Managers of the Learning Process: Preparing Future Faculty to Teach Productively

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Problem Statement and Background

For decades, it has been a recognized blight on the academic landscape that college teachers, in contrast to their colleagues in K- 12, receive little training to prepare-them for teaching. The American Association of Higher Education has recently summarized notable developments in addressing this problem[1]. Most of the programs cited are limited to training of graduate students for jobs as teaching assistants, and few describe effective teaching programs for engineering graduate students. Thus, most engineering Ph.D.'s who enter academia are very well trained for research, but have little or no training in teaching.

Colleges are continually being challenged to increase productivity and reduce costs. Downsizing of faculty and severe budget cuts are an all-too-common scenario in American institutions of higher learning[2,3]. Retention of the global pre-eminence of American higher education system must come from the rethinking of how teaching and learning take place. Approaches must be used that give students more responsibility for learning and reduce the responsibility of teachers to convey knowledge. If we are to transform higher education, in the direction of educational effectiveness and maximum productivity, then new faculty must possess a different set of skills than those trained in the traditional methods of teaching. Doctoral programs, where appropriate, must now include education of graduate students in methods of effective and efficient teaching.

Worcester Polytechnic Institute has had a strong tradition of undergraduate technical education since the inception of the WPI Plan in 1971. The primary accomplishment of the Plan has been the successful implementation of a heavily project-based curriculum. The recent reclassification (by the Carnegie Foundation) of the Institute as a comprehensive university indicates that its doctoral programs have developed to a significant degree. However, until the initiation of the project described in this paper, the school did not provide any opportunities for future faculty to learn about teaching. This meant that Ph.D. graduates from WPI hwo pursued academic careers, had no teaching preparation and probably had little knowledge of the strengths of our undergraduate program.

Objectives

It was our intent to address the general and local problems outlined above by developing,

piloting, and-evaluating a course and practicum in college teaching for engineering and science graduate students at WPI. This was not to be a teaching assistant training program. Its purpose was to provide an educational link between the undergraduate and graduate programs; it might also be a model that could be transported to other universities. In this paper, we describe the structure of the course and the practicum, our experiences in the pilot offerings of both, and our continuing assessment of the program.

Course Description: *Seminar in College Teaching*

The *Seminar in College Teaching* course was first offered the summer of 1995. Twelve students enrolled in this two-credit graduate level course. The course was team taught by the authors. The seminar was designed to acquaint students with some of the basic principles and theories of education and with instructional practices associated with effective college teaching. Required texts for the course were McKeachie[5] and Wankat and Oreovicz[6]. Some general learning objectives were that as a result of the course, students would be:

- prepared for a career as a college professor
- understand the basics of college teaching
- understand the developmental characteristics of college students
- be able to develop effective learning objectives and a course syllabus
- understand and be able to enhance student motivation for learning
- learn effective methods for evaluating student performance
- be prepared for continuous professional development.

An outline of the course in shown in Table I. Active, cooperative learning (CL), and project management appeared not just as single topics. Rather, they were philosophies that permeated the entire course experience. The class presentations and discussions on learning theories, motivation, objectives, syllabus, and evaluation, for example, were all based on the assumption (explicitly developed and discussed at many points) that active student engagement is educationally superior to passive observer status. We wanted students to understand how a variety of effective teaching techniques can be used to develop faculty that are "managers of the learning process", not just dispensers of information.

We emphasized learning theories, adolescent development, cognitive development, student variability, and cross cultural issues. We felt it important to provide the theory behind the effective teaching practices that were discussed later in the course. Emphasis was on understanding your students, how their motivation might be enhanced, and how teaching and learning styles are related. The works of Piaget, Perry, and Bloom were studied and discussed.

An essential component was cooperative and active learning techniques. This included course design for cooperative learning and task design for effective structuring of cooperative learning activities. Students were exposed to a novel method of CL management that has been developed at WPI. For the past three years, we have had a grant from the Davis Educational Foundation to improve educational quality and faculty productivity through peer-assisted cooperative learning. In the Davis model, qualified upperclass undergraduates are hired to serve as peer learning assistants (PLAs) in courses where cooperative learning structures are used extensively. These

specially trained PLAs work with individual cooperative learning groups to facilitate group process and dynamics, thus enabling cooperative learning to be used in classes of 150 or more while reducing faculty time per course. The result (in 11 courses and 7 disciplines) has been unproved educational outcomes and productivity (5). The seminar faculty have participated in that initiative, as co-principal investigators and as redesigners of our own courses using the PLA model. The Davis model was introduced and discussed in the *Seminar in College Teaching.*

A third important course component was an introduction to project-based learning. Since 1971 WPI has been a leader in using noncourse-based project curricula to teach humanities, integrate societal and technological issues, and to provide a capstone design/research experience within the major discipline. We wanted to instruct future faculty in how to properly design and conduct these project structures.

