Teaching Teachers to Teach Engineering

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Abstract

A few are born to be great artists, musicians, scientists, engineers and the myriad other vocations, but considering the numbers teaching engineering in the United States some significant number were probably not "born" teachers. The short course described in this paper has been developed to help engineering faculty improve their teaching. Topics addressed in the short course include preparation, presentation, self-critique, learning models, and different forms of teaching. Additional topics in the areas of teacher-student relations, ethics, tenure/promotion and time management are also addressed. Participants will prepare and present classes, be critiqued, and critique others. They are also expected to interact with faculty at their home institution to improve the teaching of others.

The short course has at its roots a teacher training program that has been ongoing at West Point since the 1940's. The paper will briefly discuss this highly successful program and its relation to the planned short course. In addition to the authors, the latter two who have for many years run the aforementioned teacher training program, other West Point faculty, and faculty from other universities and institutions, will be involved in the planned short course. People who are both respected teachers and experienced in sponsored research, or administration, or learning models and student development, or some combination of the above, will be cooperating on this endeavor.

The first offering of the short course is scheduled for July, 1996. Funding to support the program is being provided under a grant from the National Science Foundation.

Introduction

It may be that truly great teachers are born teachers, and would gain little from a program aimed at teaching teachers to teach, but for the rest of us such a program has many potential benefits. Probably the only aspect of teaching that cannot be improved with some instruction and practice is the heart-felt desire to educate, or convey knowledge, to one's students. The pleasure gained from successfully conveying knowledge, and the pleasure gained from the personal learning that goes along with conveying knowledge, come naturally to those who have a place in the classroom.

The need for teacher training is well documented and recognized by all involved. The mere fact that this paper is being presented and that the short course is being supported by the National Science Foundation (NSF), document the recognition of the engineering faculty. Student recognition is also quite clear as demonstrated by their own words. In her award winning essay submitted to the Association of General Contractors Education and Research Foundation, Barbara Biernat, then of Purdue University-Calumet, expresses her concerns[1]:

" The professor should be judged by the quality of his product -- the student's ability to compete in a global market upon graduation. If the professor fails to produce, there should be a system of retraining or accountability in place to make him productive.

The letters after the professors name are meaningless if he is unable to effectively communicate knowledge to the student. I don't expect every professor to be a spell-binding lecturer complete with entertaining visual aids; but I do expect him to be able to present a body of material in a logical sequence, according to a plan, designed to be comprehensible. This is, quite often, not the classroom experience. The student has the right to expect some semblance of even-exchange for his time and tuition dollars. "

These words have been echoed many times, by other students[2], and probably by yourself at some point during your formal education.

The teacher training program described herein, that will be offered for the first time in July 1996, has at its roots the annual Instructor Summer Workshop (ISW) in the Department of Civil & Mechanical Engineering at the United States Military Academy at West Point, NY. ISW is a 6-week program in which new instructors are trained to be effective teachers. The current ISW has evolved through some 40 years of offerings, and based on participant evaluations, and student evaluations of the faculty who have gone through the program, the program has been very successful. Participants repeatedly state that the program gave them the poise and confidence necessary to teach effectively in their very first class, and provided them a basis on which to personalize and refine their teaching style. Students consistently rate the faculty in the department as being above average, if not outstanding, in an institution where teaching is considered to be the faculty's primary responsibility, and where many departments provide training for their incoming faculty.

Teacher training is such an issue at West Point because the majority of the faculty are on a 3 year tour of duty. In the Department of Civil & Mechanical Engineering every year, some 25 percent of our faculty are teaching for the first time. With this many new instructors coming on board every year, they cannot be left to develop their teaching on their own if the Academy's intent is to provide its students with the best education possible.

Several factors led the authors to seek funding for a modified version of ISW to be offered to faculty from other institutions. First is the success of the ISW participants - it is clearly a program that works. Second was the recognition that most institutions do not have such a teacher training program, nor were any training programs identified in which the participants actually practiced teaching. Third was the favorable reviews ISW received from Visiting faculty in the department, and finally, was the favorable reaction to a shortened version of the program that has been given to the civilian faculty that are joining the department as part of the civilianization of USMA. The content and format of the developed 1-week course, that is in essence a 1-week version of ISW, and that is clearly focused on the teacher, will now be described.

