

AC 2007-434: SUCCESSFUL METHODS AND TECHNIQUES FOR EFFECTIVE TEACHING AND CLASS MANAGEMENT

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Successful Methods and Techniques for Effective Teaching and Class Management

Abstract

This paper describes the author's methods and techniques for effective teaching and class management, which can be considered successful due to the consistently positive feedback which the author has received from students. While the information provided in this paper certainly is applicable to new faculty, these principles also can be utilized by more experienced faculty.

From the author's experience, the majority of students wish to learn the material and are willing to work. It is critical that the professor prevent students from becoming frustrated and discouraged because of their perceptions regarding areas such as professor indifference, lack of course focus and organization, and unfair grading procedures. This especially is important for laboratory courses, for which the author has had extensive experience in teaching.

The governing principles which form the basis of the author's methods for effective teaching are discussed. Additional topics covered in this paper include using lecture time effectively, conducting a laboratory course, administering assignments and exams, and grading consistently and fairly. The effective use of helpers such as homework graders and laboratory teaching assistants is discussed. The author also addresses the use of technology for teaching, specifically warning about becoming overly reliant on such technology.

Introduction

In today's university environment, much is expected from professors regarding the education of students. One primary duty and responsibility of the university professor is to teach effectively. Specifically, the engineering professor is to train and evaluate the progress of those students who will be designing the products and conducting the research for the continued development of society and technology. The author has learned that most students genuinely appreciate instructors who make sincere efforts to fulfill this responsibility to educate them. This information is presented by the author under the core belief that it is a privilege to serve the university and society as a professor.

It is the author's belief that most engineering professors, especially the new professors, wish to teach their classes well. This paper is intended to provide advice to new engineering educators regarding the methods and techniques for effective teaching and class management which the author has used as a professor in Mechanical Engineering at Bradley University since Fall 1997. These principles also can be utilized by more experienced faculty. The advice provided in this paper, while confirming principles and practices described in previous literature, provides new insights and ideas as well. These methods and techniques can be considered successful due to the consistently positive feedback which the author has received from students. Two examples of this positive feedback are the author's inclusion in the 7th edition of Who's Who Among America's Teachers (May 2002) and the author's nomination for the Bradley University Parents' Association Award (April 2002). Both of these honors are student-initiated.

The remainder of the paper is organized as follows. The author's teaching experience is described, both as a graduate student and as a professor. The governing principles which form the basis of the author's philosophy and methods for effective teaching are discussed. The effective use of lecture time is discussed, including thoughts about the use of technology. Principles for conducting laboratory sessions, assigning homework, and administering exams are provided. Principles and procedures for grading fairly, and the effective use of assistants such as homework graders and laboratory teaching assistants are provided.

Author's Teaching Experience

The origin of the author's interest and passion for teaching can be attributed to his experiences as a graduate student in Mechanical Engineering at the University of Illinois at Urbana-Champaign, as indicated in the following Table 1. The author's observations and discussions with professors during his ten semesters as a Laboratory Teaching Assistant, in addition to his experience as Lecturer of the junior-level System Dynamics course, had helped him to start developing his Teaching philosophy and methods even before becoming a professor.

Course	Student level	Duties	Remarks
System Dynamics (10 semesters)	Juniors	Laboratory TA (also helped with grading homeworks and exams)	Named to the University List of Best TA's for each semester
System Dynamics (1 semester)	Juniors	Lecturer	Recipient of Teaching Fellowship, given to Ph.D. student who demonstrates exceptional potential to be University Professor

Table 1 Author's Teaching Experience as Graduate Student

Next, the author's teaching experience as a professor is provided in Table 2. The typical Mechanical Engineering class size at Bradley University is 25-35 students. As can be seen from the information provided in Table 1 and Table 2, the author has had extensive teaching experience as a graduate student and as a professor. His teaching experiences have focused on junior-level, senior-level, and graduate students, and these experiences are for both lecture-only courses and laboratory-based courses.

