# AC 2009-2421: DEVELOPMENT OF NONTRADITIONAL SKILLS IN GRADUATE STUDENTS THROUGH TEACHING AND CURRICULUM DESIGN

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# Development of Non-traditional Skills in Graduate Students through Teaching and Curriculum Design

This paper presents a study of communication and leadership skill development in graduate students after participating in a program for cooperative faculty/graduate student teaching. Specifically, we discuss collaboration with experienced faculty to teach and design undergraduate Electrical Engineering curricula and the impact of developing these non-traditional skills in decisions regarding a future faculty career. Graduate student teaching advances the student's knowledge not only in curriculum design but also allows fine tuning for methods of professorial leadership and mentorship, all characteristics desired by institutions with strong undergraduate engineering programs. Developing a collaborative program that enables graduate students to take on the role of course instructor while working closely with faculty benefits both parties; it can specifically provide a preview of faculty demands for the graduate student prior to committing to an undergraduate institution.

The graduate student/faculty collaborative program allows Ph.D. students to instruct and manage a large Electrical Engineering general education course while under the guidance of experienced faculty. We discuss the requirements of graduate students accepted into this program and the responsibilities that are associated with acting as a graduate student instructor. Additionally, the responsibilities of the faculty mentor are examined in depth for their impact on the instructor and the instructor's teaching team. We examine communication between the graduate instructor and the team of assistants to monitor its growth over the course of a semester. Finally, several graduate student instructors participating in this program were asked to comment on their individual growth from working as a teaching assistant to becoming a course manager. Knowledge of communication and leadership skills is mandatory in any career path, particularly for educational faculty, and learning these skills through faculty/graduate student collaboration for teaching and course design is an extremely effective method to master them.

#### Introduction

Undergraduate teaching and course design is not typically a mandatory requirement for earning a doctoral degree. In fact some institutions discourage levels of graduate student involvement that span more than simply teaching assistant or grader because it can subtract in reported percentages of faculty taught classes. Collaboration between graduate students and senior faculty for team-teaching is an optimal way to introduce graduate students to engineering instruction while satisfying the department that oversees the course. This type of nontraditional graduate education has the potential to strongly improve graduate student communication and leadership skills while teaching important educational development tactics and can contribute in the decision to pursue an academic career. Implementing a Ph.D. student teaching program is an improvement to the traditional doctoral curriculum and will strongly enhance student communication and mentoring skills.

Past approaches to educating graduate students in undergraduate engineering curriculum design and instruction have been offered in the form of classes focusing on this topic<sup>1</sup>. Another approach uses teaching assistant peer mentors for helping in the growth and development of the teaching assistant<sup>2</sup>. Others have reported on building a teaching portfolio as a graduate student and team-teaching with senior faculty<sup>4,6,6</sup>. In this paper, we report a method of team-teaching that puts the senior faculty behind the scenes to act only as an advisor or mentor. The Ph.D. student instructor assumes the majority of the responsibility of course management.

# **Program Responsibilities**

The program discussed in this paper allows a graduate student to take on the role of professor for a course for a semester or multiple semesters, depending on the course offering. The faculty mentor's role is to advise the student instructor outside of the classroom and help design course objectives, lectures, and other course material. From the perspective of the undergraduates and teaching assistant team, the graduate student instructor is the manager and is completely in control of course operation, but the faculty mentor is always available to advise and guide.

Graduate student responsibilities within the system include complete management of all aspects of the course. The classes taught for this study are Electrical Engineering general education required courses. These courses are generally high enrollment laboratory classes consisting of one hour of lecture delivered by the graduate student instructor plus two hours of smaller section laboratory work overseen by a teaching assistant. The graduate instructors were teaching assistants for at least two semesters prior to becoming a graduate instructor. For this study, the graduate student instructor responsibilities include:

- *Lecturing the high enrollment class*: Typically this type of general education class can draw 60 to 85 students per semester.
- *Managing teaching assistants*: Because faculty cannot oversee each recitation or laboratory section, teaching assistants are employed to review and grade the section. Teaching assistants encountered in this study were graduate students and peers of the instructors managing them.
- *Designing course syllabi*: The department defines requirements for general education, but the instructor will emphasize the specific objectives.
- *Making course decisions and design*: It is no surprise to any experienced faculty member that decisions about the course will sometimes be made on a case-by-case basis. The graduate student instructor will be available for these decisions and personal interactions with undergraduates.

Senior faculty members participating in this study have roles in advising and mentoring the graduate student instructors. Working with faculty enables appropriate course design decisions to satisfy department requirements. Senior faculty members play an important role in backing the graduate instructor by supporting their decisions.

- *Mentoring and guiding instructors*: Faculty mentors in this study are available for mentoring and guidance for general course problems or concerns and assistance in material development. Faculty mentors are available for at least one consultation per week to debrief after a lecture and to discuss the next lecture.
- *Evaluating the graduate student instructors*: Mentor-to-instructor feedback is essential for improving teaching and communication skills. Faculty evaluations of teaching style are important for this system to be successful.