Content of the Teacher Training Program

As noted previously, the developed teacher training program is modeled after a 6-week instructor workshop for new faculty in the Department of Civil & Mechanical Engineering at USMA. The basic tenet of that course is prepare each new instructor to:

> *Motivate each student to learn by providing an appropriate mental and physical environment; organize and convey the subject material with enthusiasm and absolute accuracy; demonstrate sincere interest in the individual performance and development of each student.*

With that in mind, the department promotes three elements of effective instruction to new instructors during its summer workshops. Each of these elements contributes to the goal of teaching excellence and contributes to creating an environment within which an engineering student is motivated to learn. These critical elements include:

Instructor knowledge. The teacher must be the master of the subject and must have sufficient in-depth knowledge to relate engineering theory to real world applications.

Instructor organization. Good instruction is characterized by logical presentations that convey material in a clear and comprehensible manner.

Instructor enthusiasm. Enthusiasm and excitement are contagious and can be transferred to students, motivating and inspiring them to pursue academic achievement. This transfer requires that an instructor maintain positive contact with his/her students throughout a lesson. Physical and mental contact skills are a critical element of good instruction -- and can be taught.

This is the foundation on which the 1-week short course has been built. Much of what filled out the 6 weeks in ISW was specifically related to USMA and the Department. The only major feature of ISW that cannot be duplicated in a 1-week time frame is the number of classes the participants will teach. But it is just that, the fact that the participants will be teaching, and be critiqued on their teaching, that distinguishes this program from any other that the authors have heard of. It is the authors' belief that only through actual practice teaching will the participants make real improvement in their teaching. Each participant will teach 3 full 50 minute classes and 1 or 2 mini-classes lasting 10 or 15 minutes each.

It is expected that the participants in the 1-week short course will be subject matter experts as most of them will have completed Ph.D. studies or will have significant work experience, and will be teaching undergraduate courses specific to their respective area of expertise. On the other hand, it is expected that the importance of being a true subject matter expert will be made clear to most of them as the "students" in their practice classes look for clarity and relevance in their presentation.

Relevance will be looked at from two points of view. Not only should a course be relevant to future experiences of the student outside of academia, but courses should also be relevant to the rest of the students' studies. Although difficult to achieve in such a short period of time, the importance of tying classes together within a course, and tying courses together within a curriculum will be addressed as part of presenting a well organized class.

Enthusiasm will be demonstrated to the participants through example "veteran" classes given by the authors and the other faculty in the short course. Being enthusiastic is one of the main criteria for keeping students involved. It is also a key element in providing an atmosphere in the classroom that is conducive to learning. Keeping the students involved in the class will be a major focus of each class critique.

Presenting material in a logical and clear fashion is also critical to keeping students involved. Good presentations hinge on adequate preparation, but also good voice modulation and diction, clear board work, and proper use of training aids and new technologies. Each of these topics will be addressed in each practice class, and will also be discussed in a workshop format.

In addition to the practice classes, 5 workshops have been planned that address the mechanics of preparing a good course and presenting good classes, the use of new technologies, learning models and the teaching-learning connection, and all of those other things faculty do when they are not in the classroom. To enhance the viability of these workshops, subject matter experts will be brought in. It is anticipated that most of these additional faculty will also role-play as students in practice classes throughout the week.

More details of the short course and its actual format are presented in the next section.

Short Course Overview and Format

The short course description being provided here is an edited version of what was included in the NSF proposal and is subject to modification. Mainly, the authors anticipate making some minor changes based upon initial meetings with the additional faculty to be recruited for the program.

Short Course Overview

Sunday

- Welcome
- Introduction of all participants (faculty and students)
- Discussion of distributed material
- Outline of the week's activities
- Group assignments
- Veteran Class (ice breaker and demonstration of the teaching techniques participants will encounter)

Monday Morning

- Groups assemble in classrooms. Each group consists of 4 students, 1 faculty member, 1 USMA participant in ISW and possibly another faculty member or ISW person. Each student gives a 50-minute class followed by a 25-minute discussion/critique. The topic of the class is open; students will know of this requirement prior to arriving at the workshop. It must be an undergraduate class, not a conference presentation. This, and the other student classes, will be video taped to document progress.

Monday Afternoon

- The 6 groups of 4 are combined into two groups of 12 for *Teaching Workshop 1* (TW - 1). This workshop focuses on the mechanics of preparing a good course and presenting good classes, including:

  Classroom Atmosphere; Board Work; Voice Modulation; Questioning Technique; Energy/Motivation; Syllabus Preparation/Content Selection; Goals and Objectives; Textbook Selection; Teacher Evaluation Instruments; Use of Audio/Visual Aids.

- Everyone is back together for a veteran class.

Tuesday Morning

- In *Teaching Workshop 2*, the students are again in two groups of 12. These workshops involve mini-classes where the points made in TW-1 are exercised. The format is meant to be flexible so that people can work on identified weaknesses. It is anticipated that each student will teach for about 15 minutes.

