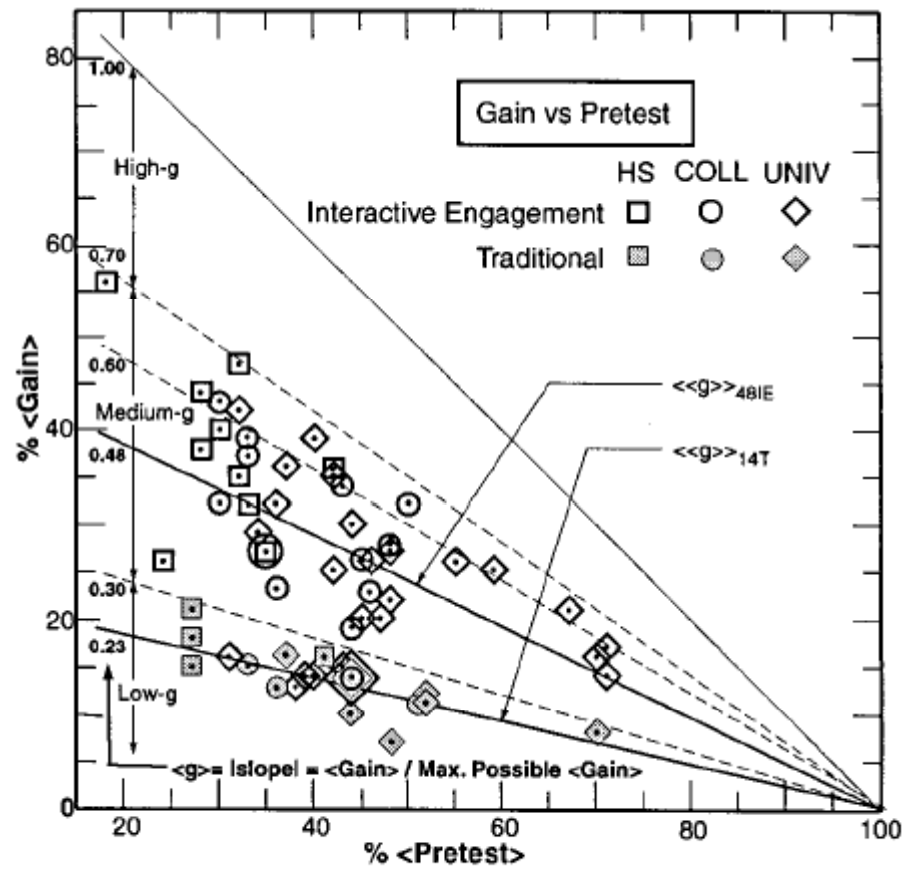


Fig. 1. %<Gain> vs %<Pre-test> score on the conceptual Mechanics Diagnostic (MD) or Force Concept Inventory (FCI) tests for 62 courses enrolling a total $N=6542$ students: 14 traditional (T) courses ($N=2084$) which made little or no use of interactive engagement (IE) methods, and 48 IE courses ($N=4458$) which made considerable use of IE methods. Slope lines for the average of the 14 T courses $\langle\langle g \rangle\rangle_{14T}$ and 48 IE courses $\langle\langle g \rangle\rangle_{48IE}$ are shown, as explained in the text.

