Preparing for an Academic Career Through Team Teaching as a Graduate Student

Timothy Murphy and Jamie Phillips

The University Of Michigan, Ann Arbor, Michigan 48109

Introduction

Many graduate students pursue their doctorate degree as a milestone towards the attainment of their ultimate goal, to be an educator. Unfortunately, many of these students will go to graduate schools where they will have little, if any, chance to develop their teaching skills in the face of the research workload necessary to obtain a doctoral degree. Many students will obtain their doctoral degrees at Research I universities, focusing primarily on research, and then end up teaching at schools where there is a greater emphasis on teaching. Typically, a graduate student will have the opportunity to be a teaching assistant for one or more semesters, but as these positions are commonly for lab classes or discussion sections, the student does not gain experience in the actual preparation, delivery, and assessment of an entire course. However, if the student graduates and is able to obtain an academic faculty position, that is exactly what they will be expected to do, most likely during their first semester on the job. Depending on what has been left behind by the last professor to teach the class, a new professor may have to develop all of the lecture material, a syllabus, homework problems, examinations, and possibly laboratory experiments. This is a daunting task for anyone, but especially so for someone who has absolutely no experience. Consequently, incorporating some type of voluntary teaching education into the PhD curriculum could provide graduates who are better prepared for their first faculty position and more confident that they are making the right choice in pursing a career as an educator.

In this work, a one-semester junior-level electrical engineering class is taught by a team of one faculty member (mentor, Phillips) and myself, a PhD-seeking graduate student (mentee, Murphy). The purpose of the project is to provide me with 'real-world' teaching experience that will help me as a future junior faculty member as well as help me make an informed decision as to whether a career in teaching is right for me. I will discuss my motivations for participating in this project, the lessons that I learned while participating, the extent of the time commitment, and the impact of the project on me regarding the two goals stated above. The results of midterm and end-of-term class evaluations are also presented to assess the attitudes of the students towards the project.

The Team Teaching Experiment

In the Fall semester of 2004, the course "EECS 320 – Introduction To Semiconductor Devices" was taught using the team teaching approach. This course is an introductory course in my field of study and is representative of a course that I would probably be assigned to teach immediately after obtaining a faculty position. There were approximately 100 undergraduate students

enrolled in the class. Prior to participating in this project, I took a class on pedagogy called "ENGIN 580 – Teaching Engineering" taught by Dr. Susan Montgomery[1] at the University of Michigan. It was decided that I would be responsible for planning and delivering approximately 25% of the course lectures as well as the associated homework and test questions, under the guidance of the faculty member. Both parties collaborated on other aspects of course planning such as the syllabus and course objectives. The collaborative environment was also used to introduce active learning techniques[2] into the course materials, which were typically absent in previous semesters of this class. The students' learning styles were assessed at the beginning of the semester using the Index of Learning Styles Questionnaire[3], which was based on the Felder and Silverman model[4]. Class session and homework/examination problems were developed to appeal to the range of learning styles, and class performance was correlated to the learning styles assessment in order to determine the effectiveness of the approach. A midterm evaluation was administered to the students of the class by Dr. Cynthia Finelli of the Center for Research on Learning and Teaching (CRLT) focusing on the team teaching aspects of the course. The standard end-of-term evaluations were also administered along with a separate evaluation specific to the team teaching project. This evaluation included questions about the team teaching environment as well as my performance. During the semester, I was actively involved in scientific research towards a Ph.D. in electrical engineering and consequently had to balance time between my research and the teaching project, similar to what an actual faculty member would have to do. I was provided with a set of course notes from previous semesters as a starting point for planning my lectures. Finally, since this project was not for credit or pay, I had the option, with the faculty mentor's approval, of discontinuing my participation at any point in the semester.

Motivation

My primary purpose for pursuing a doctoral degree was to obtain a teaching position upon graduation, with the understanding that a faculty position would also require significant research. As my PhD study proceeded I became aware that I was learning how to perform research for my eventual career, but found myself learning little about teaching. This was troubling to me because a significant fraction of a faculty member's duty is teaching. Perhaps the best way to develop and improve teaching skills is through experience; experience that will have to be gained 'on the job'. Another frightening aspect of the situation was that, having no substantial teaching experience, I was not sure if teaching was even the right career for me. I was nervous about the prospect of moving my family across the country for an assistant professor position, only to find out later that I just don't have the intrinsic capability or interest in becoming an effective educator. These concerns prompted me to take a graduate student instructor (GSI) position for one semester during my PhD work. The position turned out to raise more questions than it answered, however. My position was basically as a lab instructor for a course which I had taken several years earlier and which was out of my area of expertise. I basically had no input into the material covered in the labs and I was forced to re-learn a lot of the material for the labs just days before the students. Although I received good evaluations from my students at the end of the semester, I found the whole GSI experience very disheartening. Unwilling to give up on the profession of teaching at this point, however, I enrolled in a teaching engineering class to see where that would lead. The class ended up being very rewarding. I learned a tremendous amount about teaching and learning and felt pretty good about my decision to go into teaching

