

## Comments on classroom dynamics, by David Pengelley

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Over more than two decades I have found myself constantly reinventing how I teach. In the past few years, this has included evolving away from lecturing, towards a classroom environment in which students are engaged in very active work, exploring collective and individual inquiry. I want students to gain the most from the very precious brief time we all have together in the classroom, and over several years I have developed some realizations and strategies. It is a work in progress.

I have found that guiding an active classroom is much more demanding than lecturing, since as lecturer one prepares a set plan and carries it out, exerting essentially total pre-planned control, but consequently not adjusting much to students' immediate needs, nor placing primary responsibility on the student for classroom learning. In contrast, an active classroom is one in which the instructor must be prepared to guide the unfolding of an individual and collective dynamic. Thus the instructor must attempt to prepare for all learning eventualities as they may arise in a classroom driven in large part by spontaneous student actions and responses, a demanding and potentially unsettling challenge. The instructor must be better prepared, and confident and capable of handling whatever may occur, however unexpected. The instructor relinquishes the total control of lecturing, but retains the responsibility of simultaneously guiding the process productively for all students.

For a long time I thought about the relationship between lecturing and textbook reading. I strove mightily to break a vicious ensnaring cycle, in which our students do not learn seriously from reading a textbook because they know the instructor will lecture on the text material, while instructors lecture on text material because they know students will not learn seriously from text reading. I resolved to find ways to assist and expect all students to do substantial first-contact initial learning from serious reading, whereupon the classroom could become a place to assist them in building to a much higher level. I sought ways to get students to take reading very, very seriously, and decided that I must give them meaningful tasks to complete in writing for every reading assignment, that will cause them to engage the material in thoughtful and questioning ways, and then to make valuable use of their work, both in class and in their grade for the course (see below). I also decided to try in every course to have students read from more than one source, to gain contrasting viewpoints on new material that would stimulate the formation of their own unique understanding.

At the moment, in lower-division courses I have a three-part approach to every daily classroom unit. Students first do advance reading about a week prior to every class discussion on a new topic, submit answers to 'reading questions' I have prepared (Part A), and hand this in one class period before we will discuss this new material. I also ask them to write their own questions, or observations of connections in the new material, and some reflection, and how much time they spent. Before we ever discuss this new mathematics, I mark their responses qualitatively and gain insight from these responses. Second, and also in advance, students do some easy to medium 'warm-up' exercises (Part B). Then in class we discuss both the reading responses and the warm-up exercises, on which they have already done tremendous preparation, and move beyond to discussion of a higher level view of the material. This discussion may be done in groups, or by students at the blackboard, or as a whole class, or in individual interaction with me, as I play a roving guiding role to the whole collective,

and also to individuals and groups. This gives students a very active role and responsibility in their own learning, and moves entirely away from lecture; I no longer feel the urge, since their preparation has removed any purpose to this. I also find it allows for deeper discussion of material, since they have done a lot of advance work in first-contact at home. Part B is handed in at the end of class. Finally I assign a few more difficult ‘main exercises’ for home (Part C). The details of this scheme are explained to students in a handout.

My grading of student homework continues to give students good written feedback, but has shifted from assigning numerical points to holistic, more qualitative summary evaluations. Moreover, the nature of the classroom activity means that some of their work does not need detailed grading, and is graded only for getting preparation done. For the advance writing and reading responses (Part A) I look quickly through their responses, use them seriously to help me prepare for class, perhaps write some brief responses to student responses or questions, and give the whole paper a plus (completed), check (partly completed), or minus (largely incomplete) grade. For the warmup exercises (Part B), since these have been hashed out in class, and they have received all necessary feedback, there is no need to look at the details. This paper also receives a plus, check, minus; it takes about three seconds per student to do this. The very few final exercises, Part C, receive careful grading and feedback, a grade of A,B,C,D,F on the paper, and are perhaps redone to improve as needed.

I cannot emphasize enough that I believe it is critical that the A/B/C homework assignments together should constitute a very large part of each student’s grade in the course, so that they will know to take them very seriously, as their main work for the course. I am not at all sure this method would work otherwise. And I bolster this perspective at every turn, especially by not lecturing.

I find this approach tremendously successful. My students completely buy in to this method of learning, they come to class having prepared and written, and wanting to use their class time on active work, not listening to me lecture. The closest I ever come to lecturing is sometimes spending just a few minutes at the beginning of class, before they begin active work, discussing specific questions coming directly from what I have already read in their written responses to the reading.

I have also developed new methods of examining students, in which they sometimes write advance explanation of material, make brief classroom presentations, and then answer additional challenges in writing.

In upper level or graduate courses I apply many of these same principles, but students there are more able to carry out the independent parts of this approach with minimal guidance; for instance, there is less need for me to prepare reading questions, as I can expect more mature students to generate their own.