A Teaching Certificate Program at Michigan State University

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Introduction

A college teaching certificate program has been established in the College of Engineering at Michigan State University. Students participating in the program must complete two courses. The first course deals with the theory and practice of teaching engineering. In a once-a-week, two-hour meeting, students are introduced to both the pedagogy of teaching engineering, as well as the practical aspects. In each two-hour session, there is some lecturing, some active learning exercises, and considerable discussion. Guest instructors are frequently utilized. In this paper, the course is described in detail, including its evolution through two offerings. The results of a course survey for the latest offering of the course are also presented and discussed.

The second course involves a mentored teaching experience under the supervision of a college faculty member. The main component of this course is classroom teaching. Typically, a student will teach two to three weeks of a course that is officially assigned to a faculty member. In addition to preparing class presentations, the students will hold office hours, and prepare, monitor, and grade assignments including homework and examinations. A mentoring contract is agreed to by the student, faculty mentor, and program coordinator to insure that the experience is more than an unpaid teaching assistantship. The mentoring experience has been evaluated by program participants by the use of a survey. The survey results are provided in the paper, and their use to address problems with the mentoring experience is discussed. This paper also presents the steps in the development of the program, and discusses the evolution of the theory and practice course. This is followed by a description of the mentored teaching experience, including student feedback on this experience. The paper concludes with a review of the current status of the program and where it needs to go.

Program Development

The development of this program is detailed in Somerton et al [1]. A proposal for this college teaching certificate program was formulated by a committee of faculty and graduate students during the 1998-99 academic year. The proposal was forwarded to the Dean of the College of Engineering at Michigan State University, and after review by the administrative group of the college, the decision was made to go forward with the program. A coordinating committee of three faculty members (the authors of this paper) were identified to develop the two courses associated with the program. One purpose of this coordinating committee was to provide, on a rotating basis, the instructor for the first three offerings of the theory and practice course. The college anticipated that these three instructors would develop a turnkey course that could then be offered by the college as needed. The first offering of the theory and practice course occurred during the spring semester of 2000 with Mackenzie Davis as the instructor. This offering had an enrollment of eighteen students, predominantly from the Department of Mechanical Engineering (7) and the Civil and Environmental Engineering Department (5). However, five of the seven

departments in the College of Engineering were also represented. There was also one student from outside the college who participated in the program. The participants represented a very diverse group with several minorities (5), women (7), and international students (6). The second offering of the course was given during the fall semester of 2000 with Craig W. Somerton as instructor. This offering had an enrollment of five students, each from a different department of the College of Engineering. This group of participants also represented a very diverse group with two white males, two women (one of which is African-American), and an international student from China.

Two students completed their mentored teaching experience during the summer semester of 2000, six students completed their mentored teaching experience during the fall semester of 2000, and eight students will complete their mentored teaching experience during the summer semester of 2001. Thus, sixteen students will have earned their College Teaching Certificate by the end of the first year of the program.

A companion program in the College of Natural Science at MSU touts its primary purpose as making its doctoral graduates more competitive for teaching jobs. However, the College of Engineering program takes a slightly different perspective. Certainly, one of the challenges faced by a new faculty member is balancing the initiation of a research program and competently and effectively teaching courses. In many cases, this may be the first time the faculty member has been completely in charge of teaching a course. It is anticipated that the doctoral students who have completed the CTC program will be in an excellent position to successfully achieve this balance. Therefore, the primary objective of this program is to prepare these students to excel as new faculty members, by teaching them how they can pair their research goals with their instructional responsibilities. Two secondary benefits include enhancing the competitiveness of students for faculty positions (especially for non-research oriented schools) and improving the overall quality of instruction in engineering.

Theory and Practice Course

The theory and practice course component of the program is similar to many courses that have now appeared at colleges of engineering around the country. The text by Wankat and. Oreovicz [2] is used for the course. A list of supplemental readings is provided to the students, and includes some basic references on teaching adults, as well as relevant articles from Prism, Engineering Education, Journal of Engineering Education, and proceedings of the ASEE Annual Conference. This course has evolved through two offerings. The course goal has been set as follows:

> To provide the student with an introductory working knowledge of the definitions, concepts, and theory of teaching college level students and to provide practical tools to assist in delivery of course content.

