AC 2008-892: A HANDS-ON COURSE ON TEACHING ENGINEERING

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A Hands-on Course on Teaching Engineering

Introduction

Most of the training future faculty receive in graduate school focuses on the research aspects of the enterprise. The typical new faculty member has little if any opportunity to prepare for the teaching aspects of an academic career. In this paper I share my experiences in nine offerings of a graduate course on Teaching Engineering. The goal of the course is to prepare graduate students for the teaching responsibilities of a faculty position, acquaint them with learning theories, give them a chance to discuss teaching issues and give them practice preparing materials for a course they might teach someday. These materials include: Educational objectives using higher levels of Bloom's taxonomy, textbooks and other supporting material, detailed syllabus, sample 10 minute lecture, open-ended project and/or design activity, and hourly exam. In addition students develop teaching philosophy and teaching interest statements to help define themselves as teachers and for possible future job searches. One of the most successful initiatives in this highly interactive course has been the implementation of "teaching partners," who support each other through the process, providing feedback on all materials developed. In this paper, I describe this course and provide suggestions for faculty considering teaching such courses themselves.

Course history

This course had its origins in my participation in the National Effective Teaching Institute, run by Profs. Richard Felder and Jim Stice in 1994 [1]. This was an excellent introduction to many learning theories and preparation for effective course instruction. A session at an AIChE National Conference soon after that in which Philip Wankat outlined his teaching engineering course provided the incentive for the author to create her own course. I also have benefited tremendously from participations in workshops organized by the University of Michigan's Center for Research on Learning and Teaching. Center staff have also provided a few workshops to the class itself, and in later years have joined us as discussants. The course has been offered 9 times to over 230 students and over 75 auditors. Wankat and Oreovicz' textbook, Teaching Engineering [2], serves as the primary textbook for the course. It is supplemented by a number of readings available through the course website. In the rest of this paper students in the course will be referred to as "participants" to distinguish from the students in courses they might teach in the future.

Course objectives and components

The course outcomes are divided into three parts, as shown in Table 1. While Wankat and Oreovicz first address the preparation of course materials and then learning theories, I have found that starting with learning theories makes for a richer experience, as students can use this background in preparing the materials for a course they might teach in the future.

Table 1 – Teaching Engineering course outcomes

Learning theory – Describe and compare and consider implications of teaching of:

- Myers-Briggs Type Indicators and Soloman's Learning Styles
- Piaget's and Perry's theories of cognitive development
- Scientific and Kolb's learning cycle
- Maslow's theory of needs
- Bloom's Taxonomy
- Diversity of students

Preparation of course materials

- Prepare educational outcomes using higher levels of Bloom's taxonomy
- Choose a textbook or other supporting materials
- Prepare a detailed syllabus
- Prepare and present a brief lecture
- Prepare an open-ended project and/or design activity and grading criteria
- Critique and select appropriate educational software
- Prepare an hourly exam and corresponding grading scheme.

Academic job search preparation:

- Prepare teaching Philosophy and Teaching Statement

In the following section I outline how each of the outcomes is accomplished and provide tips for faculty considering teaching such a course.

Learning theory outcomes

In these sessions participants get a brief introduction into the ways students learn. We do not look at these in the depth a course in the School of Education might, rather in enough depth to allow them to prepare educational materials. Class participants use survey instruments to determine where they fall along various learning style models to help them see these from the students' perspective, and to help them learn that other people will learn differently from them, such that when they prepare course materials they need to keep all learning styles in mind and not just teach to their preferred learning style.

- Myers-Briggs Type Indicators and Soloman's Learning Styles – Participants learn about the range of personalities and the different types of teaching that can best reach different personalities. A simple Myers-Briggs instrument at www.humanmetrics.com/cgi-win/JTypes1.htm and they complete the Felder-Soloman inventory at http://www4.ncsu.edu/unity/lockers/users/f/felder/public/ILSpage.html prior to the class period. What works well is to have students sit in groups by personality type and discuss what makes a good teacher, then compare notes to emphasize the differing needs of students with different learning styles.

- Piaget's and Perry's theories of cognitive development – In the section on Piaget, participants learn about students whom they might not have seen before, who are not necessarily ready for

the level of teaching they have experienced as undergraduates. Perry's levels address the transitions that students go through the college experience, starting from thinking of the professor as the source for all knowledge to the point where the student takes more of the role of a coach. The focus here is on aiming the course at the right level based on the population of the class.

- Scientific and Kolb's learning cycle – This portion addresses the order in which material can be presented, and various ways of involving students in the material, giving students opportunities to experience the material and not merely have knowledge presented to them. Again the focus is on the needs of the students.

- Maslow's theory of needs – The focus here is on educating participants, many of whom might come from middle class backgrounds, that not all students have the luxury of making academics their primary focus, and that lack of participation or attendance in class might be due to a number of issues outside of the student's control. We also discuss the role of the faculty member in creating a community within their classroom that promotes a sense of acceptance and respect.

