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Four Strategies for the Lecture Format Class

Over the past 22 years, I have developed many strategies for teaching mathematics in a lecture format. I have found four of them to be particularly effective, with consistent results. They are best suited to the typical classroom with up to 40 students, but could be adapted to larger classes, other formats, and most disciplines.

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Arrive in the classroom early. Some classes are more "friendly" than others. The time of day, the percentage of disgruntled students (perhaps repeaters), and the significance of the course to student degree plans (requirement or elective) can make creating a rapport with some classes especially difficult. This prompted me to arrive early to the classroom. I would simply be present, near my "command post." The students who sit in front inevitably would strike up a conversation (one reason they sit in front). The most recalcitrant students (in the back) would see this and come to perceive me as a caring individual, perhaps with interests outside of my specialty. After several such sessions, these students often would participate in the discussion and talk about their interests and motivations.

This strategy has never failed. It is easy. By arriving in the classroom at least 10 minutes before the class is scheduled to begin says that you value the class and that you are eager to get started.

Put review problems or questions on the board before class begins. Some basic skills and themes are more important than others. I put four or five review problems on the board at least five minutes before class is scheduled to begin. A problem may go back to the beginning of the course or may review points in the homework which I know are problematic for students.

Students work on the problems as soon as they arrive and as I call the roll. When I do this on a regular basis, more and more students arrive early. This reduces tardiness, which I find disruptive, but which I would rather combat with a carrot than a stick.

My motivation is to keep old skills current, both for the next course, the comprehensive final, and, of course, to maximize retention of the material. The result is that students remember material covered early in the course when it appears on the final examination. Also, the student learns to value all of the course material equally and to realize that the course is not just a game in which you and the student try to move through the most current material as painlessly as possible.

Make every test cumulative. This is related to the second point, but does not depend upon it. I do not require my students to review the text and notes for old material, but I do require that they review all previous tests. I use questions from the old tests, but change the numbers so students cannot simply memorize answers and copy them onto the new test. Without this policy there is no incentive for a student to review a test after it is taken, or to attempt to master unlearned material prior to reviewing for the final. Anything the student did not understand on the first test is irretrievable at the end of the semester. This policy promotes better performance on a cumulative final exam, as well as information retention for the next course.

Give a half-hour test every two weeks. I do not give a one-hour exam at the end of each chapter. A chapter test seems to compartmentalize the material. Students are tempted to avoid studying until they see the end of the chapter coming—perhaps four weeks into the course. Naturally, some teachers use daily or weekly quizzes to counter this particular result, and they may be effective in this regard.

However, testing every two weeks encourages students to keep up with assignments. They know the test is inevitable and regular. The tests are one-half hour in length and are given at the end of a class period. Students do not like to take tests at the end of the period because they want to cram, then come to class and take the test before they forget the material. I tell them that I do not give the test at the beginning of class because inevitably someone wants more time, and I do not have the heart to take the test away. Thus, I lecture on new material first, and let the clock do the dirty work. (I accommodate students with learning disabilities or acute cases of math anxiety with untimed tests at other times.) I counsel students to study regularly and know the material when they arrive in class. If they do, they will make good marks on each test—my experience bears this out.

A policy of testing every two weeks produces six or seven grades by the end of the semester (no make-up tests are allowed). Because tests and the final exam are cumulative, I allow the final exam to replace two test grades.

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These strategies promote regular study, encourage mastery of material, reduce overall anxiety about grades on individual tests, and produce better results on a cumulative final examination.

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General Education Science: A STAR Approach

The educational opportunities and experiences offered and enjoyed by science and engineering students in the U.S. are among the best in the world. However, educating the non-major college student about science and the scientific process is a pressing problem.

My concern about this problem has led me to examine my own general education physical science class. Students typically come to this class with one or more problems that inhibit the learning process. Many students have an indifferent, if not negative, attitude toward science in general; they lack critical thinking skills and appropriate study skills. In the past, I have used a typical lecture format where several concepts and facts were presented each day in outline form. My expectation was that the students would comprehend the material and understand what science was really about. This expectation was naive. Many students did well in learning individual concepts, but I always felt that most left the class without an appreciation for science or the scientific process.

Several years ago I heard of Project STAR—a program designed to assist the teaching of astronomy at the secondary level. The acronym STAR caught my eye—Science Teaching from its Astronomical Roots. This notion appealed to the amateur astronomer in me. Why not expand the concept even further to a whole course? From past conversations with students and end-of-semester questionnaires, I knew that the astronomy section was the favorite of most students in the physical science class. By applying the STAR concept to other areas, I hoped the popularity of astronomy would spark interest in the entire course.

The basics of this program are very simple. Each section of the class begins with a short discussion of an astronomical concept or observation. The interest (both mine and the students') produced by this concept or observation is used to introduce students to the basic science principles that help them understand the astronomy concept. For example, the idea of different colored stars can lead to the discussion of spectra in general. The discussion of spectra leads naturally to atomic structure. The modern quantum theory is a simple extension of these concepts. All of these discussions can come from one idea that appeals naturally to the students.

The resulting overlap of the basic science principles allows me to clarify the nature of the scientific process. It also allows me to work with the students who have skill problems. For example, critical thinking skills are enhanced by using the overlapping principles to prepare for the next section. That is, I always try to ask the question, "How else can we use this information?" Students' interest in the trigger idea helps to overcome their indifferent attitude. Once I gain their interest, I can address study skills in a positive way.

There are some problems with this approach. Extra time is required to find appropriate readings in the text or supplemental books. Once students become involved, it is difficult (or impossible) to follow an inflexible plan for covering each section. Also, the amount of material that can be covered in one semester is limited. Student feedback has indicated that *quantity* of material covered has been sacrificed for *quality* of understanding—a trade I will make any semester.

In the future, I would like to see a physical science class use other basic fields of study, such as geology, as the trigger subjects in this approach. Certain sections of other basic science courses, such as biology or introductory chemistry, might profit from this approach as well. While it does not solve the national problem of scientific literacy, this method does promote a better understanding of science for students.

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