Future engineering faculty: How do they think about teaching?

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Abstract — Although many preparing future faculty programs exist, engineering graduate students interested in the professorate often have few opportunities to approach their teaching as a scholarly activity. While much research on educators’ conceptions of teaching in higher education exist, little of this research has focused on the conceptions of engineering educators and even less on the conceptions of engineering graduate students. In the Engineering Teaching Portfolio Program, graduate students in engineering who are interested in faculty careers discuss and reflect about their teaching within the context of creating individual teaching portfolios that can be used for faculty job searches. Using a qualitative research design, these engineering graduate students were observed during the peer-led, peer-facilitated program sessions, and were later interviewed about how their experiences in the teaching portfolio program influenced their teaching. In this paper, we will focus on what we learned from a pilot offering of ETPP about fifteen graduate students’ conceptions of teaching.

Index Terms — Engineering graduate students, Faculty development, Teaching conceptions, Teaching portfolio

INTRODUCTION

An awareness of the importance in preparing Ph.D. students to become faculty has increased in recent years. It is argued that there is a serious need to improve the way graduate students are prepared for an academic career [1]. The discrepancy between the graduate training that produces Ph.D.s who become the next generation of faculty and the need for those new faculty members to be able to teach has led to increased dissatisfaction among the institutions who hired them [2]. The disparity between doctoral education and faculty work needs to be addressed.

The notion of scholarship as an integral part of a faculty career has been reexamined and expanded during the 1990s. Scholars such as Boyer; Paulsen and Felderman; and Rice claimed that the specific features of faculty work have been significantly developed during this timeframe to include the various distinct, yet interrelated and often overlapping dimensions of discovery, integration, application and teaching [3]. The varying responsibilities associated with an engineering faculty career are most commonly characterized in terms of research, teaching and service. Most PhD students and people who hold PhDs in engineering may have experience with supervising and conducting research; traditional doctoral programs in engineering offer fewer opportunities to familiarize graduates with responsibilities related to teaching, such as discussing and explaining teaching decisions and teaching philosophies, and developing instructional designs based on the scholarship of teaching. Engineering graduate students are typically under-prepared to meet the rigors of teaching responsibilities that are required in academia. The findings from the 2000 National Doctoral Program Survey [4] indicated that only 42% of engineering respondents felt that their teaching experience adequately prepares them for an academic/teaching career.

The conceptions of both learning and teaching held by teachers affect their approaches to teaching [5]. Therefore, it is important to study and understand their conceptions of teaching. Most engineering faculty receive little preparation and guidance for their teaching roles [6]. Significant amounts of teaching in the engineering discipline are done using traditional lecture approaches, and with little feedback and mentoring. Ph.D. students teach the way they were taught. As Brent & Felder stated before, “college teaching may be the only skilled profession that does not routinely provide training to its novice practitioners” [7]. This indicated the assumptions that engineering faculty is often naïve about their teaching responsibilities; their teaching conceptions are heavily based on previous experiences and there is limited training and professional development to help them teach in a university setting. Increasing faculty awareness of teaching responsibilities is important to effective education of future students as well as their own faculty career. Because graduate students and postdoctoral associates represent future engineering faculty, providing opportunities for them to learn more about teaching in higher education settings and prepare for a faculty position becomes a way to promote effective teaching in engineering. Therefore, there is a clear need and demand for professional development opportunity specifically for teaching.

As educators we know we need to understand prior conceptions in order to create learning opportunities. Therefore, we need to understand these future engineering faculty’s conceptions of teaching in order to create opportunity to learn about their teaching. Although many preparing future faculty programs exist, engineering graduate students interested in the professorate often have few opportunities to approach their teaching as a scholarly activity. Compared with graduates in other fields, engineering graduate students have even fewer opportunities to prepare for the responsibilities of a faculty career.

In the Engineering Teaching Portfolio Program (ETPP), graduate students in engineering who are interested in faculty...
careers discuss and reflect upon their teaching within the context of creating individual teaching portfolios that can be used for faculty job searches. ETPP is a unique program and is a part of the NSF-funded Center for the Advancement of Engineering Education (CAEE), which was created to advance research about scholarship in engineering teaching and learning and to increase the use of effective pedagogies in engineering classrooms.

ETPP also offers an interesting place to learn about future engineering faculty’s conceptions of teaching because its: (1) peer-led, peer facilitated environment, we know these conceptions merged from these peer discussion without any other influences; and (2) 8 week sessions, these teaching conception discussions sustained through a prolonged period.

