AC 2008-1692: DEVELOPMENT OF A PEDAGOGICALLY-FOCUSED COURSE FOR ENGINEERING GRADUATE TEACHING ASSISTANTS

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Development of a Pedagogically-Focused Course for Engineering Graduate Teaching Assistants

Abstract

Graduate teaching assistants perform an important role at higher education institutions in the United States. Many universities and colleges host formal programs to enhance these graduate students' teaching skills. Such programs are needed since graduate teaching assistants who receive training, mentoring, and feedback from faculty about their teaching have been found to demonstrate higher self-esteem in their teaching abilities and to provide higher quality instruction within undergraduate courses. Graduate teaching assistant training courses range from campus-wide initiatives, with more organizational and administrative focuses and purely decontextualized teaching methods courses, to content-based discipline specific modules. Since engineering graduate teaching assistants' have training needs specific to their teaching responsibilities, courses focusing on pedagogy within engineering are desired.

This paper describes the development of a pedagogically-focused engineering education course based on elements of the "How People Learn" framework. The course, "Effective Teaching of Engineering: Linking Theory to Practice," was first implemented in fall 2007, at a large Midwestern Research I university to provide engineering graduate teaching assistants an opportunity to extend their teaching professional development. The course learning objectives include developing knowledge of effective teaching practices, establishing an engineering "community of teachers" during interactions with engineering faculty and peers, producing personal deliverables that allow reflection upon relationships between pedagogy and engineering, and receiving formative feedback about teaching within engineering courses.

Some of the topics in this one-credit graduate level seminar included "How People Learn" framework principles, characteristics of millennial students, model-eliciting activities, formative feedback, and effective teaching methods in engineering. Through activities such as journaling, creation of concept maps, development of teaching philosophy statements, and analyses of a course syllabus, course participants noted how their ideas about effective teaching evolved during the semester. Strengths and weaknesses of the course will be discussed in the paper as well as elements that may be included within future iterations of the course.

Introduction

Graduate Teaching Assistants (GTAs) perform an important role at higher education institutions in the United States. The tenure race at large research universities and the increasing number of students demanding higher education around the 1960's have been two of the main components for the growing reliance on GTAs for undergraduate instruction. While accomplishing the mission of relieving some of the faculty's teaching load, GTAs face a wide variety of responsibilities[1, 2]. Prieto[3-5] and Richards[6] findings suggest that the ways GTAs perceive their instructional roles have a significant impact in their development. Literature indicates that training courses are helpful to shape GTAs perceptions about their instructional roles. Prieto has been systematically documenting understanding of GTAs self-efficacy toward teaching as a function of training and supervision[3-5]. Her results indicate that formal training has a positive, statistically significant effect on GTAs' sense of self-efficacy toward teaching. A qualitative study[7] on GTAs perceptions about their graduate teaching experiences shows that GTAs enrolled in a pedagogical training course developed a more positive view and attitude toward teaching, as well as a desire to improve their teaching effectiveness.

Increasingly more and more higher education institutions have adopted training courses for GTAs. Graduate teaching assistant training courses range from campus-wide initiatives, with more organizational and administrative focuses and purely decontextualized teaching methods courses, to content-based discipline specific modules. However, there are a limited number of studies that explore GTAs' training courses within engineering specific contexts. In 1999, Brent et al. suggested teaching assistant training as part of the Model Program for Promoting Effective Teaching in Colleges of Engineering. In a recent study at the Civil and Environmental Engineering Department at Southern Illinois University Carbondale, Nicklow et al.[8] stressed the importance of specific discipline GTA training courses to address the particular needs of different fields of study. "Teaching quantitative problem solving skills, the evaluation of multiple and/or optimal solutions, the coupling of mathematics and technical writing to effectively convey complex ideas, and experimental investigation"[8] were identified as unique teaching skills in engineering education. A trend indicates that a big emphasis is placed on developing appropriate ways to prepare engineering GTAs, contrasting "how to teach" versus "what to teach" approaches. Since engineering graduate teaching assistants have training needs specific to their teaching responsibilities, courses focusing on pedagogy within engineering are desired. This paper describes the development of a pedagogically-focused engineering education course based on elements of the "How People Learn" framework as a result of the NSF-funded project, Course Innovations as a Basis for Engineering Graduate Student Professional Development in Teaching (Ref. #0632879).