Course	Student level	Remarks
Measurement and Instrumentation (17 semesters)	Juniors	Laboratory course
Mechanical Lab (4 semesters)	Juniors	Laboratory course
Engineering System Dynamics (4 semesters)	Juniors	Lecture course
Mechanical Control Systems (8 semesters)	Juniors/Seniors	Lecture course
Fluid Power Control (3 semesters)	Seniors/Graduate Students	Lecture course
Advanced Mechanical Control Systems (2 semesters and 1 summer)	Seniors/Graduate Students	Lecture course

Table 2 Author's Teaching Experience as Professor

Governing Principles for Effective Teaching

This section contains the governing principles on which is based the author's philosophy and methods for effective teaching. These governing principles are based on the author's teaching experiences at two different institutions, i.e. as a graduate student and as a professor. These governing principles are presented in the context of what has received positive feedback from students.

First, students genuinely appreciate instructors who make sincere efforts to teach the material well. The author strongly believes that most students wish to learn the material and are willing to do the assigned work. At the author's university the engineering students place a high priority on attending class, which confirms their desire to try to learn the material. In particular, engineering students typically have chosen their discipline due to their interest in science and math and "how things work." As a side note, the author strongly believes that those engineering

students who demonstrate little interest in learning this engineering material must be encouraged to discover what does excite them. Professors are doing such students a disservice by allowing them merely to pass through the engineering program with minimal grades and enthusiasm. The best-case result is that such students will work in jobs which they truly dislike, while the worst-case scenario is that such ill-prepared and unenthusiastic engineers will design incorrect and potentially dangerous products.

Second, students genuinely appreciate instructors who make sincere efforts to fairly judge their understanding and achievement through assignments and exams. Most students understandably are very concerned about their grade for the particular course. There is nothing wrong with the instructor using that concern to motivate the students to perform the assignments. The specifics of the author's grading policies are described in more detail in a later section. The author has a policy of not curving grades for assignments and for the final grade. Hence, a student must have a cumulative grade above 90% for "A," above 80% for "B," etc. At the start of the semester, the author explicitly informs the class about this "no-curve" policy, in order to establish the expected level of achievement and understanding. The grade distribution for all of the author's courses listed in Table 2 typically ends up with the majority of students in the "B" range, and the highest-achieving students get "A" grades. The author confirms that it is possible to challenge the students and still get this type of grade distribution.¹ Students who are willing to work hard and who have the ability should do well on the assignments and exams. Students are less inclined to complain about a course being unfair if they know that some of their classmates are doing well on the assignments and the exams.

Third, students genuinely appreciate instructors who make sincere efforts to respect their time, and scheduling constraints, in the midst of assigning such challenging assignments for a particular course. The students' responses to class meetings (lectures, lab sessions, etc.) are most positive when they are convinced that this time has been utilized wisely, i.e. to help them learn the material and to help them complete each assignment. The students' responses to the various assignments (homework, lab reports, class projects, exams, etc.) are most positive when they are convinced of each assignment's worthiness for helping them to learn and master the material. Typically, the author requires one assignment per week (homework, lab report, etc.) and provides students at least one week (i.e. 7 days) to complete each assignment. The students are responsible for budgeting their time and efforts to complete each assignment. Some instructors prefer to use smaller assignments throughout each week, but this policy may force students to spend an excessive amount of time on the particular course.

Regarding this third principle, the instructor must be organized for the sake of both the instructor and for the students. The author has learned that pre-semester preparation is critical for helping the particular course to progress as smoothly and effectively as possible. In fact, the author tries to devote the one-week/two-week period before the semester begins to course preparation. Also, this high level of organization can enable the instructor to require just one comprehensive assignment each week. As another example, this level of organization can enable the instructor to avoid trying to "squeeze in" too many topics and assignments at the end of the semester. The author develops a Master e-mail address list for each course, as a way to directly inform the students of any announcements and reminders. This capability especially can be important for laboratory-based courses because of possible room and/or time changes.