More details on the course can be found by visiting the Web site constructed by some students as one of their optional projects (see below). The site address is: http://www.wpi.edu/-isg_501.

Course Assessment and Evaluation

Evaluation of Graduate Student Performance. We evaluated graduate student course performance using a contract grading system that employed a combination of objective and performance assessment measures. Objective measures were homework assignments and two take-home exams. Performance assessments included class participation, and evaluation on a number of optional short and long-term projects that were done individually and in groups. Projects included: critique of an educational research article, critique of a textbook, design of instructional objectives and a course syllabus for one week of a course, preparation of instructional materials for teaching one concept, a pre-teaching portfolio, and other topics generated by the students and approved by the instructors.

An "A" grade was earned by achieving a total point accumulation of >90% of the total possible on 6 activities (homework, class participation, midterm exam, and 3 projects). A "B" grade was awarded for an 80% total, or by achieving a 90% total on only 5 activities. By similar means a "C" grade contract was constructed.

Since the students taking the course were a self-selected and highly motivated group, it was not surprising that the quality of the work we reviewed was uniformly outstanding. Eleven of the twelve students earned the "A" grade. At least two of the projects or portfolios will be available at the meeting presentation for review by interested attendees.

Student Course Evaluations. Student evaluation of the course was done using the WPI course and instructor evaluation form. This survey is similar to those used at most universities. The form has three parts: 1) 14 questions related to specific perceptions of the instructor, 2) 7 questions related to general perceptions, and 3) 9 questions related to outcomes. Ten of the twelve students responded with the following results: part 1 had a 100°/0 positive response, part 2 had a 9 1°/0 positive response, and part 3 had a 95% positive response. Positive comments about the course

indicated that students enjoyed the interactive discussion-type atmosphere, the team teaching approach, and the "break" from quantitative discipline-specific material. Suggestions for improvement indicated that students preferred a little more organization, a little less out of class work, 'more on the use of technology in the classroom, and more opportunities to practice effective teaching techniques during the course. These suggestions will be implemented in the next course offering.

Instructor Self-Evaluation. Each of us thoroughly enjoyed teaching this course. For two of us it was the first experience in teaching material outside of our discipline. It was a real challenge and little disconcerting to realize that every aspect of the course from syllabus preparation, to homework and exam development, and to preparation for each class was supposed to model "the best" in teaching. The team approach was very valuable and is highly recommended for others considering teaching courses like this. Our experience was that it really didn't save each of us significant amounts of time, but was more valuable from the interaction and collaboration standpoint. Each of us brought different skills and teaching styles to the course. We believe (and the students concurred) that it was very valuable for the students to observe differing delivery methods in similar contexts. Including a faculty member with an educational psychology, or similar background is also highly recommended.

Description of the Practicum

During the 1995-96 academic year we offered the second part of our program: *Practicum in College Teaching. Six* practicums involving five students ii-em the summer course are currently being (or will be) conducted. Each practicum is worth two graduate credits. One student, who will begin teaching at the U. S. Coast Guard Academy next fall, is completing two practicums. The goal of the practicum is to provide future faculty with a structured, closely supervised experience in undergraduate teaching. It provides hands-on activities in many areas of teaching such as syllabus preparation, design and grading of assignments and exam problems, laboratory instruction, project management, cooperative learning tasks, and lecturing. This is done under the mentorship of experienced faculty in the student's discipline, and with advising from the course faculty.

The general structure of the practicum is that each student selects a course and a mentor within their discipline. Presumably the mentor is the one teaching the selected course, though this is not necessary. One of us (the seminar faculty) serves as the advisor of the practicum. The mentor and the advisor may be the same person, in the case of students in one of the seminar faculty's disciplines. This structure requires the recruitment of faculty not involved in our summer course. Thus it is necessary that mentors be willing to allow the future faculty to participate in the course, be sympathetic to the goals of the program, and provide some time and intellectual input to guidance and evaluation of the graduate student's activities.