when it was over. This only partially alleviated my concerns though. I still wanted to get some experience under my belt before making the final decision. Consequently, I was extremely motivated to participate in the team teaching project. This turned out to be important as the project became a significant time commitment and I became aware that my research was suffering because of it. I considered many times discontinuing my participation, but my initial motivation carried me through to the completion of the project.

Time Commitments

Initially, I did not expect any substantial drain on my research due to the team teaching project. I assumed that I would find enough time during my research schedule to plan for my classes and that planning for my classes would not be that time consuming anyways. Especially considering that I was given a template, so to speak, of what my lectures needed to cover. However, as it turned out, the team teaching project proved to be a major consumer of my time over the course of the semester. My portions of the class were spaced out nicely, so that I had about a month in between each of my sections of two lectures each. My cycle of lecture preparation went basically like this:

- For the first two weeks of the month, I would only give cursory attention to my coming lectures and contribute time at odd intervals as I found free time available.
- Two weeks before my lectures, I would begin working in earnest on them and take some time away from my research in order to focus on the preparation.
- For the last week leading up to the lecture, I would work almost exclusively on the lecture preparation and homework assignment at the exclusion of my scientific research.

Based on this, one might conclude that if I had been teaching the entire class, I would have had to completely abandon my research and focus solely on preparing lectures and homeworks. And, as it turns out, this statement is not far from the truth. I spent considerable time making, editing, and practicing my lecture materials. I believe this to be caused by the fact that it was my first time teaching the class, however. If I were to teach the class again, I could reuse a significant amount of my material and would have a much diminished time requirement. However, I think that graduate students considering doing this type of project need to acknowledge the fact that significantly less time will be available for research. One needs to consider whether extending their Ph.D. program will be worth the experience and knowledge they gain and the potential head start in a faculty position that team teaching provides.

Some may wonder why it took me almost two weeks simply to prepare 3 hours of lectures, and I must admit that I am somewhat taken aback by the figure myself. It turns out, though, that only about a quarter of that time was spent planning the lectures. The rest was spent actually ‘building’ the lectures incorporating active learning components. This included making animations to help visualize microscopic processes, developing in-class exercises, and working through problems to present in class. Had I focused on merely lecturing to the class, my preparation time commitment would have been diminished significantly.

The Flow of the Class

One challenge in this project that I had not really anticipated was the issue of the flow of the class. It is easy to sit down before the semester and plan out who will teach which lectures and on which dates, but as the class starts going, things start to become more fluid. For instance, in a class taught by a single professor, when one lecture runs long or another doesn't take as much time as anticipated, the professor can adjust on the fly. However, in a project like this, partial lectures cannot be easily accommodated for. This seemed especially true for our class at the beginning of the semester. We could have easily moved the whole lecture schedule up one half class period because of the rate at which the material was being covered. However, that would have left us in the situation where I would have had to start my lecture in the middle of a class period, which was not an attractive option. Consequently, we ended up covering some material more slowly, with a liberal amount of review, than would have normally been done. In the end, all of the necessary class material was covered, but it might have been nice to have that extra time for some of the more challenging topics or for exam review.

Specific Lessons Learned On Teaching Methods

Over the course of the semester, I learned many lessons that I simply would not have been aware of without the team teaching experience. The first of these was 'Do not leave students stranded at the board'. During one of my early lectures, I invited two student volunteers up to the board to demonstrate a concept that I had just covered. When I planned my lecture, it seemed like a straight-forward exercise and one in which the students should have no problem. However, as it turns out, the students had no idea what to do, and so I had them sit down and then I went and fixed their drawings. It occurred to me afterward that I handled that situation in completely the wrong way. By calling them up to the board and then leaving them to flounder, I made it less likely that anyone would volunteer to come to the board again, and I am sure that the two students in question did not feel good about the experience. So, in one of my final lectures, I once again called students to draw on the board, with some difficulty finding volunteers, but this time, I helped each student to ensure that they had the right answer before they sat down. Then, I went back through with the whole class to 'check' the answers to see if they were correct. Sure enough, all of the volunteers got the right answer and I believe it turned out to be a much better experience for the class and especially for the volunteers.

