Active Student Engagement
A Precursor to Quality Education

Lakshminarayanan Samavedham
OEA Public Lecture Series
August 14, 2006

Dedicated to my teachers, colleagues and students
for having engaged me

Prof. R. M. Felder
Hoechst Celanese Professor Emeritus of Chemical Engineering
North Carolina State University

http://www.ncsu.edu/felder-public/Papers/Education_Papers.html

“Random Thoughts” section in Chemical Engineering Education.

Funny, thought-provoking, practical
THE NIGHT SOMEONE SLIPPED THE TRUTH SERUM IN THE PUNCH BOWL AT THE DEPARTMENT HEAD’S CHRISTMAS PARTY  

Harry (Dean) to Al (Assistant Prof.): "... I heard you got great teaching evaluations last semester and -- oh, hello, Bill. I was just commenting on Al’s teaching evaluations. Right up there, they tell me."

Bill (Senior Faculty): "Yeah, they’re almost obscene. If he keeps doing that, he’ll end up with a University Outstanding Teacher Award."

Harry: "Whoa, don’t want that! I’d hate to see you wind up like most of the other untenured professors who won one of those things."

Bill: "No joke. Take it from me, kid--if you’re spending that much time on your teaching, you’re not paying enough attention to the things that will get you where you want to go."

Al: "But...."

Email from a well-meaning Non-academic Staff

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......
......

You guys should be concentrating on research.

Regards
.........
... ... prompted me to take a rushed-look at my research track record which looks pretty good thanks to ......

... and the UG students who have worked with me

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The Joy of Timetabling

You mean that merely because Prof. K can’t be in two places at once, you want me to change all this?
'I know you're not happy now, but you'll soon get used to teaching Thermodynamics in the swimming pool.'
These problems also look much easier after the timetabling experience!

Provoked me to study about complexity of systems.
Upanishads: Thoughts of the Vedic Times  
(5000 BC to 600BC)

Taitrriya Upanishad → Seekshavalli (The Art of Living)

About Education and Teaching:
*The teacher is the prior; the student is the posterior; what bridges them is education; Education comes about through the process of teaching*

Prayer by Teacher to God:
*Let several qualified students come to me from all directions*

Students & Teacher together in Prayer:
*Let us gain enlightenment. Let us win fame and recognition.*

Quality in Education

No universal definition of quality

Several definitions; each with their own strengths and weaknesses

Conformance to specifications, Meeting and/or exceeding customer specifications, Value, Excellence, ...

Industry = Straightforward Mission + Easy Measurement + Specific Customers

Education = Complex Mission + Difficulty in measuring skills + multiple customer type
My Interpretation of Quality in Education

Ultimately, the quality of a teaching program is strongly dependent on the quality of the instruction that takes place in individual classrooms.

Value for the Student, Student Satisfaction
39+ hours of investment per module; how to make it worthwhile?

Ensure that students’ skill in the subject meets or exceeds the expectations of the employer

Ensure that the spirit of enquiry, creativity remains in the students

What Matters in College?: Four Critical Years Revisited
Alexander W. Astin

Based on a study of more than 20,000 students, 25,000 faculty members, and 200 institutions

• 146 input variables  
  characteristics of the entering students

• 192 Environmental variables  
  institutional and faculty characteristics

• 82 outcome variables  
  various measures of academic achievement, skills gained etc.
146 input variables - characteristics of the entering students
demographic measures, information about parental education and socioeconomic status, pre-college academic performance measures

192 Environmental variables- institutional and faculty characteristics (135 + 57)
measures of the size and type of the institution, faculty demographics and attitudes, institutional emphasis on research, and the nature and extent of student-faculty and student peer group interactions

82 outcome variables
including measures of academic achievement, retention, career choice, self-concept, patterns of behavior, self-reported growth in skills, and perceptions of and satisfaction with the college experience.

The quality of the college experience is strongly affected by student-faculty interactions.

The frequency with which students talk with professors outside class, work with them on research projects, assist them in teaching, and visit their homes, correlates with

- student grade-point average,
- degree attainment,
- enrollment in graduate or professional school,
- every self-reported area of intellectual and personal growth,
- satisfaction with quality of instruction, and
- likelihood of choosing a career in college teaching
“...the student's peer group is the single most potent source of influence on growth and development ...”