An important aspect of this faculty/ graduate student collaboration system is the ramping up of responsibility over lengths of time. The typical graduate student instructor chosen for this program spends several semesters as a teaching assistant for the course they are offered to teach. Working as a teaching assistant may be a requirement at some universities and in some cases is considered complete preparation for an academic career. This program takes this concept to the next level by allowing students to instruct and manage the course, a more comprehensive preparation for the teaching aspect of an academic career. The ramping of responsibility begins when the graduate student is working as a teaching assistant. As interest increases, the mentor begins to allow the teaching assistant to make more course decisions, write the syllabus, or design a laboratory session. Responsibility can be increased again at the stage when the assistant writes and guest lectures the course. Finally, at the next offering of the course, the graduate student will instruct rather than work as a teaching assistant.

#### Leadership of the Instruction Team

Instructors of large general education courses in the Electrical Engineering department will lecture the entire class, and lab sections meet with a teaching assistant at another time. Even though the graduate instructor has spent time as a teaching assistant, the new role of managing other graduate teaching assistants can be a challenging task. The graduate instructor needs to take on the role of manager to other graduate students that may be peers outside the classroom or students that are more senior in years or research. In addition to teaching and course design, the graduate instructor has an obligation to provide clear performance expectations to the teaching assistants.

A potentially difficult situation is when the instructor feels that he has no recourse to deal with an underperforming teaching assistant; this is where faculty mentor involvement is essential. Senior faculty can advise the instructor to handle this tricky situation on his or her own. Faculty can coach the instructor in confidence and communication of the problem and expected results, which is a communication skill very important for a future academic career. An assistant my not even understand that he or she is not meeting the expectation of the instructor, a problem easily solved with appropriate discussion. Should the communication between teaching assistant and instructor not yield the expected results, it is the responsibility of the faculty to act as a mediator between the two parties. A discussion between the three should enable understanding of the expected results. The instructor can use this type of interaction as a learning experience for future interactions with graduate students once in academia. Finally, if no compromises can be reached, the problem falls into the hands of the faculty member to bring it up in the department as any faculty would with an underperforming TA not working out in his or her class. This separation between graduate instructor and the department is necessary at this point in the process.

Communication is essential when managing teaching assistants or writing tutors. With all the new responsibility in managing a course, the instructor may let clear expectations of the assistant team fall by the wayside thinking that someone else has trained them or they have done this before. An instructor may forget that different courses have different requirements and though an assistant has plenty of experience, that person does not know the expectations of this course. An instructor may also forget that someone, at some point, trained him. Though the beginning of a

semester is full of logistic work, the instructor should take the time to write out the assistant team's responsibilities to prevent future problems. Some of the major points necessary to be mapped out for the assistant teaching team include:

- *Time commitment responsibility*: When the department hires a student assistant, they may put a label on the job as a certain number of hours per week. The instructor needs to give the assistant the jobs he is expected to do such as grading, office hours, lab time, lecture material collection and development. The instructor cannot just assume these jobs will get done without asking.
- *Deadlines*: The instructor needs to be explicit with information about deadlines for grading and submission of material for lectures, etc.
- *Grading*: It is the instructor's responsibility to map out the grading guidelines for the assistant. It cannot be assumed that assistants will grade consistently and should not be their responsibility to develop individual grading systems for an assignment. The instructor should provide rubrics, grading forms, or point value systems for assignments to be graded.

A graduate instructor managing teaching assistants is a scenario in which roles and responsibilities can become confusing. That is the reason that clearly mapping out these responsibilities upfront at the beginning of the course will benefit both parties as the semester progresses. Mapping out these responsibilities is also something that may be initially overlooked by the graduate instructor. A possible solution for this type of problem is an instructor/teaching assistant contract that outlines the expectations and responsibilities of both parties. Although it is not necessarily common to see a contract between an instructor and the teaching staff, it has many benefits that include written documentation that all parties have agreed on their roles, and that all responsibilities are clear.

Clarity and organization is essential with interaction with students, and written performance requirements are obviously necessary in dealing with the undergraduates. Any successful instructor will define performance metrics up front so as to avoid confusion in the future. It is up to the instructor to define these items, but the mentor will play an essential role in offering experience for covering topics that could be later questioned by students and presenting them in a clear manner.

## **Time Management**

Graduate student responsibilities at most research institutions include coursework, research and potentially working as a teaching assistant, but most do not include course management and instruction. Balancing teaching a large general education course with all the other student responsibilities can become a difficult task. Undergraduate students, labs, and lectures are items with deadlines or that demand immediate attention; research may be something that can be put off another day. Teaching, especially for those who very much enjoy it, can displace other student responsibilities and cause research to suffer. The graduate instructor needs to focus on spending an allotted amount of time teaching, interacting, and preparing for undergraduate work but also spend a defined amount of time researching. The graduate instructor should:

- *Set time for instructor responsibilities*: These will be the urgent, deadline items, such as having a lecture prepared in time for class or a lab ready for the lab session.
- Set an allotted amount of time for research: Clearly, research cannot be displaced and needs to be a priority as well despite the urgency of teaching responsibilities.
- *Keep track*: Time management is an important skill for future faculty. Once a faculty member, it is expected that one will teach, research, mentor, perform professional development, etc. This is a good opportunity to get a sense of how to get it all done.

