HOW ABOUT A QUICK ONE?*

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Of all instructional methods, lecturing is the most common, the easiest, and the least effective. Unless the instructor is a real spellbinder, most students cannot stay focused throughout a lecture: after about 10 minutes their attention begins to drift, first for brief moments and then for longer intervals; they find it increasingly hard to catch up on what they missed while their minds were wandering; and eventually they switch the lecture off altogether like a bad TV show. McKeachie [1] cites a study indicating that immediately after a lecture students recalled 70% of the information presented in the first ten minutes and only 20% of that from the last ten minutes.

There are better ways. Actively involving students in learning instead of simply lecturing to them leads to improved attendance, deeper questioning, higher grades, and greater lasting interest in the subject [1,2]. A problem with active instructional methods, however, is that they sound time-consuming. Whenever I describe in workshops and seminars the proven effectiveness of in-class problem-solving, problem-formulation, trouble-shooting or brainstorming exercises, I can always count on someone in the third row asking—usually sincerely, sometimes belligerently—"If I do all that, how am I supposed to get through the syllabus?"

I have a variety of answers I trot out on such occasions, depending on my mood and the tone of my questioner, but they mostly amount to "So what if you don't?" Syllabi are usually made up from the standpoint of "What do I want to cover" rather than the much more pertinent "What do I want the students to be able to do"; ,when the latter approach is adopted, it often turns out that large chunks of the syllabus serve little educational purpose and can be excised with no great loss to anyone. But never mind: let's accept—for the remainder of this column, at least—the principle that it is critically important to get through the syllabus. Can I (asks my friend in the third row) use any of those allegedly powerful teaching techniques and still cover it all?

Yes (I reply), you can. Here are two techniques for doing it.

In-class group problem-solving

As you lecture on a body of material or go through a problem solution, instead of just posing questions to the class as a whole and enduring the subsequent embarrassing and time-wasting silences, occasionally assign a task and give the class one or two minutes to work on it in groups of three to five at their seats. For example:

- *Sketch and label a flow chart (schematic, force diagram, differential control volume) for this system.*
- *Sketch a plot of what the problem solution should look like.*
- *Give several reasons why you might need or want to know the solution.*

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- *What's the next step?*
- *What's wrong with what I just wrote?*
- *How could I check this solution?*
- *What question do you have about what we just did?*
- *Suppose I run some measurements in the laboratory or plant and the results don't agree with the formula I just derived. Think of as many reasons as you can for the discrepancy.*
- *What variations of this problem might I put on the next test?* (This and the last one are particularly instructive.)

You don't have to spend a great deal of time on such exercises; one or two lasting no more than five minutes in a 50-minute session can provide enough stimulation to keep the class with you for the entire period. The syllabus is safe!

Warning, however. The first time you assign group work, the introverts in the class will hang back and try to avoid participating. Don't be surprised or discouraged—it's a natural response. Just get their attention—walk over to them if necessary—and remind them good-naturedly that they're supposed to be working together. When they find out that you can see them they'll do it, and by the time you've done three or four such exercises most of the class will need no extra prodding. Granted, there may be a few who continue to hold out, but look at it this way: in the usual lecture approach, 5% of the students (if that many) are actively involved and 95% are not. If you can do something that reverses those percentages or comes close to it, you've got a winner.

In-class reflection and question generation

The *one-minute paper* is an in-class assignment in which students nominate the most important and/or the most confusing points in the lecture just concluded [3,4]. Variations of this device can be used to powerful effect. About two minutes from the end of a class, ask the students—working individually or in small groups—to write down and turn in anonymous responses to one or two of the following questions:

- *What are the two most important points brought out in class today (this week, in the chapter we just finished covering)?* Examination of the responses will let you know immediately whether the students are getting the essential points. Also, when the students know beforehand that this question is coming they will tend to watch for the main points as the class unfolds, with obvious pedagogical benefits.

- *What were the two muddiest points in today's class (this week's classes, this section of the course)?* Rank the responses in order of their frequency of occurrence and in the next class go over the ones that came up most often.

  The responses to this question will surprise you. What you would have guessed to be the most difficult concepts may not show up on many papers, if they show up at all; what *will* appear are concepts you take for granted, which you skimmed over in your lecture but which are unfamiliar and baffling to the students.

- *What would make this material clearer to you?* You also never know what you'll get in response to this one—perhaps requests for worked-out examples of solution procedures or concrete applications of abstract material, or pleas for you to write more clearly on the board, speak more slowly, or stop some annoying mannerism that you weren't aware you

were doing. Responses to this question can provide valuable clues about what you could do to make your teaching more effective.

- *Make up a question about an everyday phenomenon that could be answered using material presented in class today (this week).* (Optional:) *One or two of your questions will show up on the next test.*

I used the last exercise—including the zinger about the next test—at the end of a course segment on convective heat transfer and got back a wonderful series of questions about such things as why you feel much colder in water at 20 degrees celcius than in air at the same temperature; why you feel a draft when you stand in front of a closed window on a cold day; why a fan cools you on a hot day and why a higher fan speed cools you even more; why a car windshield fogs up during the winter and how a defogger works; and why you don't get burned when you (a) move your hand right next to (but not quite touching) a pot of boiling water; (b) touch a very hot object very quickly; (c) walk across hot coals. I typed up the questions (sneaking a few additional ones onto the list) and posted them outside my office—and in the days preceding the test I had a great time watching the students thinking through all the questions and speculating on which one I would put on the test. (I used the one about the fan.)

There are other short, easy, and effective instructional methods, but these should do for starters. Check them out and let me know how they work for you. If I collect some good testimonials (positive or negative) I'll report them in a future column.

References

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