Fourth, students genuinely appreciate instructors who make sincere efforts to act as mentors in addition to teachers. A first key step is to try to learn the students' names and other related information as quickly as possible.²⁻³ On the first day of each class, the author asks each student to fill out a short form to provide the following information: Name, E-mail address, Phone number, and "Interesting experiences." For his lab classes, the author also gets the chance to know the students better from attending the lab sessions (10-12 students per session). The author has learned that students respond positively to instructors who know them by name. This policy also gives students incentive to try their best (or at least give more effort) in the particular course because they know that they cannot submit their work anonymously. Because the author's teaching experience has been with juniors, seniors, and graduate students, the author enjoys asking students periodically about their future plans as well. One regular mentoring opportunity which the author schedules each semester is an informational session about graduate school (engineering, business, etc.). The purpose of this informational session is to provide students the opportunity to hear from engineering professors about their graduate school experiences and to ask questions.

Lectures

For engineering courses and for university courses in general, the lecture still is the primary method of instruction. This section contains the author's thoughts and observations regarding lecture preparation and effective use of the lecture period.

As discussed previously, proper and sufficient preparation is needed for effective course management, and this principle certainly applies to lectures. One simple technique which the author uses is to create a "Lecture Cover Sheet" for each lecture which provides the following information:

- 1) Outline of topics to be covered in that day's lecture
- 2) Announcements/reminders of deadlines of upcoming assignments
- 3) Any other important announcements (e.g. changed meeting times for lab sections)

One practice which the author strongly endorses is arriving at the lecture room at least 5 minutes early (preferably 10 minutes early).⁴ The first task can be checking whatever that all audio-visual equipment is functioning properly (e.g. computer, video monitor, overhead projector). Before each lecture, the author writes on the board the items from the forementioned "Lecture Cover Sheet." The first thing the author does for each lecture is review this information with the students. The author has learned that students appreciate having this information discussed at the start of lecture, such as the topics to be covered during that lecture.

The author's emphasis on arriving early for each lecture has additional benefits. For one, this early arrival allows the instructor to avoid being rushed to start upon entering the classroom. Another benefit is that early in the course the students learn that each class will begin on time, so they must be prompt to avoid missing material and thereby falling behind.

Regarding the lecture itself, the author predominantly uses the classic "chalk on blackboard" method. Whenever possible, the author tries to engage the students in an active mode, e.g.

sketching/drawing a Bode plot on the provided handout as the instructor is drawing it on the transparency. Of course, instructors now have numerous technology options for teaching in class. The author has used media such as PowerPoint presentations, videotapes, and video clips as supplemental aides, but never for more than 10-15 minutes at a time.

The author strongly discourages the exclusive and/or extensive use of PowerPoint during lectures, especially if this removes each student's responsibility to participate actively in the lecture via note-taking. The author has received consistent feedback from students that those lectures which rely exclusively on PowerPoint presentations can be tedious due to the removal of each student's active role in taking notes during lecture. In addition, students appreciate the opportunity to have their personal class notes available for completing assignments and for preparing for exams. Another drawback of the exclusive use of PowerPoint during lecture is that students may be more tempted to skip lecture, in particular if the instructor makes the PowerPoint presentations available to the students afterwards.

Laboratory Sessions

As indicated previously in Table 1 and Table 2, the author has had extensive experience teaching laboratory courses. As a graduate student, the author has coordinated and taught lab sessions under the guidance of the course professor. As a professor, the author has taught lab courses which have two to four lab sections with at most twelve students each. The author typically works with one or two graduate assistants, depending on the size of the class. The author expects these graduate assistants to help with the lab sessions and to grade the lab reports thoroughly.

Under such circumstances, the key practice which the author strongly recommends is that the professor attend every lab session.⁵ Acting on the maxim that "an ounce of prevention is worth a pound of cure," the author makes sure to check the students' data before they leave the lab. The intention is to make sure that their data is at least acceptable for them to complete the laboratory assignment. The professor's attendance of each lab session provides additional opportunities to learn the students' names and to mentor them further.

Of course, attending every lab session may not be feasible or even possible for a professor teaching a larger lab course which has numerous lab sections. In this case, the professor needs to rely more heavily on the graduate assistants to perform these duties. Still, in this situation the professor should verify that the lab sessions are being run effectively.

Homework Assignments

For engineering courses, with or without laboratory components, homework assignments (i.e. "problem sets") traditionally have been used to provide students with the opportunity to use the concepts and principles which have been discussed in class. This section contains the author's thoughts and observations regarding the effective use of homework assignments.