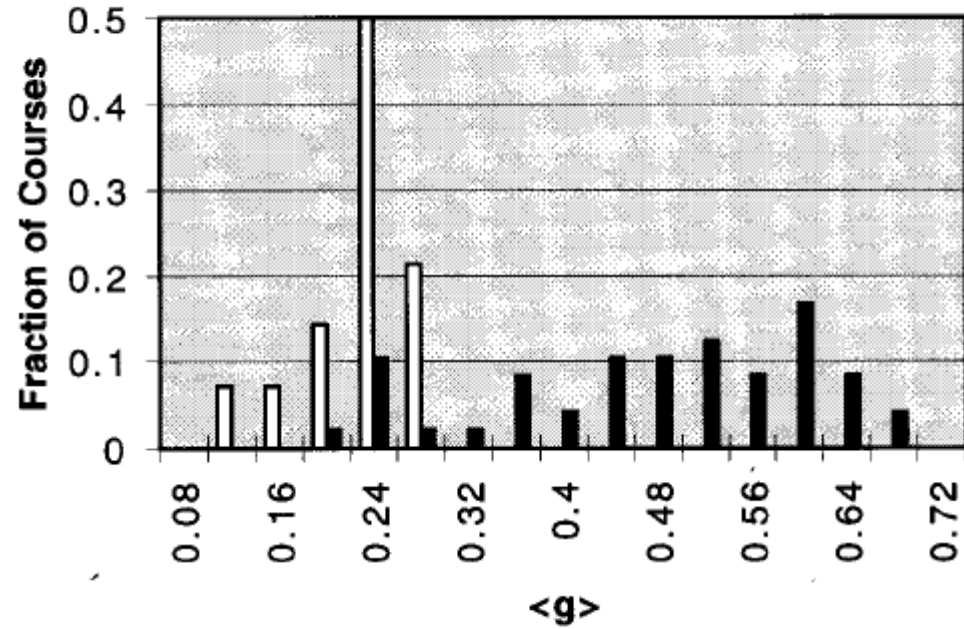


Fig. 2. Histogram of the average normalized gain $\langle g \rangle$: white bars show the *fraction* of 14 traditional courses ($N=2084$), and black bars show the *fraction* of 48 interactive engagement courses ($N=4458$), both within bins of width $\delta\langle g \rangle=0.04$ centered on the $\langle g \rangle$ values shown.

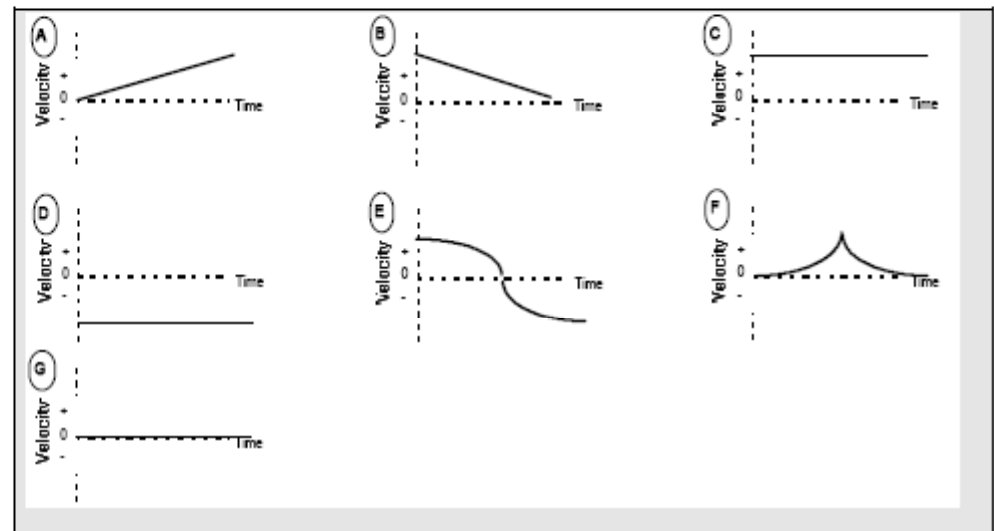
What do the tests look like?

Several educator/researchers have developed so called “concept inventories,” which are then administered in a “pre-test” and “post-test” format.

Thornton-Sokoloff Velocity graph question (VQ)

An object's motion is restricted to one dimension along the + distance axis. Answer each of the questions below by selecting the velocity graph that is the best choice to describe the answer. You may use a graph more than once or not at all.

- Which velocity graph shows an object going away from the origin at a steady velocity?
- Which velocity graph shows an object that is standing still?
- Which velocity graph shows an object moving toward the origin at a steady velocity?
- Which velocity graph shows an object changing direction?
- Which velocity graph shows an object that is steadily increasing its speed?



Common Questions

Are the gains attained because of extra time-on-effort and or due to the efficacy of active vs traditional learning?