A set of course learning objectives has been developed and is shown below:

> With successful completion of this course the student should be able to do the following:
>
> - Apply fundamental theories of cognitive processes in the practice of teaching engineering students
> - Design effective lectures, laboratories, and assignments
> - Use appropriate methods to deliver course content
> - Design and apply assessment tools
> - Write a proposal for a new course
> - Develop a web site as an engineering educational tool

Table 1 shows the topics covered in each of the two offerings of the course. The topics are listed in the order in which they were presented during the semester. They are also color coded for the two offerings, so that one can see what topics were covered in both offerings. It should be observed that, in the second offering, the practice aspect of the course was increased over the theory aspect. This was predicated on input from students who took the first offering. For several of the topics, guest lecturers were used. Faculty from the College of Education at MSU participated in some of the lectures associated with learning styles and theories. Personnel from student services, such as the learning center, the ombudsman office, diversity programs office, and the counseling center provided class presentations in areas of their expertise. College of Engineering faculty participated in sharing with the students their experiences in teaching laboratories and design, in using active learning techniques in class, and in starting their academic career. By utilizing the members of the university and college community in this way, the students received a much broader learning experience than would have been possible from a single instructor.

A side benefit of using guest lecturers from the College of Engineering is that, if they are chosen carefully, it can introduce students to a variety of different presentation styles. For example, the guest lecturer who talked on teaching design used a very aggressive Socratic method, while the guest lecturers for the teaching of laboratories used a more conventional lecture presentation style. In the second offering of the course, these lectures were given before the class session on lecturing, and the two different styles were the focus of the discussion for this class session.

This is a graded course and was designed with assignments. The assignments for the two offerings were the same, with the exception of the addition of a technology assignment (development of a course web page) for the second offering. This was done to be consistent with the criteria set by the university's graduate dean for teaching certificate programs at MSU. The details of the assignments as provided to the students are given below.

Table 1. Topics of Theory and Practice Course

First Course Offering	Second Course Offering
Attributes of a Professional (Week 1)	Teaching Philosophy (Week 1)
Learning System Design (Week 2)	Learning System Design (Week 2)
Problem Solving and Creativity (Week 3)	Learning Styles (Week 3)
Delivering Course Content - The Lecture (Week 4)	Problem Solving and Creativity (Week 4)
Delivering Course Content - Active Learning (Week 5)	Teaching Design and Laboratories (Week 5)
Teaching Design and Laboratories (Week 6)	Delivering Course Content - The Lecture (Week 6)
Designing Effective Assignments (Week 7)	Delivering Course Content - Active Learning (Week 7)
Assessment of Student Learning (Week 8)	Delivering Course Content - The Use of Technology (Week 8)
Dealing with Hostile Students (Week 9)	Assessing Teaching (Week 8)
Learning Styles (Week 10)	Designing Effective Assignments and Grading Assignments (Week 9)
Gender Issues (Week 11)	Diversity Issues (Week 10)
Models of Cognitive Development (Week 12)	Dealing with Difficult Students (Week 11)
Learning Theories (Week 13)	Grading Philosophy (Week 12)
Assessing Teaching (Week 14)	Teaching and Mentoring Graduate Students (Week 12)
Mentoring (Week 15)	Accreditation (Week 13)
Starting the Academic Career (Week 16)	Starting the Academic Career (Week 15)

Statement of Teaching Philosophy: The students were told that this should be a clear and concise, but personal statement of their philosophy about teaching. They were asked to express their feelings about the type of teacher they want to be. It was emphasized that it should be a living document, so that as their experiences grow, it will also change. The Statement of Teaching Philosophy was graded on the basis of the depth of thought presented.

Teaching Toolbox: In general, this included materials that will help and support the students' teaching. For this class, the teaching toolbox had two compartments. The first compartment dealt with items pertinent to the theory and practice of teaching. The second compartment included items that will support the teaching of a specific topic in the student's discipline. It was intended that both compartments should be an organized collection of papers, exams, projects, notes, physical models, etc. that the students can use as a reference for their future teaching assignments. The Toolbox was 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 organization for information retrieval.

Journal: Students were required to keep a journal of their reflections on the theory and practice of teaching engineering students. They were told to think of this journal as an exploration of their own philosophy of teaching. It was 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 was graded on the basis of the depth of thought presented.

