TEACHING AND MENTORING TRAINING PROGRAMS AT MICHIGAN STATE UNIVERSITY

A Doctoral Student's Perspective

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Many new faculty enter the academic world with minimal teaching experience or training in pedagogy. In fact, a majority of engineering professors have never had a formal course in education.[1] This deficiency can easily be addressed through implementation of teaching programs targeted at doctoral students who aspire to an academic career. The rationale behind a formal teaching program is that new professors who study educational methods will likely be better prepared to teach and will be more efficient during their first years in academia.[1] Benefits of graduate training in teaching include

- *Helping confirm whether the student is well suited for and would enjoy an academic career*
- *Providing both conceptual knowledge and significant experience in college-level teaching*
- *Giving a significant advantage over other candidates for an academic position.*[2]

A College Teaching Certificate (CTC) program was established in the College of Engineering at Michigan State University (MSU) to help provide such training. It was initiated in 1998 in response to a request from several graduate students for training in college teaching methods. A planning committee of faculty and graduate students was formed to develop such a program. During the 1998-1999 academic year, the committee submitted a proposal to establish the CTC program, and it was successfully initiated in the spring of 2000. A total of 23 engineering doctoral students have now successfully completed the program and received certification in college teaching.[3] The College of Natural Science had previously established a similar program.[4]

CTC PROGRAM FORMAT AND EVALUATION

Theory and Practice of Teaching Engineering Students

The overall purpose of the CTC program is to provide graduate students with valuable experience in college-level teaching and to prepare them for careers in academia. To achieve this goal, the program requires successful completion of two courses. The first course, "Theory and Practice of Teaching Engineering Students," introduces students to pedagogical theories and effective methods used in teaching engineering. The theory and practice component of the program is similar to many courses at colleges of engineering around the country.[5] Learning objectives for the course include: 1) applying fundamental theories of cognitive processes in the practice of teaching engineering students, 2) designing ef-

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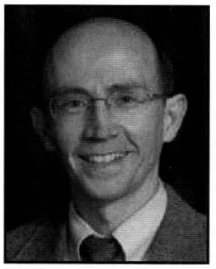

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TABLE 1
Course Topics

- Attributes of a Professional
- Student Learning Styles and Assessment
- Starting the Academic Career
- Diversity and Gender Issues
- Teaching Assessment
- Mentoring
- Course Proposal
- Accreditation
- Dealing with Hostile Students
- Understanding "Class Personality" And Student Perspectives
- Delivering Course Content: The Lecture
- Delivering Course Content: Active Learning And Cooperative Learning
- Delivering Course Content: The Use of Technology
- Designing Effective Laboratories
- Designing Effective Homework Assignments
- Incorporating Design Into Engineering Courses
- Faculty And Student Rights And Responsibilities
- How To Be An Effective Junior Faculty

TABLE 2
List of Projects

Statement of Teaching Philosophy
This entails a clear and concise, but personal statement of one's philosophy about teaching. It is considered a living document, so as one's experience grows, it also changes. This assignment is graded on the basis of the depth of thought presented.

Teaching Toolbox
This includes materials that can help and support the participant's teaching. The teaching toolbox has two compartments. The first compartment deals with items pertinent to the theory and practice of teaching and the second compartment includes items that support the teaching of a specific topic in the student's discipline. Both compartments are organized collections of papers, exams, projects, notes, physical models, etc., that the student can use as a reference for future teaching assignments. The Toolbox is graded for completeness with respect to the essential components presented in the course, the richness of development the student added beyond the course materials, and its overall organization.

Journal
This is the participant's reflection on the theory and practice of teaching engineering students and an exploration of one's own philosophy of teaching. It is allowed to be in the form of a diary, a collection of essays, a record of conversations, letters to colleagues, or a mixture of these. The Journal is graded on the basis of the depth of thought presented.

Mini- Lecture
This is a 15- to 20-minute lecture on a scientific subject area that is given by the participant during the normal two-hour class period. The grade is based on a standard oral presentation grading form that is given to the students in advance.

Course Web Page
Participants design and implement a web page based on the topics covered in the mini-lecture. The web page must have at least one download and one link to another website. This project is graded on the basis of its layout, utility, and overall organization.

Assignment
Based on the topics covered in the mini-lecture, the participant prepares an assignment, which could take the form of an examination, quiz, homework, or project. The grade is based on the attributes of the Assignment.