The specific structure of the practicum depends upon the discipline, the nature of the course, and the mentor. We were fortunate to find situations that resulted in a variety of structures and activities. These ranged from graduate student participation on a regular basis in large courses, to concentrated involvement of the graduate student for one concept or portion of a course. Table II summarizes the disciplines, courses, graduate student role, and types of teaching activities

implemented by the five practicum students. A mentor, advisor, or peer observed the practicum student at least once a week, and the group (mentor, advisor, and student) met once a week to critique the week's activities and discuss the upcoming classes. In Physics we had the unusual occurance of the mentors not being involved with the courses of interest. Fortunately the primary instructors of the courses were willing to allow our practicum students a great deal of flexibility in their teaching activities.

Practicum Evaluation and Assessment

As of the writing of this manuscript, three practicums are in progress and three more will be conducted during the spring. Thus we only have a preliminary set of data on the evaluation of each student. We are interested in assessing how our practicum students applied the theory given during the summer course, and we are interested in evaluating the effect the practicum students have on the undergraduates in the courses. The specific tools used in each case differ a bit, depending on course and discipline. In general we have measures of graduate student performance (in and out of class), peer evaluations by other practicum students, undergraduate student course evaluations, and comparative performance of practicum-taught undergraduates with those in other sections of the same course. We are interested in finding anwers to questions like: Are practicum students using the tools presented in the summer course? Are they implementing the teaching techniques effectively? Are they assessing their own progress? Are they impacting undergraduate student learning positively or negatively?

Out-of-Class Evaluation of Practicum Students. Each practicum student is keeping a journal that chronicles course activities. The journal and appropriate course materials will be compiled into a portfolio that will be graded by the advisor. The portfolio will follow the structure of a teaching portfolio, but will be specific to only one course. Material appropriate for the portfolio includes things like: instructional objectives for a classroom session that involves a demonstration, and the results of assessing the effectiveness of the demo; a description of the goals of an exam problem written to examine a particular concept, and the results of student performance on the problem; and the design of an in-class cooperative learning exercise and its evaluation.

In-Class Observation. Practicum students receive extensive in-class observation by the advisor, the mentor, and peers (see below). This provides continuous feedback to the student, and will be used as a second measure of practicum student performance relative to the goals of the practicum. For example, we can determine whether practicum students designed and successfully implemented in-class active learning strategies.

In two departments (Physics and Biology) there are two graduate students enrolled in the practicum. This allows peer observation of each other's class session in a more informal and perhaps less threatening manner than having faculty frequently present. In Physics, one graduate student observed and constructively critiqued the other practicum student for 7 weeks, after which their roles were reversed.

Outcomes Assessment. The standard WPI course and instructor evaluation forms will be used at the end of each course in the sections taught by a practicum student. This gives us quantitative feedback on how the practicum students were received by the undergraduates in course situations

that previously would have only been taught by a faculty member. Since the results of these forms are public, they can be used as an absolute measure of practicum student performance, and as a comparative measure to departmental standards.

A final measure of effectiveness is the comparison of undergraduate student performance in sections taught extensively by a practicum student to those in other course sections. The structure of the Physics practicums allows us to do this relatively easily by comparing common exam scores from each of those cohorts. We are also collecting homework, project, and quiz grade data that will be used in that comparison.

Preliminary Assessment Results. Although the assessment program is incomplete, initial indications are that the practicums are meeting or exceeding our goals. Our sense from the limited out-of-class evaluation is that practicum students are doing a conscientious and creative job. They have found ways to invigorate otherwise boring problem review sessions, have contributed new types of problems to exams, and have implemented an original in-class CL structure within the context of an out-of-class CL project. In one case, a mentor has modified teaching behavior on the basis of seeing the success of the practicum student. Portfolios from three students will be completed in January, and the remaining three in May. Similar to the summer course projects, we will bring two of these to the meeting presentation for review by interested audience members.