- Bloom's Taxonomy – Bloom's taxonomy classifies course outcomes along a range from mere memorization, through more independent learning and higher level decision making. The role of the faculty member changing depending on the level, from the "sage on the stage" at the lower levels, to the "guide on the side" at higher ones. The key is to make sure that as faculty they aim the course to the right level that challenges students to become independent learners without overwhelming them.

- Meet the needs of a diverse group of students – Through a number of panel discussions, skits, educational videotapes and workshops, participants learn about the differing experiences of women, minorities, students with learning disabilities and psychological issues, and international students in engineering. These eye-opening sessions help participants better understand the role they can play to serve the needs of diverse learners.

Preparation of course materials and implementation of teaching partners

The primary graded elements in the class are materials for a course that participants might teach in the future. The key improvement in the teaching of this portion of the class from earlier offerings is requiring students to submit drafts of these materials on the day we discussed each topic. After a brief discussion of the considerations in the development of each of these materials, participants share their drafts with their teaching partners. Teaching partners are other participants in the class who are teaching similar courses or have a similar background, such that they have a solid understanding of the course material and can provide useful feedback. Participants auditing the course are also incorporated into these discussions. Teaching partners have productive discussions within their small teams, then report back to the class as a whole, such that all benefits from the insights discussed within the small groups. Course outcomes include:

- Prepare educational outcomes using higher levels of Bloom's taxonomy - The challenge to participants is to ensure they are aiming at the right level for the expected student population,

and that objectives are measurable. ABET issues involving course outcomes and the assessment process are introduced at this point.

The following four elements are fairly self-explanatory and won't be discussed in detail:

- Choose a textbook or other supporting materials
- Prepare a detailed syllabus
- Prepare an open-ended project and/or design activity and grading criteria
- Critique and select appropriate educational software
- Prepare an hourly exam and corresponding grading scheme.

- Prepare and present a brief lecture - For this assignment participants develop and deliver an 8-10 minute lecture on a topic within their class to a subset of the class. Audience members complete evaluation forms, providing feedback on delivery rate and voice, eye contact, poise/body language, visual aids/blackboard use, keeping student interest, organization, and clarity of explanation. These lectures are videotaped and posted on the class website for all to learn from.

Academic job search preparation

This portion of the class focuses on preparing participants for their job searches. Early in the course we have a workshop on preparing a teaching philosophy and teaching statement. As with the class materials, participants bring to the class session a draft of their teaching philosophy, ready with many questions. Discussions with their teaching partners and the class as a whole provides them feedback that makes for a more thorough final product. A better understanding of themselves as teachers drives the development of the teaching materials described earlier.

Toward the end of the course we focus on the academic job search. In an overall introductory session participants are introduced to the academic job search, Carnegie classification system, and the grant proposal writing process. Panels with engineering colleagues as panelists address the academic job search, working toward tenure, and running a research group. I have been very fortunate to have the support of my colleagues in participation in these panels.

Use of student journals

An important element in teaching is the opportunity to reflect on the teaching experience. Participants are given an opportunity for reflection through required journals at various points in the class. The five required journal assignments are:

Journal 1 - Reflection on outstanding college professors - Name four adjectives that you feel define an outstanding college professor. Thinking back to outstanding college professors you've encountered in the past, cite at least one specific example of actions that exemplify each of the four adjectives.

Journal 2 – Learning theories - Choose the learning theory/model (Felder Soloman, Myers Briggs, Piaget, Perry, Scientific learning cycle, Kolb learning cycle, or Motivation) that you

feel will be most useful to you as an engineering educator inside the classroom and describe how it applies. Repeat for the theory/model that will be most useful in your interactions with students outside the classroom.

Journal 3 - Lecture video critique - For this journal, view the video of your lecture, review your classmates' comments, and critique your performance. To get a realistic assessment of your performance, pretend you are a student in the class, and try to take notes from the tape. In your critique, comment on what you learned about yourself, what you liked, and what you can work on for the future. Address the issues in the observation form. Finally, comment on what you learned by watching your classmates' lectures, and give any suggestions on how to improve this portion of the class.

Journal 4 – Student issues - Reflect on what you have learned regarding one on one interactions with students and student-student interactions from the session on gender issues, diversity issues, disabilities and psychological issues, class-based and research-based one-on-one teaching and advising. Some issues you might address: Any surprises? Insights? Ideas for your future reference? Issues that were not addressed that you'd like to see addressed?

Journal 5 – Professional issues - Reflect on the "professional concerns" sessions we've had recently: Obtaining an academic position, progress toward tenure, running a research group. Have the sessions changed the way you view the teaching profession? What insights did you gain? What lessons will you take with you as you start your teaching career?

Conclusion

I have had the privilege of meeting students from every department in our College of Engineering, and helping them embark on academic careers. In this paper I have outlined the course I teach and offered suggestions for those considering teaching this type of course at their institution. I welcome inquiries for additional information and/or course materials, and the exchange of ideas with others already teaching such courses.

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