Session 0613: Frontiers in Chemical Engineering Education
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The moderators and fourteen participants divided into small groups to discuss four questions. Their reports are presented here, along with notes on the subsequent discussion.

Group A: How can we use elements of curriculum, materials, and teaching to cultivate desirable student skills, attributes, and values?

Desirable student skills, attributes, and values:

skills	attributes	values
critical thinking (seeing the big picture beyond the immediate question)		safety
communication - oral and written	out-of-the-box thinking	ethics
multidisciplinary teamwork	kindergarten-level creativity	environmental stewardship
problem formulation	inquisitive	societal stewardship
think on a molecular level	live with uncertainty	sustainability
connect molecular to bulk-design of products/processes		personal responsibility
spelling; grammar		
independent, lifelong learning		

- reinforce the skills, attributes, and values. Communicate to the students that you are doing this, early, often, clearly.
- maintain relevance - use real-world problems
- open-ended problems, either somewhat constrained, or completely unconstrained in the solution path. An example is the AIChE Car Competition
- group learning (students teaching students)
- multiyear projects, using students from various years in the curriculum, drawn from multiple disciplines

Group B: How can we foster <u>integrated</u>, rather than <u>compartmentalized</u>, knowledge and skills?

Current techniques:

- use design throughout the curriculum
- team teach: science/engineering
- problem-based learning (just-in-time)
- spiral curriculum: revisit topics with more depth in subsequent courses

New Ideas:

- ChE faculty teach all courses
- use coherent/strategic repetition - that is, focus on key points throughout the curriculum.
- repackage the courses taught by service departments so that they contain what is needed, not just what is nice.

Problems:

- insufficient course-to-course communication throughout the curriculum - horizontal and vertical
- training versus education (go to college to be educated rather than merely trained)
- inconsistency between faculty members teaching the same class in different years
- faculty reward system does not motivate faculty members to look beyond their own expertise areas within the curriculum
- need curricular/instructional materials

Group C: What teaching/presentation methods can we use to convey the excitement and novelty of our field?

- learning styles
- projects
    - vertical integration
    - case studies
    - all levels
    - design and project management
- hands-on (which may include web-based virtual experiments and demonstrations)
- e-learning
- use industrial participants
- coordinate with science and math, perhaps with interdisciplinary instruction

Group D: What teaching materials are needed; e.g., traditional textbooks vs. web delivery? examples and case studies? teaching resources in addition to subject-matter resources?

- Both textbooks and web sources will be useful (note that students usually print out material anyway)
- CD or web are particularly useful for supplemental sources and materials

Case studies:

- bring in more design
- can be used throughout curriculum
- promote integration across years 1-4, and across courses
- need traditional topics, as well as bio, nano, waste treatment, etc. - variety is needed. (It is hard to find suitable materials for instruction on nanotechnology.)

- need a mechanism for sharing case studies

Resources:

- software
- means to train the teachers, so that we don't simply teach as we were taught
- texts that include business, ethics, etc. as part of their topic

Discussion

- Can other departments (chemistry, etc.) help in reinforcing skills and attributes?
- Our faculty must themselves model the skills and attributes we wish to cultivate in students!
- Faculty are uncomfortable with the uncertainty inherent in the new ABET guidelines (bean-counting has been replaced with a design problem)
- How to share case studies? over the web, a clearinghouse? an Amazon-style rating system?
- Can faculty be rewarded for preparing case studies? Business schools do this.
- Possible repositories of case studies: CEE journal, CAChE, AIChE?
- For AIChE it would be good marketing to the students, and a good image to other disciplines.
- Monsanto once underwrote case studies - would companies contribute them now?
- What could make the case studies useful, so that they would be used? Is it a matter of developing a standard style or format for them? CAChE is not widely used.
- Oregon State University is assembling learning objectives into a tree for the whole curriculum.
- One ChE department found that their math department was very cooperative about making the content of its courses more relevant for chemical engineering. The chemistry department also made changes to its offerings motivated by suggestions from chemical engineering.
- Early presentation of material/concepts in the curriculum may make it difficult for transfer students
- Some universities have used learning communities for freshmen or incoming students to help orient them to engineering and resolve differences in background.