Mini-Lecture: Each student was required to give one 15 to 20-minute lecture. In the first offering of the course, the lecture was video taped, and reviewed with the instructor. In the second offering of the course, the mini-lectures were given during the normal two-hour class period. The grade was based on a standard oral presentation grading form that was provided to the students well in advance of their lecture.

Web Page: The students were required to design and implement a web page based on the topic(s) covered by their mini-lecture. The web page must have had at least one download and one link to another web site. It was graded on the basis of its layout, utility, and satisfying the stated requirements.

Course Proposal: The students submitted a proposal for a course. This proposal included all the administrative details for new course proposals at Michigan State University. Appropriate forms were provided to the students. Required to be included with the proposal was a course description in ABET format. The proposal was graded for completeness and responsiveness to the material presented in the course.

Assignment: Based upon the topic(s) covered in their mini-lecture the students prepare an assignment. This could be an examination, quiz, homework assignment or project assignment. Its grade was based on the attributes of the assignment.

The students who took the second offering of the course were surveyed concerning the usefulness of the topics covered. They were asked to evaluate each lecture topic as to how much

it will help their teaching and how much will it help in their career. A 5-1 scale was used as indicated below:

5: should be a big help 4: should be some help 3: may be a little help
2: was interesting, but will not help at all 1: should be replaced with another topic

The results of this survey are shown in Table 2. In general, the students found all of the lecture material useful for their teaching endeavors. Not unexpectedly, they perceived the mini-lecture to be most useful. They found the lectures on teaching design and laboratories and on dealing with difficult students the least helpful. As one student observed concerning the lecture on difficult students, it is "just good to know its out there but didn't need to be so much talking". From their comments, students indicated that they would like to see more time spent on teaching with technology and designing and grading effective assignments. They were also very pleased with the opportunity to interact with a faculty panel concerning the starting of an academic career. These results will be reviewed for the third offering of the course, scheduled for fall semester 2001. It is also interesting to note that the results indicate that the students felt the topics were more helpful for their teaching than for their careers.

Mentored Teaching Experience

The second course requirement in the college teaching certificate program is a mentored teaching experience. This course uses the student teaching model that has been popular in the preparation of teachers for K-12 education. Typically, the student would take on full responsibility for 2-4 weeks of an engineering class under the supervision of the faculty member who has been assigned the course by the department. Full responsibility includes lecturing, holding office hours, creating assignments (homework and examination problems), and grading. The mentoring faculty member is to provide guidance and constructive criticism during this experience. The faculty is responsible for attending all class periods for which the student is the instructor in charge. The mentored teaching experience is a graded course. The student is required to compile a course portfolio that includes all of their teaching aids (lecture notes, homework assignments, examination problems), examples of student work, and documented observations by the faculty mentor. The students are also expected to keep a journal of their experience.

In order to ensure that both the mentor and student understand the mentoring experience, a contract is signed by the student, the mentor, and the program coordinator. An example contract is shown in Figure 1. In general, the mentored teaching experience is not to be simply an unpaid teaching assistantship. The mentored teaching has covered a range of experiences. Two of the program participants have actually served as instructors-in-charge of classes, while another participant has only had contact with students in a laboratory setting. The students choose their own mentors and this has led to a couple of challenges. Several of the students have chosen their research advisors as their teaching mentors. This has given rise to some conflict of interest between the teaching responsibilities and research responsibilities of the student. Secondly, the students do not always choose a master teacher as their mentor. Hence the education model of student teaching breaks down somewhat.

Table 2. Survey Results from Theory and Practice Course (5-1 scale)

Lecture Topic	**Will Help Teaching***	**Will Help Career***
Learning System Design	4.8	4.4
Problem Solving and Creativity	4.4	4.6
Learning Styles	4.6	4.6
Teaching Design and Laboratories	3.6	3.6
Delivering Course Content - The Lecture	4.6	4.0
Delivering Course Content - Active Learning	4.5	4.25
Assessing Teaching	4.0	3.5
Delivering Course Content - The Use of Technology	4.5	4.5
Designing Effective Assignments and Grading Assignments	4.4	3.4
Diversity Issues	4.4	4.4
Dealing with Difficult Students	3.8	3.0
Teaching and Mentoring Graduate Students	4.4	3.6
Grading Philosophy	4.2	3.6
Accreditation	4.0	3.4
Mini-Lecture	5.0	4.6

