Random Thoughts . . .

TO FLIP OR NOT TO FLIP

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In traditional teaching, students first encounter new course material in class and then apply it to problem solving in out-of-class assignments. In a *flipped classroom*, the opposite approach is taken—new material outside class, followed by application in class.

Flipping has some attractive features and moderate research support, but as with every other teaching method, there are good and bad ways to do it. Here are two common bad ones:

How NOT to flip a classroom

(1) Before students come to class, assign them to read some of the course text or watch slides or a video of a complete lecture.

(2) Assign new material before class, and then present more new material in a lecture.

What's wrong with those approaches? If you ever assigned students a technical reading and expected them to apply the content next morning, you've known disappointment. Having students sit through a straight online lecture is no better—they have little chance of understanding the content without being able to ask questions about it or get feedback on their initial attempts to apply it. And assigning readings or online lectures before class and then giving more lectures in class is not flipping anything—it's just doubling the rate of fire-hosing the students with information.

So if those methods of flipping don't work, what does? Effective classroom flipping has two components: *interactive online presentation of information before class*, and *active learning in class*.[1,2] The online materials might include short videos, lecture clips, and screencasts; hands-on experiences with virtual labs, control rooms, and plants; and quizzes on presented material. Each presentation segment should be roughly six minutes: when it goes much above that, students' attention starts drifting.[3]

Here are several suggestions to consider before flipping your class.

- ***Don't try flipping until you're comfortable with active learning and know how to deal with student resistance to it.***

Flipping gives students the responsibility for their own learning that active learning always imposes, and it also forces them to learn on their own before they come to class. Many students are not thrilled about either feature of this teaching method, and some aren't shy about letting their instructors know about it. If you're not prepared for pushback, your first flipped classroom experience could be grim for both you and the students. If you can, teach for several semesters using active learning in an otherwise traditional course, and if student resistance starts becoming uncomfortable, take steps to defuse it.[2,4] When you are confident that you can handle

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the resistance, if you still want to flip (not every teacher has to), go for it.

- ***Have good online lessons with integrated assessments in place for every class session you plan to flip.***

If slide shows and complete taped lectures are the only online resources you have, hold off on flipping until you can assemble interactive materials of the kinds we mentioned above. Screencasts and simulations suitable for most core courses in chemical engineering can be found at <*www.learncheme.com*> and by entering "*Tutorial (topic)*" or "*Simulation (topic)*" into a search engine, and Koretsky[5] and Velegol *et al*.[6] offer excellent examples of online materials and assignments.

A powerful component of online instruction is quizzes during and following online lessons, with immediate affirmative or corrective feedback on the students' responses.[7,8] The quizzes should not just be simple tests of factual information but should include assessments of deep understanding of the online material, such as the conceptual questions found in the AIChE Concept Warehouse (<*http://jimi.cbee.oregonstate.edu/concept_warehouse/*>).

- ***Make class sessions mainly activities that build on previous online lessons.***

Structure the sessions using active learning techniques, especially *thinking-aloud pair problem solving* for working through complex problems.[2,9] Be flexible during the sessions, paying careful attention to what the students are doing, and be prepared to intervene with a mini-lecture when common stumbling blocks and misunderstandings arise.

- ***When you decide to flip, get help if you can, and start gradually.***

If you have colleagues who have successfully flipped their classrooms or a campus center for teaching and learning that provides consulting assistance, call on them for guidance. Instead of trying to flip an entire course, identify a small portion of the course that you feel enthusiastic about teaching and for which good online materials are available, and try flipping only that portion. Learn from that experience and continue expanding your use of the method in subsequent course offerings.

- ***Consider flipped flipping.***

In a flipped class, the basic material is presented in online modules and some or all of the application is done in a subsequent class. Another approach is to introduce new material via active/interactive exploration in class, *then* send the students out to view the screencasts and work through the tutorials online. Researchers at Stanford University refer to this approach as the "flipped flipped classroom," and have found it superior to flipping in many respects.[10]

Jensen *et al*.[11] carried out a well-designed study in which students' performance and attitudes in a flipped classroom and a flipped flipped classroom were compared. No significant between-section differences were found in the students' learning gains or in their attitudes about their instruction. The authors concluded that the key to the effectiveness of both approaches is the extensive use of active student engagement (which has been repeatedly shown to be superior to straight lecturing[12]) in both the online and in-class instruction.

In short, flip your class if you want to, observing the precautions we suggested—and if you don't want to flip, don't flip. As long as you keep students actively engaged in both flipped classrooms (new material out of class, problem solving in class) and nonflipped classrooms (vice versa), you should see the learning you're looking for.

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