

Effective, Efficient Teaching

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Abstract

New professors are anxious to prove themselves in the classroom, but they know that their promotion and tenure prospects likely depend more on research productivity than teaching. The challenge is not only to teach well, but also to teach efficiently. Fortunately, most good teaching practices are both effective and efficient. Methods for developing a good course and hints on lecturing, testing and improving rapport with students are presented. Finally, a path for future development is suggested.

I. Introduction

What is good teaching? Most importantly, students must learn the right content, but they should also have a good attitude and learn how-to-learn. To be sustainable over the long haul, teaching must also be efficient. A course is efficient for professors when there is a high ratio of (student learning)/(professor's time on the course). Teaching will be efficient for students when there is a high ratio of (student learning)/(student time on the course). Although there are times when effective teaching and efficient teaching conflict, most of the time effective teaching can also be efficient.

What can you as new faculty do to become effective, efficient teachers? First, learn some of the basics of teaching before you start. On-the-job training is simply not an efficient way to learn to teach. If at all possible, take a course or sign up for either a national teaching workshop (such as the ASEE NETI) or a local workshop at your school. If you have already taught, sign up anyway. Although you cannot redo mistakes already made, the previous teaching experience will make the teaching workshop more meaningful.

Second, learn the techniques of time management and efficiency which are applicable to all parts of your job and your life. Become familiar with concepts such as missions, goals, priorities, to-do lists, calendars, prime time, saying no, controlling procrastination, efficient methods for handling mail, and the tyranny of the urgent.^{1,2} Apply these methods to your academic position,³ paying special attention to efficient teaching.⁴ If you are still in graduate school or work with graduate students, Peters' book⁵ is good despite his somewhat cynical attitude. If you feel overworked and lonely, realize most assistant professors feel the same way.⁶

II. Efficient Teaching Methods

Course Development. Arrange to teach the same course three or four times in succession. The first-time course is often a mad-scramble to stay ahead of the students. The second time around offers an opportunity to fix most things. The third time is often the best since only fine tuning is needed. In these later offerings you will do a better job teaching the course while spending less time. Beyond the third or fourth time you may start to become bored with the course, and it may be time to move on.

Designing a course is basically an engineering design problem. First, gather information. What is the purpose of the course? The purpose of a required undergraduate course is obviously very different than the purpose of an elective. Obtain several old outlines and syllabi. Talk to those professors who have taught the course and those who teach prerequisite courses to see what you can expect the students to know (but cut rosy comments based on "coverage" in half). Talk to professors who teach follow-up courses to determine what students *must* learn in your course.

Then develop your tentative outline from these outlines and ideas. Plan to spend one or two periods at the beginning of the semester on material the students are supposed to already know, and plan one period before every major test to catch up and review. Cover *less*, not more, than in the previous outlines. Since many students only work when there are assignments or tests, there needs to be something for the students to do at least every other week, and preferably more often. For freshman and sophomores you may want as many as seven tests during the semester.

The syllabus is a contract with the students. Find a good one - that means longer than you would expect - and copy it with appropriate modifications for your course. Be explicit about rules and regulations. The students will not know what you expect until you tell them, and even then some students will claim ignorance. It is much easier and more effective if you start with firm and perhaps even tough rules, and then relax later. Never try the reverse!

If you get to pick the textbook, either use one that has worked well at your school in the past or one with which you are familiar. Consider this adoption of the textbook to be a trial run. If the students don't like the book, change it before you teach the course a second time. But, don't disparage the text during the course. If you do, the students will wonder why *you* made them buy a lousy book.

Shortly after the first test, pass out index cards and ask students what you can do to help them learn more. Collate the responses and make some changes to improve the course. A course headed for disaster can be turned around by such midcourse corrections based on this formative evaluation. Letting students have input into test dates and due dates of projects also reinforces your willingness to listen--and will be greatly appreciated.

At the end of the semester ask for student evaluations and reflectively analyze the success of the course. Plan what you will change for the next offering while the pain of any failures is sharp. The formative and summative evaluations provide the feedback needed to improve our engineering design.

Lectures. For a brief moment in pedagogical time--the first time a course is taught--lecturing is the most efficient teaching method because lectures can be prepared immediately before class. Other teaching techniques may require a much more detailed course outline and significantly more preparation before the semester starts. In subsequent offerings try modifying the lecture approach or try other teaching approaches such as cooperative group techniques.

Assuming that you know the material, prepare new lectures in two or at most three hours per lecture hour. Repeat lectures can be prepared in one half to one hour. Trying to prepare in less time is obviously dangerous. But many new faculty spend significantly more time than this without improving their lectures significantly.⁶

The maximum attention span of an audience, whether student or "adult," is 15 to 20 minutes. Since students have to pay attention to learn, arrange the standard 50 minute lecture hour as follows:

- Introduction and very short review
- Mini-lecture
- Lecture break
- Mini-lecture
- Summary and brief comment about next class.

Good lecture breaks include active learning exercises such as small group discussion, small group problem solving, brainstorming, or student introductions. Since the limited attention span of the audience forces you to put in breaks, it is necessary to cover less material. But the breaks allow the students to do in-depth processing which increases their learning.

Choreograph your lecture notes. In addition to content, include stage directions. Remind yourself of when to walk into the audience and when to make a dramatic gesture. List questions, both rhetorical and real. Include the location of lecture breaks and the details of the activity. If a particular analogy works well, record it so that you can use it again.

Work at becoming comfortable while lecturing. If you are uncomfortable the students will be uncomfortable, regardless of how well prepared you are. Try to act naturally and work to overcome the anxiety which all new teachers feel.