The author's philosophy concerning the relationship between lecture material and homework is that the lecture material should guide the students towards being able to understand and solve the homework problems. The author's typical homework assignments are a combination of textbook

questions and self-made questions. The students quickly realize that attending lecture faithfully will help them to complete the assignments and to learn the required material.

As stated previously, the author has a policy of not curving grades for assignments. Regarding homework, a key principle for maintaining this policy is to provide students with homework assignments which are challenging but can be completed, at least by the hardest-working and best students. One way to accomplish this goal, and to encourage students, is to provide some answers in the homework assignments. This allows the students to develop confidence in their work, and to review their work if their initial answer is incorrect. For example, the first homework assignments in the Dynamics and Controls courses typically focus on math review topics such as complex numbers and differential equations. Students have responded positively to the provisions of some of these answers with helping them master these fundamental math topics, with the understanding that the instructor subsequently expects them to be able to solve such problems in the future.

Exams

For engineering courses, exams traditionally have been used to provide students with the opportunity to demonstrate their mastery of the course material. This section contains the author's thoughts and observations regarding the effective use and administration of exams.

The author strongly believes that exams must be used to fairly measure each student's mastery of the material as presented in lecture and as practiced in the assignments. The author's policy of not curving grades is reflected in the exams as well, in terms of exam format, content, and length. The author's goal is to administer exams to students which are challenging but are reasonable, at least for the hardest-working and best students.

One key principle is to provide the students clear information about what information they are expected to know for the exam (e.g. specific homework assignments, material from lecture). Specifically, the author will write this information on the board and discuss it with the students during lecture. Another way to help the students prepare for the exam is to provide them with the questions from the corresponding exam for that course from the previous semester. The reality is that students can gain access to previous exams through various means, so this provision of the previous semester's questions provides each student with the same opportunity to benefit potentially from such information. Some instructors deal with this issue by not allowing students to keep their exams, but the author feels that allowing students to keep each exam helps them to learn and review the material.

Another key principle is to allow the students sufficient access to information during the exam itself. For each course, the author allows students to prepare one side of the 8.5"x11" sheet of paper, on which they can write formulas, derivations, even worked-out problems from the various assignments of that semester. This allows them to include more information than on just a 3" x 5" index card. This policy has several benefits: it forces the students to decide what to put on their help sheet, it allows the instructor to ask tougher exam questions, and it permits the instructor to be more strict regarding partial credit. Each student must submit this sheet with the

exam. Each sheet is checked for any irregularities, and the author returns the sheet to each student after the exam has been graded.

Another key principle is to provide the students sufficient time (within reason) to complete the exam, and to inform them of this policy beforehand. This may require re-scheduling the exam to an evening. Typically, the author allows the students to spend up to 2 hours on the exam, instead of just the 50-75 minutes allotted for the typical class period. This policy provides the students the best opportunity to demonstrate their mastery of the material within a reasonable time constraint. For example, it is quite possible that even the best students may not approach a given exam question correctly at first, so they need time to correct this mistake. Every professor should try to avoid the situation where students, due to time pressures, are just writing formulas and other such information for each exam question just to receive some partial credit. This policy regarding extra time also allows the instructor to spend time before the exam reading through each question, so any initial confusion can be removed.

Another key principle is to for the instructor to be present at the exam itself. The author truly feels that this is very important, especially if students need to ask something about a particular question, i.e. the instructor certainly is the best person to answer such questions.

Consider the following schedule from the Spring 2006 semester regarding the first Exam for the author's undergraduate Mechanical Control Systems course, which meets on Mondays and Wednesdays for 75 minutes per meeting:

- a) Wednesday, March 1st
 - Students are given information regarding Exam 1
 - Students are provided questions from Exam 1 from previous semester
 - Regular lecture is resumed
- b) Monday, March 6th
 - Focus of this class is review of material (based on their questions) and discussion of the Exam 1 questions from previous semester
- c) Wednesday, March 8th
 - Exam 1 is given during class, with extra time being provided

Grading

Most students understandably are very concerned about their grade for the particular course. As stated previously, students genuinely appreciate instructors who make sincere efforts to fairly judge their understanding and achievement through assignments and exams.