Tuesday Afternoon

- The group is back together for two veteran classes. The first should utilize fairly common classroom technology; that is, nothing beyond a PC hooked into an overhead projection system. Then the group moves to the Advanced Technology Classroom Laboratory for a full blown multimedia class. This should still be recognizable as an undergraduate engineering class.

Wednesday Morning

- The students give their second full class, each followed by a critique. The topic of this class will be assigned the previous day.

Wednesday Afternoon

- *Teaching Workshop 3* is meant to focus on the teaching-learning connection. Learning models and corresponding teaching/instructional methods, i.e. PSI, cooperative groups, and project oriented classes, will be discussed. Cognitive- science research would be discussed; possibly a historic perspective followed by a discussion of current advances.

Thursday Morning

- *Teaching Workshop 4* focuses on all those things that a faculty member is supposed to be doing beyond teaching. Issues to be discussed are time management, research, grantsmanship, scholarship and publishing, service activities, promotion and tenure, and maintaining a life outside of work. It is anticipated that most of the faculty would participate in this, including someone from the NSF. Beyond giving the participants the tools to teach well, they have to find the time to devote to teaching since teaching generally falls low on the importance scale in tenure and promotion reviews.

Thursday Afternoon

- Students give their third class and are asked to review their tape that evening so that they might better contribute to the closing discussion. Class topic is assigned.

Friday Morning

- *Teaching Workshop 5* focuses on faculty/student relations, especially advising, testing/grading, cheating/discipline, and some of the legal issues related to this. Some discussion about the general character of the faculty-student relationship should be helpful for new faculty.

- The program wraps up with an evaluation of the short course and dissemination of information related to post-program feedback - how helpful do they feel the program was after being in the classroom for several weeks?

Participant Selection and Program Review

Participant focus will be on faculty with relatively little teaching experience, although some experienced faculty may be recruited to provide viewpoints different than that of the workshop team. Special recruiting of under-represented groups will be undertaken. There should be both faculty and administrative commitment to teaching excellence, and as part of the application process each participant will have provided a statement of support from the applicant's department chairperson or dean.

Each applicant will submit a short two-page resume detailing educational background, teaching experience, and research interests. A brief outline of the teaching plan to be used in the coming term will be

submitted along with a course description of one undergraduate course to be taught. Each applicant must agree to participate in all activities in the workshop and the follow-up program. Participating faculty will be expected to disseminate information from this project to faculty at their home institution, and to lead efforts at the home institution in improving classroom teaching.

Evaluation of the conduct and accomplishments of the project will be performed at three levels by (1) the workshop administrator (responsibility of the P.I.'s), (2) the workshop participants, and (3) the immediate supervisors of the participants.

*Workshop Administrator Evaluation***:** The project director and staff of the program will use established target specifications as metrics of success. Progress during the short course will be assessed against these specifications. Similar evaluations will take place during the project follow-up

*Workshop Participant Evaluation***:** Participants will evaluate workshop progress during the workshop and upon completion of activities. Three questionnaires, objective and qualitative, will provide data for assessment: Faculty Comment Sheets, Faculty Evaluation Sheets, and Comments on Social/Professional Interactions. Each participant will write an evaluation of activities at the completion of the short course, followed by an update of the evaluation, six months after completion of the short course.

*Evaluation by Participant Administrator***:** An evaluation will be requested from the chairperson or dean of the faculty participant at the home institution. Project effectiveness will be explored through a number of educational metrics:

Evaluation of classroom teaching by the administrator.
Mid-term evaluation of faculty by students.
End-of-term evaluation by students.
Faculty efficiency in teaching/research.
Overall evaluation of faculty effectiveness.

The Future of the Program

ISW will go on, and will continually involve more and more civilian faculty at USMA. It is the authors' hopes that the short course described herein will also go on for at least 3 years to get to the point at which the product could be exported. Specifically, after offering the short course for 3 summers, the authors hope to then run a "train-the-trainer" program such that similar short courses could be run throughout the country, if not on most campuses, at least regionally. It is also hoped that the short course(s) foster an environment where teaching is given more importance, and faculty welcome considered feedback on their in-class performance. The authors welcome your input, and look forward to reporting on the actual workshop a year hence.

References

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COL THOMAS A. LENOX is the Director of the Civil Engineering Division in the department. He has taught courses in Statics & Dynamics, Strength of Materials, Vibration Engineering, Structural Mechanics, Structural Analysis, Matrix Structural Analysis, Design of Steel Structures, and Design of Structural Systems. COL Lenox is an active member of ASEE -- holding leadership positions in the Civil Engineering Division, the Mechanics Division, and the Middle-Atlantic Section. He has written and presented many papers on various aspects of undergraduate engineering education.