Course Proposal
The participants submit a proposal for a course that includes all the administrative details for a new course proposal at Michigan State University. A course description in ABET format accompanies the proposal. The Course Proposal is graded for completeness and innovative thought.

fective lectures, laboratories, and assignments, 3) using appropriate methods to deliver course content, 4) designing and applying assessment tools, 5) writing a proposal for a new course, and 6) developing a website as an engineering educational tool.[5] A list of topics facilitated in the course is shown in Table 1. In addition to the text[1] used in this course, supplemental reading is provided, including articles from *Prism*, *Journal of Engineering Education*, and proceedings of the ASEE Annual Conference.

I (author TB) felt that the course provided an excellent background on the theories and methods used to effectively teach engineering students. The assigned projects, listed in Table 2, taught me how to organize and present course material and encouraged me to think critically about how to reach engineering students through innovative teaching strategies. The class, which met once a week for 2 hours, was interactive and thus allowed participants to engage in discussions about teaching and to exchange personal experiences involving education and teaching styles.

Mentored Teaching of Engineering Students

In the second course, "Mentored Teaching of Engineering Students," participants gained experience in teaching under the close guidance and supervision of an engineering faculty member of their choice. Typically, participants chose their research advisors as the teaching mentor. I chose my research advisor because of our well-developed relationship and his expertise in the subject matter. Faculty mentors participate in the program without special compensation and are largely motivated by their commitment to developing academicians of the future. The mentored teaching experience allows participants to cultivate their own teaching styles by taking full responsibility for developing lecture presentations, delivering course materials, preparing assignments (homework and examination problems), and conducting office hours, typically over 2-to-4 weeks. In order to prepare for the mentored teaching experience, a contract between the faculty mentor and the graduate student is established that details the duties and responsibilities of both parties. The mentor is mainly responsible for attending all class sessions, for which the participant is the instructor, and evaluating the participant's teaching. Furthermore, CTC participants are required to compile a teaching portfolio that includes all of their teaching aids and materials (*e.g.,* lecture notes, homework assignments, examination problems), examples of student work, student and faculty evaluations, and a statement describing their teaching philosophy. Additional information contained in the portfolio includes a listing of service contributions to Michigan State University or to the profession, such as participation on teaching committees, work on curriculum revision,

attendance at professional meetings in education, evidence of contribution to the larger community through Service Learning Activities, and teaching honors or recognitions. The portfolio is evaluated on its organization, presentation, and completeness. Grading for this course is based on the completion of both the graduate student's contractual duties and evaluation of the teaching portfolio. Upon successful completion of this course, participants receive a College Teaching Certificate notation on their transcripts.

In the second course described above, I had an opportunity to teach a portion of an undergraduate thermodynamics course. Through this experience, I gained an appreciation of the challenges that faculty members face when balancing teaching and research. Over a three-week period, I taught three chapters from *Introductory Chemical Engineering Thermodynamics*.[6] Content included Departure Functions (Chapter 7), Phase Equilibrium in a Pure Fluid (Chapter 8), and Reacting Systems (Chapter 14). I chose these topics because of my previous experience as a teaching assistant for this course and my familiarity in these areas.

As a first-time instructor, I found that the time required to prepare for lecture was much greater than expected. This is a common issue for many faculty members and has been addressed by Reis,[2] who suggests that the real time for classroom preparation is three times the original estimation. Careful preparation of handouts, meticulous attention to accuracy, and thorough structuring of numerous example problems consumed a significant amount of time. In the end, some of this material wasn't covered in class due to time constraints. This incident was an excellent lesson on the balancing of fervent preparation with the pace of a typical classroom lecture.

As part of the requirements for the teaching portfolio, the students provided feedback, suggesting strengths and weaknesses for my style of teaching. Most students expressed appreciation for the detailed example problems worked in class because it helped solidify concepts. Three chemical engineering faculty members (Carl Lira and coauthors DB and MW) also provided valuable feedback.

CTC PROGRAM RECOMMENDATIONS AND FUTURE DIRECTIONS

I felt that the first course provided an excellent background on the theories and methods used to effectively teach engineering students, and the second course allowed me to implement these principles by having the same teaching responsibilities as faculty members. My main recommendation for enhancing the CTC program is to improve the recruitment of participants. Recruitment efforts of both faculty and graduate students were originally done through email, but this method was an informal and non-interactive way of promoting the program. I recommend broader advertising to better inform faculty and graduate students of this training opportunity, such as a general seminar or an informational session scheduled each semester. During the session, the rationale and benefits of the program could be explained, detailing the success and areas of improvement of the program. This type of session would allow both faculty and students to ask questions and to interact. It could also motivate graduate students to pursue an academic career and encourage faculty members to become mentors.