Our in-class observation data from peers, mentors, and advisors has shown that practicum students have gone through an evolution in their teaching style as a course developed. Initial nervousness, and the tendency to resort to straight lecturing, has changed as they each have become more confident with themselves and the methods. The “crash-and-burn” experience has been very valuable, though we would not recommend designing it into a practicum. Students who have found themselves in front of a class, perhaps not as well prepared as they thought, or facing a demo that failed, or questions that they couldn’t answer have learned much from the episode. Proper feedback from mentors and advisors has allowed them to learn from the experience and in doing so develop confidence that has been readily observed in subsequent classes.

The collection of data quantifying undergraduate student performance in practicum-taught classes is just beginning. Student course evaluation survey data is not yet available. However, we have two sets of results that are positive regarding the effects practicum students have had on undergraduates. Results from one exam in the Physics course have shown that practicum-taught students had a slightly higher mean, and a greater percentage of them scored above the mean than students in the rest of the course. In the Mechanical Engineering practicum, the graduate student has participated in the same course twice, under two different mentors. The mentors have taught the course differently; therefore the practicum student has used differing methods. Very preliminary data indicates that the students that were practicum-taught, using significant CL structures, have done a bit better than others that were taught more traditionally. Since WPI is a school that strongly encourages faculty participation in conference sections, and in general does not use graduate teaching assistants in the classroom, this data is of great value to us. It is also valuable to others considering similar programs. We will present the fill range of quantitative results from this outcome assessment at the meeting.

Summary

We have described the development, implementation, and preliminary assessment of a course and practicum in college students for Ph.D. students. The program was designed to address some of the current national and local problems in higher education. Our experience has led us to conclude:

- A course in college teaching should contain significant material on knowing your students: intellectual development, learning styles, cultural issues, etc.

- The course should contain an emphasis on active learning, project-based learning and significant training in cooperative learning, particularly structures that can potentially increase faculty productivity.

- A hands-on (practicum) experience should be available for graduate students desiring to obtain supervised practice college teaching.

- Our course has been successful in achieving its goals. Preliminary results from the practicums indicate that it is a great learning experience for the graduate students and that undergraduates in their classes have not been affected in any negative way.

Our future plans include incorporating more project-based teaching activities into the practicum, and developing the concept of teaching productivity and the assessment of productivity into the practicum.

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Table I. Outline of *Seminar in College Teaching*

I. Introduction
- A. The basics of effective teaching
- B. The "World of Academia" or what it's really like to be a college teacher

II. Knowing Your Students
- A. The basics of adolescent development
- B. Theories of learning and cognitive development
- C. Dealing with student variability
- D. Dealing with cultural variability
- E. The "typical" WPI student

III. Enhancing Student Motivation for Learning

IV. Specifying What is to be Learned
- A. Devising and using instructional objectives
- B. Developing an effective syllabus

V. Effective Teaching Skills
- A. Lecturing
- B. Leading discussions
- C. Using educational technology
- D. Cooperative learning: task design, course design
- E. Project management: the WPI system, teaching with case studies
- F. Enhancing critical thinking and creativity

VI. Evaluating Student Performance
- A. Writing fair and meaningful exams
- B. Grading: courses, group assignments, projects
- C. Graduate student advising

VII. Becoming a College Educator
- A. Developing a teaching portfolio
- B. Balancing teaching and research
- C. Discussion of student-generated topics

Table II. Summary of Graduate Student Practicums

Discipline	Course Title	Level	Structure/Size	Number Practicum Students	Offering	Practicum Student Involvement	Practicum Activities	Observation
Physics	Mechanics	First year	weekly: 3 lectures: 300 2 conf.: 25-30	2	Fall '95 Spring '96	3 different conference sections/week	in-class problems exam prep. demonstrations homework	Course director, mentor, advisor, peer
Physics	Electricity and Magnetism	First year	weekly: 3 lectures: 300 2 conf: 25-30	1	Fall '95	2 conference sections/week (same students)	in-class problems exam prep. grading homework demonstrations	Course director, mentor, advisor, peer
Mechanical Engineering	Introduction to Material Science	2nd and 3rd year	weekly: 3 lectures: 60 2 conf: 10-25	1	Fall '95	3 ditferent conference sections/week	syllabus prep. in-class problems CL tasks lecturing	mentor, advisor
Biology	Introduction to Biology	1st and 2nd year	weekly: 2 lectures: 70 3 conf:25	2	Spring '96	One complete 2-week section of the course	objectives, syllabus, project design, CL tasks, lectures, grading	mentor, advisor