The author strongly believes that all student work (homeworks, lab reports, exams, etc.) should be graded fairly and promptly. This fair and prompt feedback especially is important during the

first few weeks of the course, because the students must have feedback regarding their performance and their mastery of material.²

A fundamental principle is that each student's grade must reflect what the instructor would have given without grading assistance, and the students must be made aware that the instructor considers this to be of highest importance. This serves two purposes. For one, it encourages students that they can expect their work to be graded fairly and completely. Also, it warns students that they will not be able to depend on simply passing through the class due to a grader who is not receiving much (if any) input from the instructor.

Hence, it is the instructor's responsibility to determine explicitly how the assignments should be graded. This is obvious if the instructor must grade the entire assignment without assistance. For those situations where the instructor is receiving grading assistance, the instructor must provide explicit guidelines and ideally some graded assignments as examples at the start of the process. Then, before returning assignments to the students, the instructor should check the grading of each student's assignment. One benefit of doing this is that the instructor can learn if many students are struggling with a particular question or concept. The instructor then can address this during lecture. Procedures and guidelines for situations with and without grading assistance are provided next.

Procedure 1 - Grading student work which will be given to a grader and/or TA:

Benefits and strategies regarding the effective use of a TA/grader have been discussed in previous literature⁶, but the following procedure enables the instructor to be further pro-active in the grading.

- 1) Obtain solutions
 - Of course, a solutions manual can be used when appropriate. Also, some solutions can be obtained from a student's correct assignment.
- 2) Determine point breakdown for each question/part. Again, this is the responsibility of the instructor, not of the grader.
- 3) Grade a few assignments for a range of students, and provide some explanation about why points have been deducted
- 4) Give assignments to graders.
 - Be explicit about the deadline for having the assignments graded.
 - For large assignments or assignments which must be graded quickly, it often helps to give advance warning to the graders that the particular assignment must be graded by a certain day. Hence, it is the graders' responsibility to organize their schedule to complete the grading by the deadline.

- 5) After receiving assignments from graders, look through assignments
 - Add/subtract points where needed, especially for the first few assignments
- 6) Record grades in Excel spreadsheet.
 - The author always records the grades himself, in order to monitor the overall class understanding of the material and to see if any students are struggling or perhaps not doing the assignments at all.
- 7) Return assignments to students at the end of the next lecture
 - The author always returns the assignments to the students individually

Procedure 2 - Grading student work without grading assistance:

- 1) Obtain the solutions
 - Again, the solutions manual and perhaps a student's correct solution can be used.
- 2) Determine the point breakdown for each question/part
- 3) Do the "First Pass" for everyone's assignment⁶
 - Determine what sections are correct
 - Determine which sections are wrong, and to what extent
- 4) Assign partial credit "one question at a time"
 - e.g. finish grading everyone's Question 1 first
- 5) Record grades in Excel spreadsheet
- 6) Return assignments to students at the end of the next lecture

The author confirms that often it is best to grade assignments "one question at a time."⁶ One advantage of this method is that the particular question remains fresh in the mind of instructor or grader for each student's assignment. Another advantage of this method is that the grading process can be interrupted or even stopped for the day after that particular question has been graded for each student, without compromising the fairness of the grading procedure.

As a final note, the author has learned that usually the most difficult part of grading assignments and/or preparing assignments for the grader is "getting the process started." Whenever possible, the author tries to begin the process as soon as possible after receiving the assignments from the students. Another possibility is for the instructor to begin preparing for the grading process soon after giving the assignment to the students, by working on items such as solutions and grading

guidelines even before students hand in the assignments. This can be critical for situations where the assignments need to be graded within a short amount of time.

Conclusion

This paper has described the methods and techniques for effective teaching and class management which the author has utilized in his classes at Bradley University. The information presented in this paper is applicable to new faculty and more experienced faculty. The author's four governing principles for effective teaching and course administration have been presented. This paper has described the author's philosophies and techniques regarding lectures, lab sessions, homework assignments, and exams. The author's techniques for grading have been presented, both for situations with and without grading assistance. This information has been presented by the author under the core belief that serving the university and society as a professor truly is a privilege, and the author has learned that most students genuinely appreciate instructors who make sincere efforts to fulfill the responsibility to educate them.

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