Course Context

The one-credit graduate level course, "Effective Teaching of Engineering: Linking Theory to Practice," (ENE 595G) was designed for GTAs within an innovative first-year engineering laboratory course (ENGR 126) to provide an opportunity to extend GTAs' teaching professional development (NSF #0632879). ENGR 126 introduces all first-year engineering students to computer skills and techniques, provide practice with fundamental engineering concepts, and foster open-ended problem solving activities, known as model-eliciting activities (MEAs)[9]. GTAs are responsible for supervising weekly 2-hour laboratory sessions. Within these laboratories, they provide formative and summative feedback on students' assignments, and guide students through the weekly tasks. In addition, GTAs design and grade quizzes. Usually each GTA is in charge of three laboratory sections of approximately 30 students per section.

Traditional training for ENGR 126 GTAs consists of an intensive week of training prior to the start of the semester. Training is provided by the Center for Instructional Excellence (CIE) and the Department of Engineering Education (ENE) faculty and staff. This training is very practical – focused on tips for successful teaching. The Director of Laboratory Instruction and the Course Coordinator meet with the ENGR 126 GTAs weekly thereafter to overview each week's lab and address logistical and grading issues. The Director of Laboratory Instruction provides verbal feedback on the GTAs performance throughout the semester – this feedback typically focuses on very practical GTA duties (e.g. quality and length of lab overview, keeping students on task).

ENE 595G was first implemented in Fall 2007 as a complement to the traditional training for ENG 126 GTAs. ENGR 126 GTAs received information about ENE 595G within their appointment packets and were encouraged to enroll by the Director of Laboratory Instruction and the Course Coordinator; however, the enrollment was not mandatory.

ENE 595G Curriculum

The course learning objectives were developed around the principles of the "How People Learn" framework. These objectives include the following: 1) developing knowledge of effective teaching practices, 2) establishing an engineering "community of teachers" during interactions with engineering faculty and peers, 3) producing personal deliverables that allow reflection upon relationships between pedagogy and engineering, and 4) receiving formative feedback about teaching within engineering courses. Excerpts from texts such as Bransford et al.'s *How People Learn: Brain, Mind, Experiences, and School* (2000), Donovan and Bransford's *How Students Learn: Science in the Classroom* (2005) and Wiggins and McTighe's *Understanding by Design* (2005) were used within the course.

Table 1 presents an overview of the course agenda. Main themes discussed included: HPL framework principles, characteristics of Millennial students, MEAs, formative feedback, and effective teaching methods in engineering. The effective teaching sessions (sessions 8-12) were aligned to the participants' interests; among others, topics discussed in these sessions were teaching in large classes, engaging students in collaborative learning, and self-assessing one's teaching practices.

Since MEAs are one of the core components of ENGR 126, they were discussed in detail during the course, and they were used as an example of how curriculum design lines up with a learning model (HPL). The solution of an MEA requires the development of one or more mathematical, scientific, or engineering concepts that are unspecified by the problem – students must grapple with their existing knowledge to develop a generalizable mathematical model to solve the problem. An MEA has the potential to create an environment in which skills such as communication, verbalization, and an ability to work cooperatively and collaboratively are valued. Further, the attributes of MEAs support the development of the abilities and skills required of graduates of accredited engineering programs as stated in ABET Criterion 3 a to k[10]. The features of MEAs and their implementation align with the four dimensions of the HPL framework, since MEAs, by design, work with students' preexisting knowledge, are thought-revealing, and encourage active learning. Further, MEA implementation includes mechanisms for formative and summative assessment as recommended by the HPL framework.

Table 1. Seminar Agenda

Session	Topic
1	Course Overview and Discussion
2	Introduction to HPL Framework
3	Millennial Students Discussion
4	Formative Feedback Discussion
5	Introduction to Model-Eliciting Activities
6	Connections between HPL framework and MEAs
7	Curricular Discussion
8	Effective Teaching Session 1
9	Effective Teaching Session 2
10	Effective Teaching Session 3
11	Effective Teaching Session 4
12	Effective Teaching Session 5
13	Effective Teaching Session 6
14	Class Wrap-Up & Evaluation