In this study, we explored engineering graduate students’ conceptions of teaching as directed by teaching portfolio construction activities. Although much research exists on educators’ conceptions of teaching in higher education, little of this research has focused on the conceptions of engineering educators and even less on the conceptions of engineering graduate students.

To investigate this issue we analyzed our field observation and interview notes using qualitative methodology. The data we collected was from a pilot offering of the ETPP [6]. The focus of this program was to help engineering graduate students formulate and create a teaching portfolio for future academic job searches. In this paper, we focus on what constitutes graduate students’ conceptions of teaching that we hope will provide a useful resource for examining and bridging the discrepancy between the realities of Ph.D. programs and faculty career.

METHODOLOGY

I. Participants

From two information sessions and a college wide email list, there was a high level of interest in responses. However, our study involved participants committing to participating in the entire eight-week program. Fifteen participants eventually volunteered to participate in the ETPP. The participants for this group were diverse – especially in terms of background and education. There were 7 females and 8 males in the participating group. Participants were divided into two groups. All were advanced engineering Ph.D. students with the exception of one engineering post-doctoral associate. Six participants were in Computer Science & Engineering, four participants were in Mechanical Engineering, three participants were in Civil & Environmental Engineering, and two participants were in Electrical Engineering. Among the three participants in the Civil & Environmental Engineering, one was a post-doctoral associate. The rest of the participants were Ph.D. students in the College of Engineering.

II. Context – ETPP program sessions

Participants met weekly for 1.5 hours. Participants were encouraged to provide constructive feedback to peers and to receive feedback. The objectives of ETPP were to help participants (a) create a draft teaching portfolio; (b) develop a network of fellow graduate students and early career postdocs interested in teaching; (c) discuss teaching issues with colleagues; (d) envisage teaching as decision making; and (e) explore the teaching responsibilities of a faculty career. The end result of attending the ETPP is to have participants:
1. Create a teaching philosophy statement;
2. Identify 2-5 teaching artifacts;
3. Annotate these teaching artifacts;
4. Create a diversity statement;
5. Complete a draft of teaching portfolio.

III. Data Collection

A large portion of the data was collected through an ethnographic method of direct field observation. Two graduate students were paid to participate in one group and observe the other group. The graduate student observers maintained the consistency of a peer-led research design. The field observations included real time typing on a laptop to record all participants’ contributions. At the end of the last ETPP session, a focus group interview was conducted. Each participant also completed an individual written exit survey as well as an individual exit interview. All data collection methodology was approved by the University of Washington Human Subjects Division and all participants signed consent forms agreeing to participate in the study.

IV. Data Analysis

The entire data set consists of field notes, semi-structured interview notes, focus group discussions and an exit-survey. In this study, we used the field observation, interviews and focus group discussion notes to identify and code for participants teaching conceptions. All of the notes from field observation, interviews and focus group discussions were analyzed using constant comparison techniques and NVivo qualitative data analysis software. The constant comparison method is a research approach developed by Glaser & Strauss (1967). Each researcher compared and contrasted data field notes systematically and frequently to identify emergent themes. Codes were assigned to specific lines of emerging data and then further organized into broader categories encompassing these initial codes. The data was rich and descriptive; in this paper we report themes that are related to participants’ conceptions of teaching.

FINDINGS

The breadth of teaching experience among these participants ranged from significant teaching experience with numerous teaching assistant (TA) appointments, lecturers, lab assistant, mentor and/or tutor experience to minimal teaching experience with no formal teaching experience. Some participants had worked as lecturers in which they designed and taught courses and supervised multiple TA’s. A couple of the participants were actively seeking faculty positions during the program.
Most of the participants were thinking ahead and were planning to look for faculty positions actively within 1.5 – 3 years. Many of the participants expressed interest in a faculty position in a teaching and research institution. A couple of the participants specified teaching intensive institutions.

The empirical assessment of the pilot study data indicated that a significant number of the advanced graduate students involved had a very sophisticated awareness of teaching as a scholarly activity and were able to conduct and engage in very high level discussions about pedagogy. Participants with limited teaching experience also had strong opinions about teaching and were able to discuss teaching issues constructively. Each participant was assigned a unique identification code (i.e. T6, S7…etc) in order to protect their confidentiality. We divided the findings into three different dimensions: (1) the ABC’s of teaching; (2) teaching as decision making; and (3) on the road to scholarship of teaching. In each dimension, we show excerpts of conversation from ETPP participants.

