A Course on Teaching Engineering

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Introduction

The second fundamental canon of the NSPE Code of Ethics for Engineers\(^1\) states that

“Engineers shall perform services only in areas of their competence.”

In the United States the primary focus of graduate engineering education is to train our graduate students to become researchers. We also have an ethical obligation to provide those students interested in academic careers with adequate education and training to ensure competence in the teaching aspects of their careers.

A number of universities are now offering such courses. A course on teaching engineering has been offered twice by the University of Michigan’s College of Engineering, with an enrollment of approximately 30 graduate students per offering. The idea for this course came from the author’s participation in the three-day National Effective Teaching Institute, offered annually by Richard Felder and Jim Stice prior to the ASEE Conference.

Course description

The course consists of three major components:

- Understanding of learning styles, learning theories and other issues relevant to engineering education,
- Preparation of course materials, and
- Academic career planning.

Wankat and Oreovicz’ textbook\(^2\) is used as the required book for the course, with Reis’ excellent guide to the professional preparation for an academic career\(^3\) as a recommended book. The goals and objectives of the class are given in Table 1, some adapted from a course syllabus graciously provided by Phil Wankat.

The topics addressed in each 80 minute class period are shown in Table 2. Discussing learning styles and learning theories early in the term provides a backdrop for the later discussions on methods and procedures.
**Table 1 - Course goals and objectives**

**Goals:**
- Help prepare students to become professors
- Acquaint students with learning theories
- Give students a chance to discuss teaching issues
- Give students practice preparing a course

**Objectives:**
By the end of this course each student should be able to, among others:
- Understand their learning style
- Describe Myers-Briggs Type Indicators and Soloman’s Learning Styles
- Describe and compare Piaget’s and Perry’s theories of cognitive development
- Describe and compare Kolb’s learning cycle and Maslow’s theory of needs
- Classify course activities using Bloom’s Taxonomy
- Adapt their teaching style to various types of learners
- Be a better listener and adviser
- Prepare a plan for personal development as a faculty member and a professional

**Table 2 - Course topics**

<table>
<thead>
<tr>
<th>Introduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Introduction, learning styles</td>
</tr>
<tr>
<td>- Efficiency</td>
</tr>
<tr>
<td>- Designing your first class</td>
</tr>
</tbody>
</table>

**Theory - Student learning styles, development, and learning theories**
- Myers-Briggs
- Piaget
- Perry
- Learning Theories

**Methods and Procedures**
- Taxonomy, Objectives and ABET
- Syllabus Design, Textbook selection
- Problem solving and creativity
- Lectures
  - student lectures
- Discussions and teamwork
- Technology in engineering education
- Design and laboratory
- One-to-one teaching and advising
- Gender issues in teaching engineering
- Race issues in teaching engineering
- Testing and grading
- Cheating, discipline, and ethics
- Evaluation of teaching

**Academic Career Planning**
- Obtaining a faculty position
- Professional concerns (2 sessions)
- Wrap up
My preparation for the course consisted of a literature survey and gathering of materials from past workshops. Students were expected to arrive prepared to discuss the day’s topic, and only a small amount of class time was spent presenting material. A homework problem from Wankat and Oreovicz’ book was assigned for each class period to ensure this preparation, although the assignment was not turned in. The rest of the class time was spent in small group discussions or projects based on the assignment. Material from the National Effective Institute was used liberally for class discussions. For the first class, for example, students completed the Index of Learning Styles Questionnaire, based on Felder and Silverman’s Learning Styles model, to start the discussion on learning styles.

For many class periods a discussant with expertise in the area would also make a brief presentation. Some examples: staff from the University’s Center for Research on Learning and Teaching discussed the Teaching Portfolio; the president of the student Honor Council was present in our ethics session; a videotape of vignettes involving gender issues in engineering education and accompanying booklet, developed at the University of California at Davis was used as a discussion starter in the gender issues session; for the session on obtaining a faculty position three graduate students who were currently going through the process volunteered to serve as panel members, eliciting many questions from the class. The two “professional concerns” sessions were left open for students to choose which topics they wanted to have addressed. Topics have included starting a research program, preparing a grant proposal budget, tenure and promotion issues, and balancing an academic career and family.