* arithmetic mean

Figure 1. Example Mentoring Contract

EGR 911 Mentored Teaching of Engineering Students
Class Contract

Student: J. Spartan Faculty Mentor: Professor Green

Course: ME 201Thermodynamics Section: 001

Please provide specific details on the duties of the student under the following categories:

Lecturing (including attendance at lectures): The student shall prepare and give all of the lectures concerning the unit on the first law of thermodynamics (second unit in the course). The student will attend the class lectures given by the faculty mentor concerning the evaluation of properties, which constitutes the first unit in the course. The student and faculty mentor shall meet regularly to discuss the success of the lectures for these two units. Following completion of the second unit, the student will not be required to attend lectures.

Assigning and grading homework and/or class projects: The student will develop, assign, and grade the homework associated with the first law of thermodynamics unit. These assignments should be reviewed by the faculty mentor before they are assigned to the class. The student shall work the homework dealing with the property evaluation unit and these assignments should be discussed between the student and the faculty mentor.

Creating, giving, and grading tests: The student shall create, give, and grade the exam dealing with the first law of thermodynamics unit. This exam will be reviewed by the faculty mentor before it is given to the class. The creation of the exam for the property evaluation unit should be a collaborative effort between the student and the faculty mentor.

Office hours: During the both the property evaluation and first law of thermodynamics unit, the student and faculty mentor shall have joint office hours. During the first unit, it is expected that the faculty mentor will take the lead, while for the second unit the student is expected to take the lead.

Course development and improvement: In their course portfolio, the student is expected to provide recommendations dealing with the first two units of the course.

Team building activities: The student will have no duties or responsibilities in this area.

I agree to the conditions of this class contract.

Signed: _____ _____
Student Faculty Mentor

_____
Program Coordinator

A survey has been administered to the students who have completed their mentored teaching experiences. The results are shown in Table 3. It is not surprising that the students really value the teaching experience. With the difficulties noted above, it is also not surprising that the mentoring is not as valued by the students as the teaching experience alone. A discussion topic for the program coordinating committee will be the selection of mentors. One possibility might be the identification of master teachers in each department, and the requirement that the mentor must be chosen from this pool. The students represented by these results all took the first offering of the theory and practice course, so it will be of interest to see if the value of the theory and practice course increases with the improvements made in the second offering.

Program Review and Future Directions

A number of doctoral students have now completed the two-course sequence that represents the college teaching certificate program in the College of Engineering at Michigan State University. The participants are very positive about their experience and believe that it is of value in both teaching and in their career development. It will be important to track these participants in their careers to assess the program's true impact. The theory and practice course has been taught twice and appears to be nearly in turnkey condition. There appears to be some challenges in the mentored teaching component of the program, primarily with respect to the selection of mentors. This is an issue that needs to be addressed by the program coordinating committee, perhaps following a model closer to the traditional student teaching approach used in education.

Bibliography

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Craig W. Somerton is an Associate Professor of Mechanical Engineering at Michigan State University. He teaches in the area of thermal engineering, including thermodynamics, heat transfer, and thermal design. Dr. Somerton has research interests in computer design of thermal systems, transport phenomena in porous media, and application of continuous quality improvement principles to engineering education. He received his B.S. in 1976, his M.S. in 1979, and his Ph.D. in 1982, all in engineering from UCLA.

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Dr. Davis is a Professor of Environmental Engineering at Michigan State University. He received all of his degrees from the University of Illinois. He has received teaching awards from the student chapter of American Society of Civil Engineers, the College of Engineering at Michigan State University, the Great Lakes District of Chi Epsilon, the North Central Region of the American Society for Engineering Education, and the Amoco Foundation. He is the recipient of Air & Waste Management Association's Lyman A. Ripperton Outstanding Teacher Award. He is a registered professional engineer in Illinois and Michigan and a Diplomate of the American Academy of Environmental Engineers.

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Table 3. Survey Results for Mentored Teaching Experience

A 5 - 1 scale was used as indicated below:

5: very valuable 4: some value 3: may be of value
2: no value 1: was a very negative experience

	Will Help Teaching*	Will Help Career*
The teaching experience alone:	4.57	4.14
The mentoring experience:	4.29	3.86
The theory and practice course taken previously:	4.29	4.00
The teaching certificate program as a whole:	4.71	4.29

* arithmetic mean