

Motivation

In the first two Teaching Tips (TT) on Lang's book^[1] increasing knowledge retention^[2] and understanding^[3] were discussed. Both previous TTs implicitly assumed that students were motivated and had the focus and energy required for learning. This TT presents proven methods for increasing student motivation.

An easy activity to start class is to post a thought-provoking image, question, or quotation before class starts. Anything that will relate to class, provoke student curiosity, and help students make connections is useful. For example, one of my questions is, why is there a difference between degrees of freedom for equilibrium and degrees of freedom for complete design? After a few minutes or partway through the class, I make sure the question is answered or the image has been discussed. This method taps into the students' curiosity and starts students thinking before class starts.

Before class is a great time to talk to students, but do not limit yourself to the students who voluntarily come up to talk. Lang suggests you try to talk to every student in the course at least once during the semester. Attention shows caring and will improve class rapport. In smaller classes I require students to come to my office and discuss their goals after college. In larger classes this visit is optional.

Tell stories. People are genetically programmed to remember stories. Most chemical engineering content is answers to questions. The answers by themselves are often less interesting than the question and the way answers were generated. For example, while teaching distillation I like to tell how Lewis simplified Sorel's analysis for binary distillation, taught the material in a graduate-level course, and then had two students, McCabe and Thiele, develop an even simpler graphical analysis.

Remind students why they are in college studying a subject as difficult as chemical engineering. Perhaps surprisingly, research^[1, p. 185-186] shows that goals that transcend personal gain and involve using the discipline to improve the lives of people, are the strongest motivators. Don't know any good stories about chemical engineers improving people's lives? Try the resources in the Leonardo project.^[4]

Dull professors result in dull classes. Something sparked your interest in a particular area of chemical engineering (in my case it was McCabe-Thiele analysis of distillation). Share your enthusiasm, which for me has lasted for 50 years, with your students.

Reward effort and growth. Lang^[1, pp 195-206] explains in detail the psychological background for this suggestion. An easy way to reward growth is increase the weight of later exams. Thus, weigh three exams as 10%, 15%, and 20% of the course grade instead of 15% each. An alternative I have used is to have an optional cumulative final that can increase, but not decrease a student's grade. The test score used to determine their course grade is the higher of their regular test average or the optional final score. Students with A and A- grades and students who have given up do not take the final. Students in-between these extremes often take the final and sometimes improve their grades significantly.

Emotions greatly affect the ability of students to learn and of teachers to teach. The day my dog died I had to take the morning off to grieve. Fortunately, I did not teach that day. If I had been a student in your class and did not turn in an assignment that day what would you do? If you do not ask why I did not turn in the assignment I probably will not say anything because I am afraid I will break down and cry. If you ask, would you believe my story? Do not assume the worst. Show compassion when life interferes with learning. Yes, students will occasionally take advantage of you, but most of the time compassion will help your students.

REFERENCES

1. Lang, J.M., *Small Teaching: Everyday Lessons from the Science of Learning*, San Francisco, Jossey-Bass, 2016
2. Wankat, P.C., "Teaching Tips: Helping Students Learn Knowledge," *Chem. Eng. Ed.*, **50**(4), 237 (2016)
3. Wankat, P.C., "Teaching Tips: Increasing Student Understanding," *Chem. Eng. Ed.*, **51**(1), 21 (2017)
4. Prausnitz, J.M., "Teaching Tips: Humanities and Social Relevance for Chemistry and Chemical Engineering Students: The Leonardo Project," *Chem. Eng. Ed.*, **50**(3), 175 (2016) □

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Submit teaching tips of about 450 words to Phil Wankat, <wankat@ecn.purdue.edu> for review and editing. Subject: CEE Teaching Tip. See <http://che.ufl.edu/CEE> for guidelines.