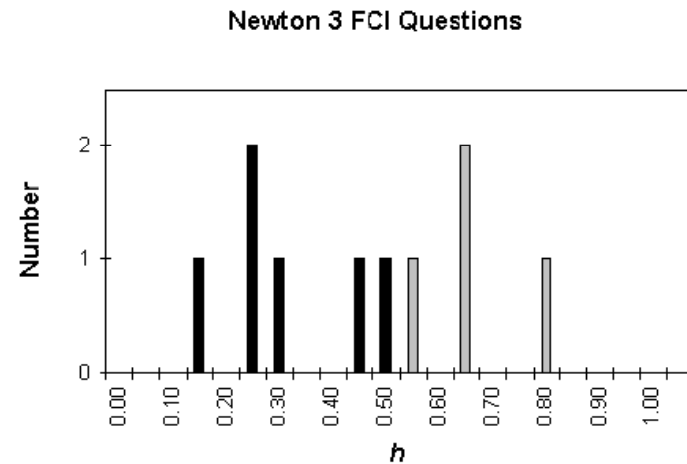
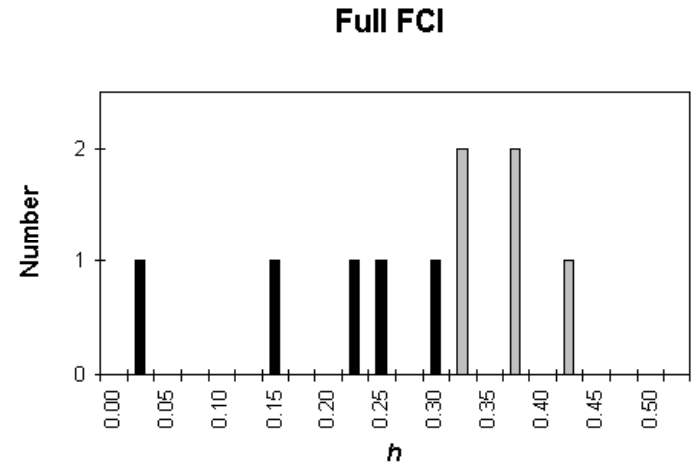
- Similar results were also obtained by Redish (1998) who carefully controlled the total number of contact hours per week.

Does the gain only happen when measured using “standardized tests” or do they also occur for free-response solution?

What about Hawthorne Effects?

Ceiling Effects?

What about John-Henry Effects?



Traditional (solid bars), active-engagement (grey bars). From Redish, et al., Am. J. Phys., 1998)

Classes that Click!

Chen, et al. (2010) studied the use of “rapid feedback” to students taking statics

Used both low-tech “colored index cards” and high-tech PDAs. PDA’s allowed the instructor to collect responses to their computer and to display tabulated responses to the rest of the students.

Experiment Design

Same instructor in two different sections. Repeated in two semesters. Used “crossover design” where the techniques were switched midterm between sections to eliminate the influence of other “confounding” factors such as meeting times, non-random assignment of students to sections, etc. Each student acts as a control to eliminate non-correctible confounders.

Hypothesis: Learning is improved by providing rapid feedback to students on their understanding of key concepts and skills. The feedback also provides students with insights into their strategies for learning.

Findings: *The use of rapid feedback was statistically significant with a positive effect. Rapid feedback was associated with a gain of 5 to 16% in the score on tests and quizzes. Much higher correlation than prior performance on related foundation courses such as Calculus I, II, and Physics I.*

The study is consistent with a vast array of literature on the use of clickers in higher education. Much of the research is anecdotal, but some of it is very carefully done.

Caldwell (2007) found that across a variety of disciplines, “clicker use improved student outcomes, including higher exam scores, improved passing rates, and student comprehension, and that students viewed clickers highly favorably, though their ratings were less consistent when asked if the clickers helped them to learn.”

Why does it work? Is it just an empirical result?

The findings are consistent with recent studies on the science of memory and learning. Information residing in short-term memory will be lost unless it can be moved to long-term memory using, for example, testing, rehearsal, imaging, mnemonic phrases, etc.