Table 3 - Major course assignments

| - Prepare a set of educational objectives |
| - Choose a textbook or other supporting materials |
| - Prepare a syllabus |
| - Prepare a web page |
| - Select a strategy for selecting collaborative learning groups |
| - Prepare and present a five minute lecture |
| - Prepare an open ended project and/or design activity |
| - Critique and select appropriate educational software |
| - Prepare an hourly exam and corresponding grading scheme. |
| - Write and submit five journal entries through the semester to address course topics. |

The major course assignments, shown in Table 3, centered on the preparation of course materials for a course a student might teach in the future. This part of the class proved quite enlightening to most students, as they had little idea how much effort and time it took to adequately prepare for an exam or a five-minute lecture. All materials were submitted and graded, and the grading scheme for the course is shown in Table 4.
### Table 4 - Course grading scheme

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Journals</td>
<td>15%</td>
</tr>
<tr>
<td>Mini-lecture</td>
<td>15%</td>
</tr>
<tr>
<td>Syllabus and objectives</td>
<td>20%</td>
</tr>
<tr>
<td>Open ended project</td>
<td>15%</td>
</tr>
<tr>
<td>Web page</td>
<td>15%</td>
</tr>
<tr>
<td>Hourly exam and solution</td>
<td>20%</td>
</tr>
</tbody>
</table>

Students presented the five-minute lecture in front of their classmates, who submitted evaluation forms, shown in Table 5, with comments and suggestions for improvement. The lectures were also videotaped, with the videotape provided to the student. They were encouraged to review the tape with staff from the Center for Research on Learning and Teaching to obtain additional suggestions on improving their lecturing techniques.

### Table 5- Five minute lecture evaluation form

<table>
<thead>
<tr>
<th>Evaluation Category</th>
<th>Rating Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delivery rate and voice</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>Eye contact and manner</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>Poise / body language</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>Visual aids / blackboard use</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>Interaction with students</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>Material explained clearly</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>Kept my interest</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>I learned something</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td><strong>OVERALL PERFORMANCE</strong></td>
<td><strong>1 2 3 4 5</strong></td>
</tr>
</tbody>
</table>

Suggestions for improvement:

In the journal entries, students shared their thoughts regarding relevant course topics. Specific questions were assigned for each journal to focus the discussion, although students were encouraged to discuss other topics as well. These journals were read, questions answered, and a summary of opinions and thoughts discussed at the next class period.

### Course evaluation and future plans

The class has been very well received in each of its two offerings, earning ratings of 4.47 and 4.82/5.0 with 5.0 being best. Student comments have included:
- This is a very good course – it definitely opened my eyes to subtleties and complexities of education.

- This information will be invaluable in my professional career

- Every assignment showed me how difficult it is to be a teacher. I have even a greater appreciation for teachers.

The course is expected to continue to be offered approximately every two years. Future improvements might include development of a course-pack to provide current journal articles and other materials, and examination of broader issues such as curriculum planning and the ABET criteria.

Bibliography

6. Henes, Robby, “Creating Gender Equity in your Teaching,” University of California at Davis College of Engineering, 1997 and accompanying videotape, “Equity in Education: Gender Bias in the College Classroom.”

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Susan Montgomery is an Assistant Professor of Chemical Engineering at the University of Michigan, and head undergraduate advisor. She received a BSEChE from the University of Michigan in 1984, an MA and PhD from Princeton University in 1991. In 1995 she was the recipient of a Dow Outstanding New Faculty Award. She serves as ASEE Campus Representative and Faculty Advisor to the graduate student group of ASEE and the Society of Hispanic Professional Engineers.