I. The ABC’s of Teaching (Attitudes, Beliefs and Conceptions)

Participants showed different attitudes, beliefs and conceptions of teaching throughout the program’s sessions. Participants also challenged one another in their attitudes, beliefs and conceptions of teaching.

1. **Attitude: Attitudes about teaching**

   We noted any example, story, or discussion of how a participant feels or thinks about some aspect of teaching.

   “I also thought about how teaching agreed with my life. Yeah, I took a global view, how teaching fits into my life. It was more of a spiritual thing. I believe teaching is my life calling. It was around 1996, about the middle time I was in the Navy. I felt then that I was first called to teach” (S6).

   “I struggled between making it sound sincere while fighting the feeling that it was not really, well I don’t know how to say it, but it doesn’t really matter in academic settings. Professors don’t think teaching is important and they don’t care” (S2).

   “I figured it was better to do this now than after I am out of school. A couple of months ago, I was talking to a friend of mine from my master’s program who worked in industry and is now back in academia. He told me to think about my teaching in graduate school, don’t wait until later since that was really a problem for him when he got back in academia. I never thought that I would need to think about teaching this early in my career. I really took my friend’s advice. This is why I was looking for something like the teaching portfolio program” (T6).

2. **Belief: Responsibilities toward students**

   These were descriptions or discussions of what responsibilities teachers/faculty have towards their students or what relationship teaching should have with their students.

   “Some people would not envision the relationship terminating when students leave” (S4).

   “These other two are things I wrote for the class webpage so that students would understand the course…I chose these because it shows that I care about students understanding what they are supposed to do… and this one is not from a class I TA’ed or taught…I was sitting in on an undergraduate class…at one point the teacher started discussing something that was very confusing and not in the book…I sat down and wrote out a clear explanation and then posted it to the class” (T3).

3. **Belief: The role of mentoring**

   These were discussions or descriptions of mentoring as it pertains to teaching.

   “I picked up on that, too, I saw three paragraphs about mentoring underrepresented groups. You could contribute to diversity by mentoring to a wide variety of groups participating in programs” (S3).

   “I have a lot of students that I TA’ed a few years ago and we still meet for coffee” (S7).

   “Mentoring…what do you think that mentoring offers that could compliment classroom teaching…” (T5)

4. **Conception: What constitutes teaching?**

   Participants had varying ideas about the definition of an activity or activities that they considered to be some form of teaching.

   “In the past I didn’t see what counts as teaching, such as tutoring” (T6).

   “I think the industry stuff is a lot like teaching. Isn’t that what you do as a consultant, teach people things?” (S7).

   Usually participants could define activities that they engaged in as a form of teaching. Although occasionally participants disagreed and challenged one another on what really constitutes teaching.

   “What about mentoring masters students in the lab?”(S3)
   “In my CV, I put that under research experience” (S6)
   “But I think it’s more teaching than research” (S3)
   “But it’s training in research” (S6)
   “But I think of it as teaching” (S3).
5. Conception: What is “good” teaching?
Here we coded for any discussion in which participants evaluated some aspect of their teaching as being effective, good, useful, something they would recommend that others do, and/or something they would continue to do.

“I wanted something that touched on a bunch of concepts. Give an example of every possible situation” (S6).

“Good teaching…if you try different styles to reach everyone rather than just one group” (T3).

“What I do is after every class, as soon as the mob of students disappears, write yourself an email describing what worked, what didn’t work, what the high points were” (T2)

“So really reflect on your teaching” (T1).

“I think I’m aware of diversity, case by case basis, I don’t think of it as lumping it as three women in my class, what will I do to encourage them, I try to offer all the students what they need, I have never thought about it as encouraging minorities and underrepresented groups” (S2)

“I think I’m aware of diversity, case by case basis, I don’t think of it as lumping it as three women in my class, what will I do to encourage them, I try to offer all the students what they need, I have never thought about it as encouraging minorities and underrepresented groups” (S2)

“I liked the basic goal statement, open and encouraging for all students, that’s the best thing you can do” (S3)

“Checking up on those who are struggling would fall nicely with frequent feedback” (S2).

II. Teaching as Decision Making
Participants routinely discussed decisions that they had made about their teaching. The topics of discussions ranged from decisions of teaching context to discussions on how to accommodate different student learning styles.

1. Recognizing teachers are decision makers
Some participants recognized themselves as a decision maker. Participants realized that they have to decide what are the most important materials, as well as what approach to use to deliver these materials to their students.