Recent study by Karpicke and Roediger (2008) Examined college students trying to learn Swahili-English word pairs. Considered 3 study/test regimens:

Group 1: Once word pairs were learned, they were dropped from further study, but retained on all future tests

Group 2: All word pairs were repeatedly studied, but only pairs that were not yet learned were included on future tests

Group 3: Dropped all learned pairs from further study and future tests

All three methods resulted in students learning the words at essentially the same rate. However, after 1 week, those in Group 1 retained 80% of the vocabulary, compared with ~35% by those in Groups 2 and 3.

What Does an Active Classroom Look like?



Video from: <http://web.mit.edu/edtech/casestudies/teal.html>

Opportunities Enabled by New Technologies

Clough Commons will have many classrooms equipped with computer screens, etc.

Scale-Up Project



TEAL (Technology Enhanced Active Learning) project at MIT

Most of the ME classrooms are equipped with computers, projectors, etc. Does this promote better learning?

Active Learning in Computer-Based Classrooms

Holbert and Karady, IEEE Trans. On Education, 2009

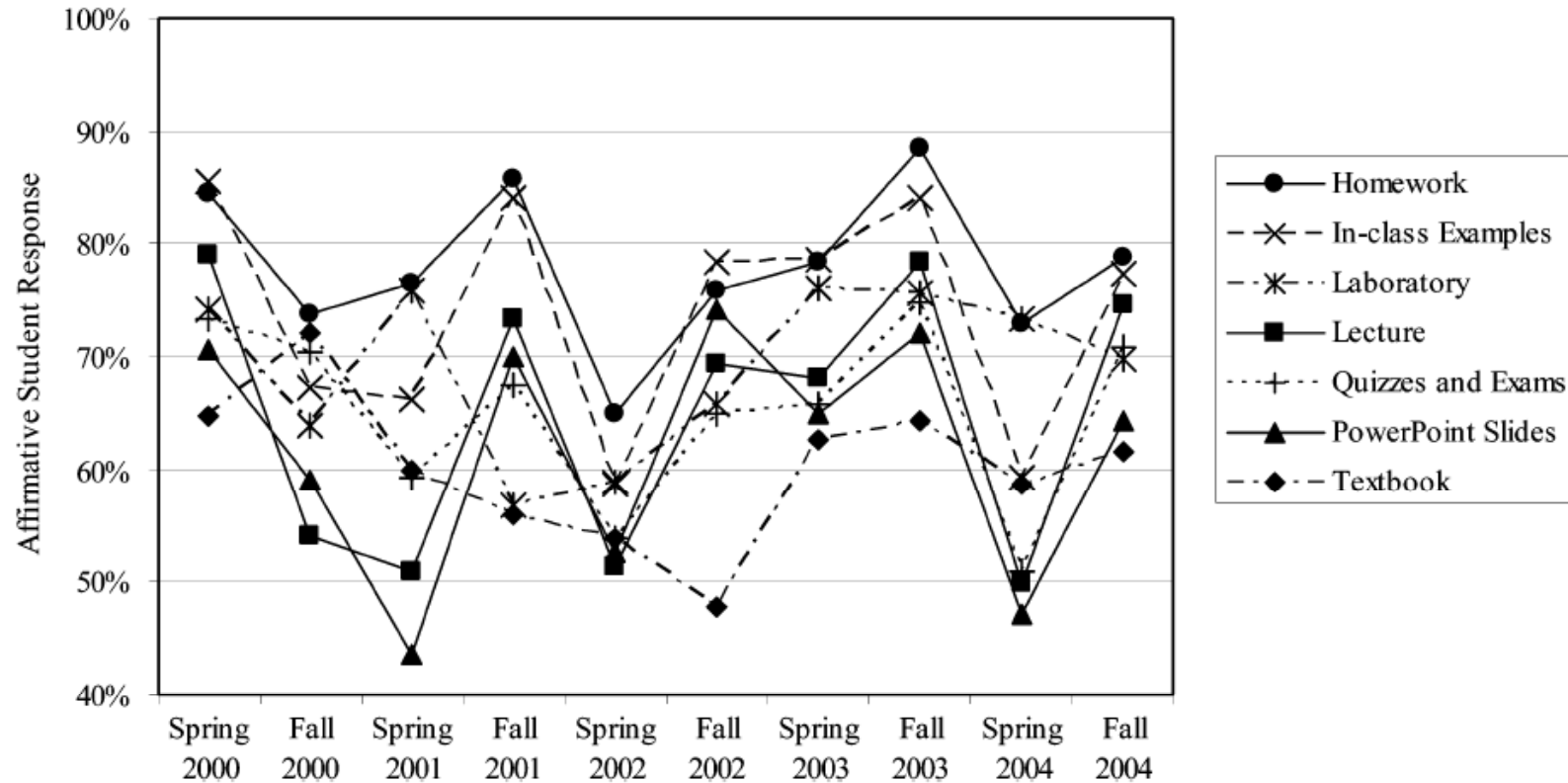
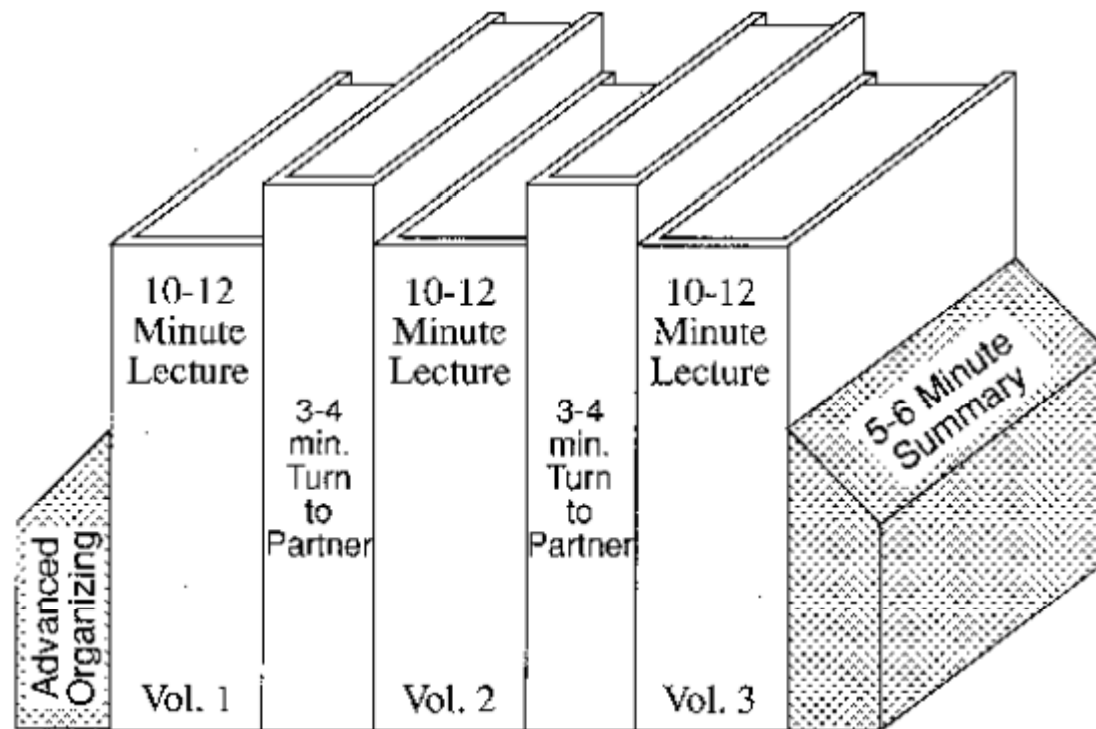


Fig. 3. Percentage of students responding that the particular course element either helped or strongly helped their achievement of the electrical circuits course objective.