The second time you teach the course try the following advanced lecture technique during part of the semester. Make up partial lecture transparencies using a word processing program or presentation software such as Powerpoint. Include most of the material needed for the transparency but skip key points which the students will have to fill in during the lecture. Then give copies of these notes to the students. This procedure will eliminate many of the errors of note taking and give the students time to think, but still require them to pay attention. You can cover more material without sacrificing student understanding.

Tests. Students believe tests and grades are the most important part of a course. Write new tests every term. Students actually appreciate it if the professor uses old tests as

homework since then everyone in the class gets to see the old tests, not just the students with access to files.

Create a file of possible test problems as you teach. These can be variants of homework problems, problems sparked by student misunderstandings, ideas from other professors, and so forth. Then when you start to write the test you will have several potential problems which can be fleshed out. Solve the test completely before using it. If you don't, you will pay sometime during the semester. And a test with an unsolvable problem is a disaster.

Record how long it takes you to solve the test. Freshmen and sophomores will need about five times as long, juniors about four times as long, and seniors about three times as long. If possible, have the teaching assistant or another professor solve the printed form of the test. Discussing testing procedures in class thoroughly before the first test will help reduce test anxiety. The common policy of giving tests when the professor is out of town is bad policy. Be present for the test since you can fix any last minute errors or problems better than anyone else. In addition, there is less cheating when the professor is present. If at least half the class is unable to finish the test on time, the test is too long. Tests which are too long confound speed with knowledge and do not do a good job discriminating those who know the material but are slow from those who are fast but do not know the material. Speed is much less important in industry.

Prepare a solution key with partial credit to ensure that scoring is uniform whether the professor or TAs score the tests. Try grading problems by both subtracting points for errors and adding points for correct parts of the solutions. These two approaches should, but often do not, give the same results. Show the TAs how you want them to score problems and ask to see any solutions which differ radically from the approach used on the solution key. A spreadsheet can be useful to check whether the student made a fundamental mistake or an arithmetic one. For reasons of consistency, one person should do all of the grading of one problem.

Requiring written requests will reduce the hassle of regrades. It is also another way of ensuring that grading is fair.

Rapport and Attention to Students. Students want and deserve individual attention. They are very tolerant of fumbling in the lecture if you are available outside of class and the students believe you care about them. Starting with the right attitude involves believing that your students are intelligent and can learn if they decide to do so. Although the average engineering undergraduate may not be as smart as your peers in graduate school, he or she is among the best undergraduates at your school. And the sheer technical competence so admired by professors is less important for success in industry than motivation, hard work, communication skills and the ability to work with diverse people. Look for the best in your students, and you will probably find it. Professors with a good attitude usually end up with students with good attitudes.

Second, learn every student's name; otherwise, they will feel like numbers. And numbers are much more likely to skip class, be disruptive, not do the work and cheat

than real people with names. Of course, learning names in large classes is difficult. Photograph every student and then study the photographs before class (digital cameras make this process simple and even allow you to incorporate the photographs directly into your grade or evaluation sheets for your students). Anything you know beyond their name such as their home town or career goals will help you gain rapport.

Since availability and attention require significant time, the demands of efficiency and effectiveness compete. A reasonable compromise is to hold scheduled group help sessions particularly before tests and a modest number of scheduled office hours weekly. Be available for your office hours--it is impossible to overstress this dictum. If you have teaching assistants have them hold office hours also. Since the teaching assistants are likely to explain things differently than you do, this provides another opportunity for the students to learn.

One almost magical and efficient method to develop rapport with students is to come to class five minutes early and stay five minutes after class. In addition to giving you a chance to correct any problems in the classroom, such as erasing a filled blackboard, coming early allows you to chat with students and sends the signal that you are looking forward to this class. Staying late is a prime time to answer questions. The combination of coming early and staying late provides some individual attention particularly for students who will not use office hours.

If you treat students as adults, most of them will act accordingly. Students, particularly seniors and part-time students, are often very busy. Although they will try to juggle their many responsibilities, occasionally something legitimate will prevent them from turning in an assignment or taking a test on time. Be flexible, but require the students to be responsible and inform you in advance if possible. A few students may take advantage of your generosity. It will usually be clear when this has happened and you can make sure it does not happen a second time.

III. Improvement and Growth

Master teachers may be born, not made; but good, efficient teaching is a learned skill. Sign up for a teaching workshop. Study good teaching methods and then try them. After each class sit down and determine what worked and what didn't, making notes so that you can improve the course next time. Find someone in your department who you can discuss teaching with on a regular basis. Try new techniques and determine which worked. Continual experimentation with teaching methods helps to prevent boredom and burnout which can be major problems later in your career. And such experimentation will probably be interpreted as attention by the students (this is the Hawthorne effect).

Bibliography

1. Covey, S. R., *The Seven Habits of Highly Effective People*, Simon and Schuster, New York, 1989.
2. Lakein, A., *How to Get Control of Your Time and Your Life*, Signet Books, New York, 1973.
3. Kelly, V. M., "Time Out for Some Timely Advice," *ASEE PRISM*, 30-33 (Sept., 1995).

4. Wankat, P. C. and Oreovicz, F. S., *Teaching Engineering*, McGraw-Hill, New York, Chapter 2, 1993.
[Out of print. Will be available free on ASEE web site on teaching engineering.]
5. Peters, R. L., *Getting What you Came For: The Smart Student's Guide to Earning a Master's or a PhD*, The Noonday Press, New York, 1992.
6. Boice, R. *The New Faculty Member*, Jossey-Bass, San Francisco, 1992.

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