“I think teachers fall into this category too. The teachers are deciding what information to present. For example, an intro to microbiology teacher decides what is most important for their students to know” (S6).

“After talking with other people in the program I have more awareness of how to make class better for student as an instructor…In practice, I will be more proactive even if I am only a tutor or grader” (T6).

2. Teaching Context
Participants reported instances where they made a specific teaching decision based on some context for their teaching, such as being in a classroom or lab, time constraints, size of class, room layout, etc.

“I guess it depends on how much control you have in a class as an instructor or a TA. I have a changed viewpoint. Before, I wouldn’t have considered changing the class format unless prompted to do so by the instructor. I would be more motivated to do this now. Before, I would have taken a more passive role. It’s good to be exposed to what other people did in their classes, other ideas, actually thinking about it in advance. This definitely will affect my future decisions” (T6).

“How do you discern when a teaching institution or a research institution…” (S1)

“How do you discern when a teaching institution or a research institution…” (S1)

“Teaching is undergraduate [institution] only” (S2)

“When at a small institutions, you need to pick a specific research niche” (S1).

3. Decisions about teaching content
There was some evidence showing that some participants’ teaching decisions were made over what content to include in certain aspects of their teaching.

“I’ve thought about it…what to do in classroom…try to make everyone feel included…so hard to cater to the beginner students…So hard to teach to them…so you teach to the middle ground…assuming that they have this background from the previous class…don’t assume anything else” (T1).

“It was a conscious decision for me to talk about form rather than using a lot of concrete examples” (T5).

4. Decisions based on student characteristics
Participants were aware of different student characteristics such as their background, ethnicity, gender, and learning styles, etc.

“I thought it was fine, sometimes students learning needs are based on their backgrounds, ethnicity, gender” (S3).

“I remember you talking about ESL…you gave an example test that was worded simply…then you gave a question on the test that had them apply the theory… so you were catering to different learning styles…some people learn better from examples…some people better in big pictures…I think it’s all there, you just need to sequence it” (T4).

Some excerpts showed where a teaching decision was made based upon the students’ learning styles.

“I’ve seen examples where people give students different options for assignments” (S4).

 “…Talks about women might learn in a more hands-on way” (S3).
"I didn’t want to penalize students who couldn’t do them so I tried to make sure learning styles were addressed” (T1).

We also observed that participants were challenging one another on their awareness of students’ learning needs.

"I didn’t see the sensitive as a bad thing; it shows that you are developing as a teacher. The question I have is about the second paragraph [of the teaching philosophy], how would you teach students with different learning needs, in a class of 50 if people are doing a lot of different things, then how will you deal with it?” (S7)

III. On the Road to the Scholarship of Teaching

Many participants indicated awareness of teaching as a form of scholarly work. All participants acknowledged that teaching is beyond lecturing, they viewed teaching as an active endeavor to convey their knowledge to assist student learning. For some participants, they indicated that they have always wanted a career in teaching and research. This was a common reason why the participants reported pursuing a Ph.D. in their discipline, so they can teach in higher education.

1. Goals and accomplishments of teaching

While engaging in the program’s sessions, participants were vocal and analytical about their teaching goals and accomplishments. In the first excerpt, participants were engaged in a discussion about the items they could put in their teaching portfolio. The participants generated a list including awards, publication, and grants. However, an important issue was brought up by T3 that he saw was missing from the list.

"I didn’t see any evidence about teaching and mentoring graduate students. I thought this was really odd given that this is a really important aspect of research” (T3).

“What do you want to accomplish when you teach? (S3)

Make sure that students are getting it” (S2).

2. Recognizing pedagogy

In reflecting upon their past teaching experiences, participants showed awareness of pedagogy with or without using commonly accepted pedagogical terminology.

“I like how you talk about teaching as an art, how to make the class motivated, how to make it fun, then I liked how you talked about the profession” (S3).

“It’s unconventional but great…really perspicacious…this is the kind of creativity that you get with collaborative learning…you told us you hadn’t really read much ed theory…but you get it all…where you describe explaining to your 3 year old son it’s just classic in learning theory” (T5 after reviewing a statement from T4).

3. Applying pedagogy

In the following examples, participants showed evidence of applying some aspect of pedagogy in their teaching. Some participants were aware of pedagogy and actively apply it to certain aspects of their teaching.