Frequency of student-student interactions (including discussing course content with other students, working on group projects, tutoring other students, and participating in intramural sports) correlates with

- improvement in GPA,
- graduating with honors,
- analytical and problem-solving skills,
- leadership ability, public speaking skills, interpersonal skills,
- preparation for graduate and professional school, and
- general knowledge

and correlates negatively with feeling depressed

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Invited by the Singapore government to analyze why Creativity and Initiative were lacking in the workplace even though these attributes were evident in school children

If the “richest learning experience happens when people are actively designing, experimenting and exploring,” then why can’t we extend this approach into the school curriculum?
Building Quality into my Modules

Formulate module with clear learning objectives

Have assessment components that align with objectives

Benchmark content and assessment with those of similar modules taught at renowned Univs.

Step into students’ shoes and see how they might like to see the content presented and examined

Being unpredictable in terms of content, emphasis, types of problems, projects etc.

Teacher

Student

Curriculum

Interaction

Tuning

Interaction

Interaction
Building Interactivity into Modules

In-Class Exercises

Summarizing the lecture (last 2-3 minutes)

Use the IVLE Discussion Forum

Project work (outside class)

Group Assignments

Respond to questions and provide feedback on a quick & regular basis

Traditional engineering instruction is deductive, beginning with theories and progressing to applications of those theories.
Inductive Teaching: Instruction begins with specifics — a set of observations or experimental data to interpret, a case study to analyze, or a complex real-world problem to solve.

Show the need for facts, rules, procedures and then introduce them to students or let them discover.

Good Teaching and Learning does and should involve both inductive and deductive components.

... and it is better that induction precedes deduction.

Why?
Educational psychology research shows that people are most strongly motivated to learn things they clearly perceive a need to know.

Inductive teaching and learning offers a very easy and natural way to engage students.
Learning ANOVA

The coagulation time in seconds for blood drawn from 24 animals randomly allocated to four different diets is given in the Table below.

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Class of 2006: A Class of Exceptional Attitude
Experiences with CN3121 & CN3421

What students take away from the modules

Concepts are based on commonsense (formalization of common/everyday experiences)

Emphasis on broader philosophical connectivity to medical, social, economic and political systems

Interconnectedness of behavior and strategy – the Systems Approach

The first emphasis is on qualitative aspects which is later complemented with quantitative analysis

How far can students go?

Pencil & Paper + Discussion Forum + Industrial Strength Computer Software

Can also deal with realistic processes

Very importantly, students can define their own objectives and strategies for solving problems (creativity)

Group Projects: Stretching minds beyond the classroom

Various choices available for the students – students’ pick one depending on their proficiency and interest.

Involves self-study of material not explicitly covered in lectures/tutorials

Students work in groups → development of soft skills, peer-to-peer learning

An opportunity to engage in technical report writing
Experimental Projects: CN3421

- Rice Making:
- Popcorn Making:
- Ribena Drinks:
- Nasi Lemak:
- Boiling Water:
- Absorbing ability of a sponge:
- Preparation of Agar-agar dessert:
- Making of Fried Egg:
- Making of Toasted Garlic Bread:
- Loss of moisture in popcorn:
- Oxidation of apples:
- Making Chicken rice:
- Making tasty rice:
- Germination and growth of Mung Beans:
- Making time for Macaroni:
- Making Pancakes:
- Flight performance of thunder bomber:
- Rock Climbing:
- Cycle Riding:
- Coffee Making:

In changed mode (roughly 60% the overall time)

Experimental Projects: CN3121

Multivariable Control

Inclusion of Biomedical Control Applications

Challenge of controlling blood glucose level in three diabetic "patients"

provides a stimulating introduction to Robust Control Design.
Students in NUS are facing more and more stress ....... Instead of making this project another chore to us, we decided that since we are given so much free play in the project, we will do something much more interesting and Fun......

Video Clip: climbing.asv
Mr. Velu Prabhakaran  
B.Tech. (Chem. Engg.) Student  
2005 Cohort  
Employee of a MNC Pharma Company

Took initiative and implemented the ideas taught in TC3412 (Design of Experiments).

Resulted in two recommendations for yield improvement

9 kg of additional product per batch. US$14,000 savings per batch. US$0.84 Million annual profit

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Intensity in Undergraduate Research

Mr. Martin Wijaya Hermanto  
B.Eng. (Chemical Engg.)  
FYP with Prof. Rangaiah and me  
Currently Ph.D. Student with A/P. Chiu

Estimation of Variance Reduction Opportunities through Cascade Control
Intensity in Undergraduate Research

Mr. Muthu Velmurugan  
B.Tech. (Chem. Engg.) Student  
2003 Cohort

Employee of a Chemical Company

A ten-fold decrease in process variability

“Engagement Gifts”

Emails

Greeting Cards

Friendly smiles from students

Small Gifts

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