The next important lesson I learned was that you need to work completely through the homework before assigning to the class. On one of my homework assignments, I just did some rough calculations to ensure that the problems worked, only to discover during office hours that one of the problems did not work the way that I had intended. This led to the dreaded 'homework update' email going out to the whole class and a feeling of inadequacy for me.

In engineering it is very common to see the same Greek letter or symbol used for many different physical parameters. Even worse, in some cases, the same physical parameter will be defined in a slightly different way depending on the text book or source you are using. During this course, I had one such incident in which the text book defined a parameter in one way, but I chose to define it in a slightly different, what I believed to be more standard, way. This led to significant confusion on the ensuing homework assignment, and when it was done, I wished I had just taken

the meaning from the textbook and avoided the whole situation, especially since the parameter in question wasn't even central to the course material. It proved to be a huge distraction with essentially no benefit to the students. I know that it can't always be the case, but I think that whenever possible, I learned that I should just use the symbols and definitions in the text book.

The last important lesson that I took away from this project is, I am sure, familiar to any veteran educator and that is: you have to be very specific on examination questions. Students will come up with answers you have never dreamed of, and in their own way there may be some truth to their answers, which, if not worded precisely enough, leaves you in a position to have to award credit for answers that may have nothing to do with your intentions for the problem and may not demonstrate the knowledge that you were intending to examine. Having this type of problem also makes the exam questions that much more difficult to grade, which is a significant problem when there are 100 such exams to grade. I encountered this problem on one of my exam questions, where I was expecting an answer of a sentence or two in length which was basically just a re-statement of a concept we discussed in class. Several students looked at the problem in a different way and got by with a two-word answer that really didn't show any insight into the problem. In the end, I was forced to give full credit for the short answer, while taking away points from students who had attempted to get the correct long answer but fell short. This was a very troubling outcome for me because I try to reward people for their progress towards the correct answer as much as getting the correct answer, but in this case, in order to be fair, I had to give full credit for almost no work. I felt fortunate that I was only responsible for one of the questions on this test, so that this one mistake of mine didn't have a significant impact on the overall test. Had I been responsible for the whole test, for instance in my first year of teaching, and made this mistake it could have been a very big problem.

Each of the lessons learned that I mentioned above was a specific result of the team teaching project, as it is very unlikely that I would be called upon to make up test questions, homework questions, or have students work problems on the board as a graduate student instructor. Consequently, I don't feel that being a graduate student instructor can take the place of a team teaching type experience.

Evaluation Results

As mentioned in the introduction, midterm evaluations were performed in order to assess both the team teaching environment and my performance. Eighty-four students participated in the evaluation. First they worked in teams of three to seven students discussing and reaching consensus on the strengths and suggested changes for the course. Then the facilitator (Dr. Finelli) worked with the class as a whole to gather the responses. Some of the responses as to the major strengths of the course included:

- Together, we provide a good coverage of the material that applies to a variety of learning styles.
- The pace of the material is reasonable and the lectures are well-organized.
- The visual aids in class and the Java applets[5] online are very good, and there is a nice mix of PowerPoint and board work.

Some of the comments regarding changes that could be made to the class included using a microphone when talking, clarifying homework, and providing a list of variables for the class. None of these were unexpected except possibly the microphone issue which had somehow escaped mention for half of the semester. In reference to the team teaching environment, about 10% of students suggested that the teaching time should be split evenly between the two instructors, and about 75% said that the consistent lecture notes but differing teaching style between the two instructors worked well to keep things versatile.

End of semester evaluations were also used to gain feedback on the team teaching environment and my performance specifically. The students were asked if they felt that the team teaching environment aided their learning in the class and then on a subsequent question, they were asked if it was an impediment to their learning. The mean of the responses to the first question was solidly in the "Neutral" area, meaning they did not strongly agree or disagree with this statement. The responses to the second question tended more toward the "Disagree" side, which seems to indicate that the class as a whole did not feel that they were cheated by participating in the team teaching project. Other questions pertaining to the student's learning styles showed a mean in the "Neutral" area and questions about the effectiveness of the learning aids received a predictable "Agree" response. The questions regarding my teaching effectiveness, preparation, and presentation skills all had means between "Neutral" and "Agree", indicating that the students felt I performed in an average manner on my sections. The standard deviations on all questions were 1 or less indicating that there was widespread agreement among the students on the ratings.