“I’m also more inclined to pay attention to publications that relate to teaching practices and try some of the techniques. I’ll take them more seriously, and think about them critically. I guess I’ll have a more scientific approach to teaching” (S6).

“I already had experience with non-lecture based teaching methods, finding undergraduate research mentors, and talking about mentoring undergraduates” (S7).

4. Analyzing pedagogy

Participants were discussing research about teaching, comparing the efficacy of different teaching methodologies or discussing their own scholarly research about teaching.

“I also plan to spend more effort in the future on diversity readings, there is wide importance of diversity in teaching” (T2).

“Call this my car salesmen paragraph…my interest in gender diversity is considered in all activities as faculty…in teaching, in classroom, in interactions with other students…in my research for gender parity in CS…” (T5).

5. What are my options?

This category includes any evidence that participants recognized as less traditional forms of teaching, i.e., non-lecture based teaching. This could be recognizing or validating active learning methods such as (but not limited to) problem based learning, collaborative learning, and/or inquiry-based learning.

“Until I went through the program [ETPP], I always thought my teaching style would be traditional with lectures, homework, and exams. But then I also thought that writing and group work were important too. So I thought about how I could fit those into traditional teaching. I had heard of some of the buzz words…” (S3)

“When I first saw active learning, I thought this would be a good way for a person new to teaching or new to the subject matter. It was just a thought that came to mind. In engineering, no single right approach exists – I thought it was too strong to say that. There are certainly aspects of engineering that could be done wrong” (S6)

“It’s true, but I’m not sure how much this follows the introduction of how I teach for them, the students are the center of the teaching” (S4).
6. Assessment as an integral part of teaching
Participants also engaged in discussion about how to assess whether students are learning or how to evaluate whether their teaching methods are working. Participants were aware that assessment is an essential part of teaching.

“What about encouraging a change in students, not measuring the students?” (S3).
“Maybe it’s more shortening that or using it as just one example...how you would apply a fair measure of success” (T4).

The scholarship of teaching will always be an integral part of a faculty member’s career. The intention of ETPP was to provide a space for engineering graduate students to think, discuss and reflect on teaching as a scholarly activity. According to our findings, engineering graduate students in this sample are very aware and sophisticated in thinking of teaching as a form of scholarly work. Attitudes, beliefs and conceptions of teaching were reflected throughout the program session discussions, interviews, and focus group interviews.

CONCLUDING REMARKS

The majority of the future engineering educators in this study commented that reflective thinking on their teaching experiences helped shape their conceptions of teaching. Furthermore, participants gleaned from extra-curricular resources, peer experiences and daily life when discussions about teaching emerged. This evidence suggests that the “empty vessel” model does not apply to this specific group of Ph.D. graduate students and post-docs. These participants recognize the importance of teaching in higher education and continue to engage and seek external assistance to help shape and educate their own teaching practice.

I. Limitations

The ETPP participants were a self-selected group as they volunteered to be a part of the pilot offering. These participants were also highly interested in teaching in higher education, therefore their motivation and enthusiasm to discuss the scholarship of teaching are not necessarily applicable to all engineering graduate students. Several students also participated in the Computer Science (CS) Education group and were actively pursuing engineering education research. Since this may have contributed to extremely fluent and lively discussions about teaching engineering, our data may not accurately portray a more aggregate population of advanced graduate students in engineering across other institutions. Although participants who were affiliated with the CS education group had a more sophisticated understanding of the pedagogy, our results also showed that the participants with limited teaching experience still hold strong opinions about teaching and were able to systematically engage in teaching discussions. Our results further imply the need to understand the teaching conceptions of future engineering faculty.

II. Future Implication

ETPP provided a space for graduate students who are interested in the faculty career to discuss teaching decisions. We believe the program has potential to help participants view teaching as a form of scholarly activity. Some participants reported gaining a greater awareness of what constitutes teaching through their participation in the program. Participants assimilated their conceptions of teaching through peer reviews and peer interaction. In the peer environment, participants reflected upon their past experiences as teachers, tutors, and/or mentors. Participants were also comfortable in challenging each other’s conceptions of teaching. Participants found these peer discussions valuable and helpful in increasing their awareness about the effect of their teaching decisions.

Self reflection and peer review may help in recognizing important teaching experiences and support professional development for engineering graduate students. Discussing teaching while constructing a teaching portfolio provided a space for participants to reflect on their own experiences as well as helping one another. Creating a teaching portfolio is a promising tool for advanced engineering graduate students who are interested in pursuing a faculty career.

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