Based on decades of research, students retain 70% of information in the first 10 minutes of a lecture and only 20% in the last 10 minutes (McKeachie, 1986)

Book Ends on a Class Session



Thinking Together: Collaborative Learning in the Sciences – Harvard University – Derek Bok Center – www.fas.harvard.edu/~bok_cen/

Opportunities Enabled by New Technologies

Classroom “flip” – numerous examples in the literature

Use pre-recorded modules or “microlectures” 10-15 minutes in length. Students watch 2 or 3 before each lecture, then use the class time for individual or group based activities with the instructor acting more as a guide.

Outsourcing of lectures to various “open courseware” (OCW) sites, MIT’s being the most famous.

Use of tablet PC’s in the classroom

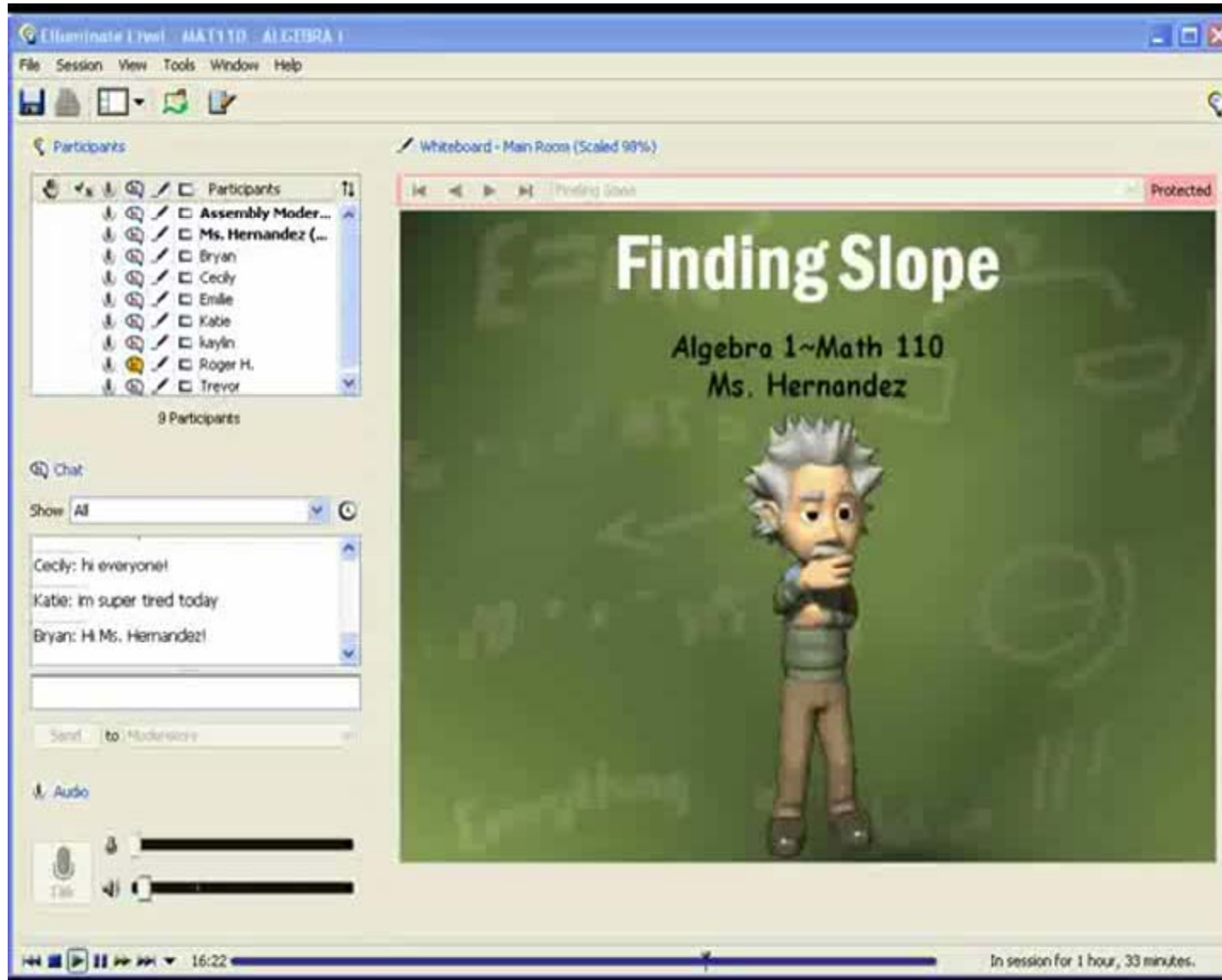
Tablet PC provides an easy way to display combinations of prepared material with “live” annotations. *Classroom Presenter*- free software from U. of Washington.