Senior faculty can be a great resource for managing all the new responsibilities of the instructor role on top of the usual graduate student tasks. Mentoring this aspect is an invaluable tool for future faculty.

## **Instructor Experiences**

In this paper, we present the results of several case studies that participated in this program to analyze their experience in faculty mentored graduate instruction. The overall interview results report on the effectiveness of this program for preparing graduate students for faculty jobs, the benefits of their experience and problems they have encountered. In all cases, the subject of the study is a Ph.D. student with research responsibilities and teaching assistant experience prior to undertaking the role as course instructor. The courses taught through this program are limited to Electrical Engineering general education laboratory classes in which the instructor manages the course content, designs the course rules, leads a team of assistants, and delivers the lectures.

In the cases studied, each Ph.D. student was a TA for several semesters of the course ultimately offered to instruct. The student instructors conveyed that this experience was important when instructing the class because it offered a foundation and an understanding of how the course operated under senior faculty. This is a benefit to the program because it enables instructors to have a good idea how to manage some of the curriculum. It also offers a list of topics required by the department to be taught. One of the overall benefits of the instructor program is that it allows graduate students to experience all of the *other* aspects of managing a course besides the teaching assistant role.

When asking the study subjects how much training they received or if senior faculty applied any rules when they started as assistants, the answers varied from little to no guidance to almost micromanaging. It seems that stylistically professors differ in the management of their assistants. However, when asked what responsibilities were taken on as an assistant, the responses were common: the assistants prepared for their sections by performing the labs and reviewing and grading the homework within one week of submission. In transitioning from assistant to instructor, the differences in their individual experiences could lead the instructor to different ways of communicating with assistants. Several students commented that they tried different methods but eventually learned that more communication and clarity yielded the best results and that it cannot be just assumed that an assistant will perform expected tasks without management.

Graduate student instructors were asked to comment on the faculty mentor involvement with management of the teaching team. Students were asked about the evolution of their communication and leadership skills as they progressed from TA to instructor mentoring TA's

and how faculty guidance played a part in this learning experience. Study subjects working under different mentors were advised in different ways, some were allowed to use their best judgment in combination with their experience as an assistant. Others were strongly advised to set teaching team expectations up front to avoid confusion later. Despite different mentor advice, all of the questioned graduate instructors agreed that the program ran smoothly when defining expectations up front. This is an important lesson in team leadership that most of the graduate instructors were not aware of before instructing a large course.

The case study graduate students were asked to comment on communication with undergraduates when starting out as a TA and how it changed once they were instated as an instructor. Many of the graduate instructors discussed a large role in working with undergraduates as a teaching assistant and acted as the first contact for questions and disputes most likely because of the small lab sessions taught by the TA. It was reported by all of the graduate instructors that in order to maintain a relationship with the students, attendance in the lab sessions was necessary. Instructors all agreed that spending even a small amount of time in the lab session made them more accessible as a teacher for the undergraduates. The faculty mentors also agreed with this policy and advised graduate instructors to participate and interact with students outside of the lecture hall.

Time management is an important concept for graduate student instructors. The graduate students were asked how they manage to fulfill the expectations of their research advisor while at the same time instructing a large course. With such an immense workload made only more difficult with the steep learning curve of managing a course, much of the work spilled over into evenings and weekends. One student reported research suffering because of the extra work; others reported work crossing into personal time. The faculty mentors' comments regarding time management are interesting and useful because senior faculty manage research, teaching, and so much more. This experience proves to be a good opportunity for training. Learning how to manage a class early on will only make things work more smoothly for an academic future.

The case study graduate students were asked if this program affected their decisions about future faculty careers. All students asked commented that the program has affected their decision and given them a good idea of the demands on full time faculty. Several of the students reported that this experience gave them confidence to enter a faculty position and a feeling like they are being well prepared for education. They noted that they felt prepared to design courses on the undergraduate level and learned skills that could be applied to the development of graduate courses. Many commented that they had no idea how much more time and responsibility was involved in being the course instructor than being an assistant, and that this program much more thoroughly prepared them for academia. One student reported that the program reinforced an ambition to become an undergraduate engineering professor, and another stated that the cooperative program created a strong interest in becoming university faculty.

## Conclusions

Engineering education is evolving with the new generation of young faculty entering universities. Training these instructors as Ph.D. students prepares future faculty for the expectations of a high quality undergraduate engineering program. Preparation in lecture and

course development is an important skill to take to that first faculty position, but skills in time management, mentoring, communication and leadership are even more invaluable for an academic career.

We performed a case study analysis of a new program that allows interested graduate students to be paired with a faculty mentor to experience the teaching responsibilities of faculty working with a large undergraduate general education class. Communication and leadership challenges can arise from managing the assistants to managing a large lecture, but the cooperative program allows any problems be dealt with through advice from the experienced faculty mentor. The unique experiences of the instructors show growth in their communication and leadership skills from working as an assistant to becoming a full instructor. The case study participants acknowledge this program as invaluable preparation for an academic career, and several attribute it to reinforcing their desire to be engineering faculty.

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