Impact Analysis

Considering that the purpose of this project was to give me real world teaching experience as well as help me determine if teaching is the right career for me, it seems relevant to discuss the impact of this project on me in these areas. There is no question that this project provided valuable experience for me. Even though I only managed 25% of the class, it gave me a sufficient feel for what it would be like to run my own class. As mentioned above many lessons were learned in the comfort and safety of a mentored environment. Many more lessons were learned outside the classroom while planning lectures, homeworks, and tests with my mentor. I have to assume that without this mentoring opportunity, I would have had to learn these things on my own once I obtained a faculty position. However, having worked on this project, I now feel that I could do a very good job teaching a class in my first semester as a junior faculty member and successfully avoid the 'rookie mistakes' some of which I have mentioned previously. In this respect, this project was an invaluable experience and a big success. I also feel that having had the team teaching experience will enable me to shield my first year of students from these 'rookie mistakes' and therefore have a benefit to the students that I teach my first year as a faculty member.

Going into this project, I was fairly certain that teaching was the right career path for me. This is something that I have believed for many years. There can be no question that this project gave me every opportunity to change my mind. I had a certain anxiety about presenting my lectures in front of nearly one hundred students, and this anxiety did not subside over the course of the semester. For me, this anxiety stems from apprehension about whether I will be able to answer the questions posed by students, whether the students will perceive me as a credible instructor,

and the possibility that I will simply bore them to tears. As to whether I bored them to tears, I have no idea. The majority of the class stayed awake through my lectures, despite the 8:30 a.m. start, so I have to assume that I performed adequately in this regard. Credibility is another issue that I cannot measure. I did not have any students openly attack my credentials or knowledge, so I am left to assume that I performed adequately in this regard as well. However, the students' questions turned out to be a very relevant fear. On more than one occasion, students asked me questions that I simply did not have answers for, or that I was unable to find a suitable explanation for. I have to admit that these occasions were my lowest points mentally on this project. It is a very diminishing experience to fumble around for an answer in front of 100 students only to realize how obvious the answer was an hour later. If there was any aspect of this project which caused me to question whether teaching was right for me, it was this. Every other issue that came up, I felt that I could overcome with practice or simply awareness. However, having the appropriate answers to students' questions at your fingertips is a whole different matter entirely. It requires a very broad knowledge in the subject which is something my PhD work, a very narrow focus, will never provide me. However, having taught the class for the whole semester, I do feel that I have a clarity on this material that I haven't felt since I took the class myself. So it is possible, that after teaching the class a few times, I will have these difficult answers more readily at my fingertips. In the end, I can only trust that this is a skill that either comes with experience or after a few years of teaching you've either heard all the questions before or you become a better predictor of what types of questions the students will ask. Although this seemed to cast a gray shadow over the project for me, in all fairness, this is an issue with teaching in general and is merely exposed by the team teaching project, not caused by it. Consequently, I can't consider this to be a negative of team teaching. There were, however, many positive outcomes. I enjoyed the opportunity to lecture in front of real students. I appreciated the feedback I received from both the students and my mentor. I gained a new respect for the amount of time involved in preparing to teach and I think that I became more efficient in my preparation as the semester progressed. And mostly, I was extremely happy to have a 'safe' environment to get my first teaching experience under my belt. Taking all this into consideration, I believe that the team teaching project has shown me that teaching would be a positive and rewarding career for me.

Conclusions

The current engineering PhD curriculum at most universities does not provide graduate students with the opportunity to learn how to teach or the opportunity to make an informed, experience-based decision on whether a career in teaching is right for them. The establishment of a team teaching opportunity for graduate students could alleviate both of these problems. In participating in this team teaching project, I learned many lessons that I could apply to a future teaching career, I developed more confidence in my ability to teach, and I feel more able to make an informed decision about pursuing a career in academia after my PhD work. Further, based on student feedback, the project does not seem to have had any detrimental effects on the students in the class, and some students even preferred having two instructors. Consequently, it seems that providing the option for team teaching in the PhD curriculum could be valuable for not only graduate students, but also the academic community as a whole.

Acknowledgements

The authors would like to thank Dr. Cynthia Finelli from the Center for Research on Learning and Teaching at the University Of Michigan for valuable advice and conducting the midterm student feedback session. The authors would also like to thank the EECS Dept. Chair Prof. David Munson for his encouragement of this project.

Bibliography

[1] http://www.engin.umich.edu/dept/cheme/people/montgomery.html

[2] Wankat, P. C. and Oreovicz, F. S., *Teaching Engineering*, available online at https://engineering.purdue.edu/ChE/News_and_Events/Publications/teaching_engineering/index.html.

[3] http://www.engr.ncsu.edu/learningstyles/ilsweb.html

[4] R.M. Felder and L.K. Silverman, J. *Engr. Education*, 78(7), 674 (1988).

[5] http://jas.eng.buffalo.edu/