Instructor and students all interact using tablet PC’s. Instructor can display/project their PC in the classroom and/or broadcast their slides to all students’ PC’s.

Students can work on problems individually or in small groups and submit their work to the instructor for review. Instructor can use submitted work as a basis for further discussion and/or to get immediate feedback on student comprehension.

Students can be “anywhere;” software supports virtual “classroom.”

“Elluminate Live” similar to Wimba



Video from: <http://www.youtube.com/watch?v=mMEhLCpA3I>

Opportunities Enabled by New Technologies (continued)

On-Line and Distance-Learning Classes

Synchronous vs Non-synchronous delivery

Shared courses- Can GT share courses with other universities? Sloan Foundation Program in asynchronous learning, “Anytime, Anywhere, Online.”

Camtasia and *Tegrity* software for low-cost authoring of lectures – podcasting

Elluminate software for highly interactive synchronous distributed classes

Advances in Lab Classes

“Virtual labs” using simulation software.




Shared “Remote labs” that students access over the internet.

“Backpack labs” that students can do at home, or in the lecture room.

Laboratories- Opportunities and Challenges

Teaching Enhancement via Small-Scale Affordable Labs (TESSAL) Center in ECE
(Bonnie Ferri, ECE)

Developed an assortment of “backpack labs” to be used in ECE lecture classes. Topics include digital logic, RC circuits, signals and systems, and control systems, electric energy, and electromagnetics.

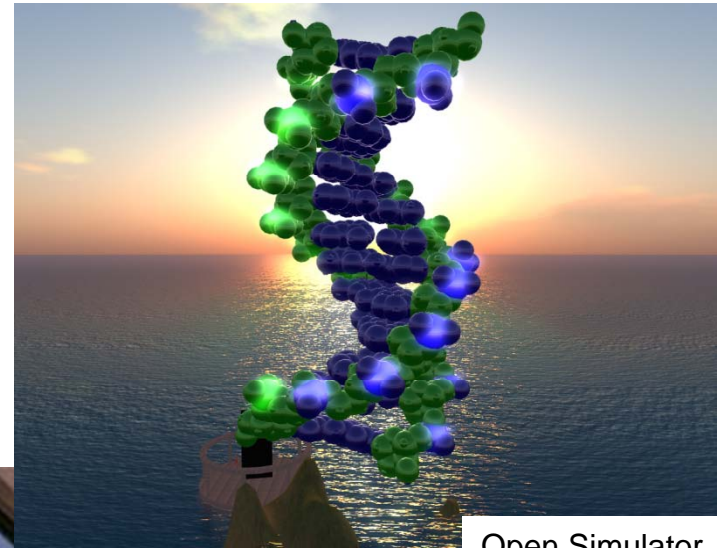
Labs	Concepts	Goals &Description
<p>Motor Control Demo</p> 	Effect of Feedback Control, Root Locus	The experiment is meant to be passed around in class. Students can enter different gains into the processor and run a position control program.
<p>Motor Velocity Control</p> 	P, PI, and PID Control, Ziegler-Nichols Tuning Rules, Frequency Response	Students are introduced to PID control by using simple design methods for speed control of a motor. They are asked to find the frequency response of the open and closed loop systems experimentally.
<p>Position Control</p> 	System Identification, Root Locus, Control Design and Implementation	Students are asked to identify a system, design a dynamic controller to achieve time domain specifications, discretize and implement the control, and show the tracking response to sine waves of different

Fully Immersive 3D Multi-User Virtual Environments (3D MUVEs)