Currently, the CTC program is being jointly taught with the College of Natural Science, specifically through the Division of Science and Mathematics Education (DSME). The DSME is co-administered by the Colleges of Natural Science and Education and its mission is to improve science and mathematics education, from kindergarten through the undergraduate years, through the professional development of pre-service and in-service teachers and faculty members.[7] Academic specialists and faculty members with partial appointments in various departments and other colleges (including the College of Engineering), graduate and undergraduate students, and professional and clerical staff work together in DSME to conduct a variety of courses, degree programs, and other activities in support of its mission. In addition to connections with the College of Natural Science, links to the NSF-sponsored Center for the Integration of Research, Teaching and Learning (CIRTL) are being established. The objective of CIRTL is to create a model interdisciplinary professional development program that will prepare graduate students, post-doctoral researchers, and current faculty to meet the future challenges of national Science, Technology, Engineering and Mathematics (STEM) higher education.[8]

OTHER TEACHING AND MENTORING TRAINING PROGRAMS AT MSU

MSU offers numerous teaching and mentoring opportunities, through programs, seminars, and workshops that are directed at faculty development, many of which are also open to graduate students. As a doctoral student with a passion for teaching, I tried to take advantage of all of them! I served as a teaching assistant for the undergraduate introductory thermodynamics course during my first semester at MSU. In this role, I was responsible for attending lectures, preparing and facilitating recitation sessions, proctoring examinations, conducting office hours, and preparing solutions to homework problems. These tasks familiarized me with the essential tangential responsibilities of a professor.

For the two consecutive summers of 2002 and 2003, I served as a chemistry instructor for a summer enrichment program conducted through the College of Human Medicine.

The Pre-Health Professions Preparation Institute (PPPI) is a six-week residential summer program designed to provide students from under-represented minority and/or disadvantaged backgrounds with preliminary education to enhance their preparation and probability for successful completion of college-level course work. I taught the first four chapters of the course material covered in the freshmen general chemistry course.[9] In addition to teaching and tutoring, I had the opportunity to mentor these students. Mentoring included leading discussions about the expectations of college-level work and the importance of conducting research, even at the undergraduate-level. I also assisted these students in weekend community-based service learning activities.

MSU has developed a relatively new graduate program, the Multidisciplinary Graduate Training Program on Technologies for a Biobased Economy (TBE), that promotes interdisciplinary scholarly interactions between students and faculty in various scientific disciplines. I am a participant of this graduate program. It's purpose is to produce a diverse group of PhD scientists and engineers who have broad training related to biobased industrial product formation, have strong research skills, and are able to work effectively in multidisciplinary teams. The program addresses the increasing need to conduct basic and applied research requiring the contributions of two or more disciplines and yielding new areas of inquiry and application.[2] Furthermore, multidisciplinary programs and centers allow graduate students to think "outside the box" through exposure to philosophies of other scientists and engineers not in their immediate discipline. Working with a range of individuals who have differing perspectives and skills is excellent training for the interdisciplinary opportunities that await students as new professors.[2]

One requirement of the TBE program was participation in the College Teaching Certificate Program described above. As a TBE participant, I was also required to complete the Multidisciplinary Bioprocessing Laboratory (MBL) course. The goal of this course is to teach students how to work effectively in multidisciplinary teams in a research environment.[10] The students, both undergraduate and graduate, are divided into multidisciplinary teams that conduct a semester-long, mentored research project in a participating faculty member's research lab. To prepare students to carry out their projects efficiently, the MBL course also incorporates innovative teaching practices to help students to develop communication and critical thinking skills; these include collaborative and problem-based learning, project-management concepts, peer assessment, and ethics. I also served as a research mentor for this course, in which I was responsible for guiding three students to complete a research project. This mentoring role provided experience in another essential duty of a professor—serving as a research advisor. The TBE program is an innovative training venue that allows graduate students to participate in contemporary research problems and to develop and enhance essential skills to effectively teach technical concepts. Detailed information on the institutionalization of the CTC and TBE programs and the MBL course at MSU is provided in several papers.[4,5,10,11] They can assist colleges or departments interested in developing similar programs and courses at their institution.

CONCLUSIONS

I found the teaching and mentoring training programs offered at MSU to be an effective and valuable program for preparing future educators. As a result of participating in these programs, I am a better-prepared, more competitive, and marketable engineer, researcher, and professor. My extensive teaching and mentoring experiences have improved my organizational and communication skills. Furthermore, my experience explaining technical and abstract concepts has developed my critical-thinking skills. My experience suggests that, although participation in these types of programs takes time away from research, the time invested in graduate teaching and mentoring experiences is worthwhile and has enhanced my preparation for a career in academia. Similar programs at other universities can provide the same benefits to engineering graduate students.

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