Assessment

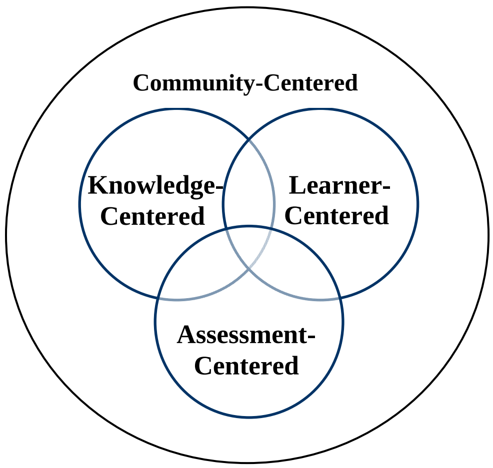
The course has six main assignments (summative assessment) and different opportunities to receive feedback from the instructors (formative assessment). Through activities such as journaling, creation of concept maps, development of teaching philosophy statements, and analyses of a course syllabus, GTAs noted how their ideas about effective teaching evolved during the semester. The assignments and grading system were designed to be meaningful to the GTAs (as some of the artifacts developed could be included in a teaching portfolio), and to provide evidence of GTAs' advancement towards the achievement of course goals along the semester. Table 2 shows a brief description of course assignments along with the purpose of each assignment.

Table 2. Course Assignments

Assignment	Description	Purpose
Journaling	Brief reflection addressing a posed question (weekly).	Reflect on various aspects of GTAs' teaching experiences and interests and facilitate participation in class discussion.
Teaching Philosophy	Concept map and written statement concerning GTAs' teaching philosophy (beginning and end of the semester).	Articulate GTAs' beliefs about effective teaching practices in engineering.
Reflection on Millennial Students	Reflection addressing the following: Who are millennial students? How are you the same or different to millennial students? How do these similarities and differences affect teaching practices?	Develop awareness of how attitudes, beliefs, and behaviors of this particular generation affect their learning experience.
HPL Analysis of Undergraduate Course	ENGR 126 syllabus analysis using the dimensions of the HPL framework (beginning and end of the semester).	Recognize the importance of aligning curriculum design to a model of learning (HPL in this case).
Faculty Interview	Synopsis of a four question themed face-to-face interview with a faculty member within the College of Engineering about his/her teaching.	Create an opportunity for networking and answering questions that GTAs might have about teaching in general, teaching engineering content, faculty's preparation as teachers, etc.
Journaling Synthesis	Wrapping-up reflection addressing important aspects learned during the semester.	Foster metacognition and reinforce course objectives.

Instruction

The course was designed and co-taught by a professor with background in both engineering and education with expertise in educational research methods and a professor who coordinated the ENGR 126 course for the past six years and led the integration of MEAs into the curriculum. The design of the course was around the HPL framework, addressing its four dimensions: community, knowledge, learner and assessment (Figure 1). During the weekly meetings, instructors guided discussions based on course agenda and students' journal reflections and interests. A collegial environment was promoted by the instructors, and the learning experiences were designed to support the achievement of course goals.



- ***Community***- Achieved by building learning communities of graduate students and faculty interested in improving their engineering teaching using research-based strategies and innovations.
- ***Learner***- Addressed by discovering what GTAs know about engineering teaching, curriculum development, undergraduate students, and drivers (e.g., ABET, resources, university and departmental goals and constraints).
- ***Knowledge***- Achieved by applying course materials and ideas to GTAs' current and future teaching experiences.
- ***Assessment***- Achieved by using formative and summative assessment tools to help GTAs reflect upon their applications of pedagogical innovations and strategies.

Figure 1. Graduate Course Model Using Four Dimensions of the HPL Framework

Lessons Learned/ Suggestions for Improvement

Course instructors learned much during the initial implementation of ENE 595G. First, since the enrolled engineering graduate students had not taken graduate level courses that required them to reflect upon their teaching and their views about teaching, course instructors had to ease students' apprehension about enrolling in such a course. Second, the optional nature of the course meant that course enrollment was based upon students' intrinsic desires to reflect upon their pedagogical practices. Finally, this course was designed for targeted group of GTAs, thereby reducing the generalizability of the course.

Course instructors have begun to reflect upon these issues as they begin a second iteration of the course. Options for the course include the integration of current GTA training with course content. This content might be presented during weekly training meetings.

Conclusions

Currently, ENE 595G allows graduate engineering students to apply effective pedagogical principles within first-year engineering environments and to leave the course with deliverables such as teaching philosophy statements and personal reflections of their teaching. ENE 595G is a unique course that could serve as a model for departments that want to offer pedagogical experiences for their graduate teaching assistants and focus upon the development of students who may become future faculty.

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