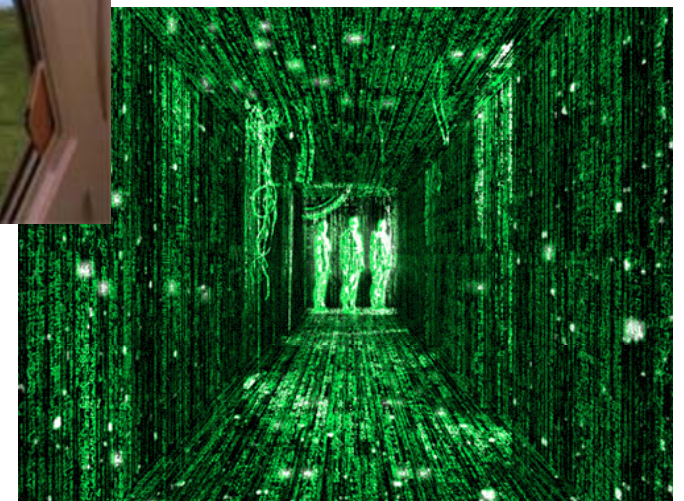
Open Simulator (OpenSim)

Second Life

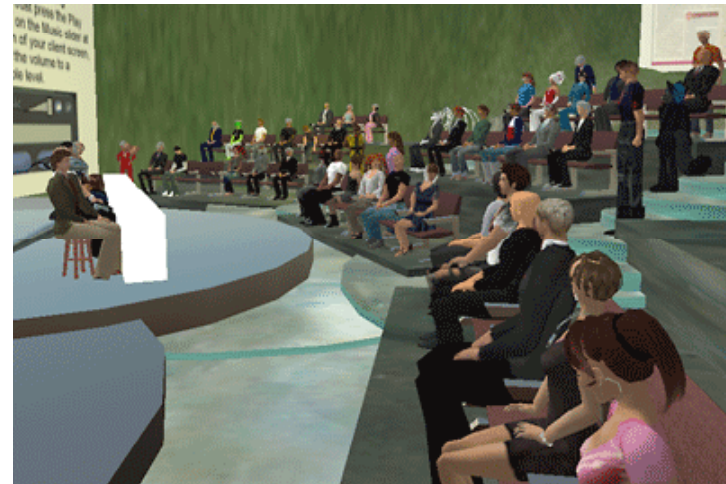
World of Warcraft



Open Simulator



Second Life



Will active learning improve my teacher ratings?

Maybe, but maybe not....

Some students will object:

“I did not learn in this class because the teacher did not teach”

“I didn’t come to college to teach myself”

However, much of the research finds that students are more motivated, and “feel better” about the topic or course.

Proposed Burdell Center

The Burdell Center has the potential to be the premier facility in the country where hands-on learning takes place.

As currently envisioned, the center will be a focal point for student design activities including capstone, competition teams, etc

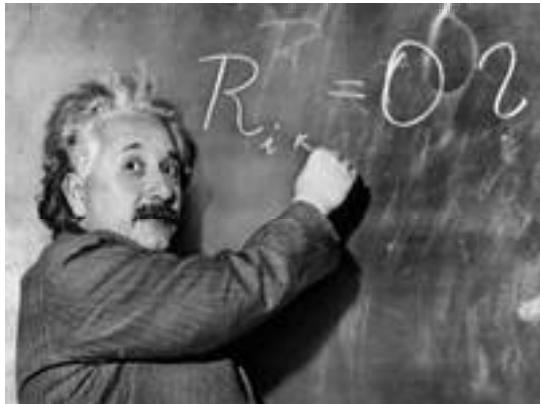


Concluding Remarks

So, do I use a lot of active learning in my classes?

How about high tech?

How about different color pens and an occasional ppt slide?



What's a podcast?



Many Thanks...

My wife Bonnie

Colleagues, especially Wayne Whiteman, Jerry Ginsberg,
Peter Rogers

Former teachers: Earl Dowell, Robert Scanlan, Terry Delph,...

Students who have been receptive to my style of teaching,
and who make all the hard work worthwhile