

Preparing Future Engineering Faculty: Influences of a Professional Development Seminar on Doctoral Students' Understanding of Faculty Work

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Additional projects involvement include: Engineering is Elementary (EiE) Project; Computational Thinking/Pedagogy Project; Rocket Project of SystemsGo; World MOON Project; East Lubbock Promise Neighborhood (ELPN) Project; and Robotics. Since 2013 he has served as the president of the Nu Sigma chapter of Kappa Delta Pi: International Honor Society in Education and was the founding president of ASEE Student Chapter at Texas Tech University. He can be reached at ibrahim.yeter@ttu.edu.

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Introduction

Systematic, thorough preparation of doctoral students in graduate school for academic careers in engineering increases the likelihood of their future successes in professoriate roles¹. Doctoral education has therefore been undergoing curricular changes to complement students' traditional disciplinary preparations with interventions that raise student awareness of expectations of faculty members in engineering and offer opportunities to address these expectations while still in graduate school. Examples of curricular activities include department or college level seminars and institution or multi-institution level professional development programs. Intent of curricular activities has ranged across preparation for research, teaching, and/or service². However, in-depth evaluations about how such curricular activities influence students' preparation for academic careers in engineering are still sparse. This exploratory study examined influences of one curricular activity – a professional development seminar – on students' understanding of faculty work, to provide evidence for the seminar's effectiveness on students' preparation for academic careers in engineering.

Background

Traditional models of doctoral education, included in engineering education, have focused on developing abilities of doctoral students to conduct disciplinary research. While ability to conduct disciplinary research is an area of expertise required for success as an engineering faculty member, future engineering faculty also need abilities to work in other roles in the professoriate, including supporting programs for scholarly/creative inquiry, teaching and service³. In these roles, faculty engage in both base-professional (e.g., content expertise, research techniques) and meta-professional (e.g., instructional design, public speaking, resource management) skills. Previous research suggested that doctoral students do not completely understand the roles and responsibilities of the professoriate because current models of doctoral education formally develop students' base-professional skills only through disciplinary research^{1,4}. Further, students often lack formal preparation for the meta-professional skills required of faculty to be successful in their roles^{1,3}. Insufficient preparations for faculty careers results in low self-efficacy in students and can affect doctoral students' performances as future faculty⁵.

One way to potentially improve preparation of future faculty through engineering doctoral education is doctoral students' participation in professional development seminars that allows them to explore different dimensions of faculty work. Professional development seminars can provide formal opportunities for students to socialize themselves into faculty roles, receive guidance from faculty and professional speakers on various aspects of faculty life, and become aware of the knowledge and skill-sets essential for success in faculty roles^{6,7,8}. For example, STEM students who participate in teaching preparation programs become more aware of different types of academic roles and institutions and are apt at handling teaching situations as faculty after participation in the programs⁹. Further, according to Anthony and Taylor,^{10, 11} students who understand the norms and expectations of their workplace are successfully employed. Similarly, engineering students who become familiar with roles and expectations of

faculty may become successful engineering faculty after being formally socialized to the academic profession.

Purpose, framework and research questions

Given roles of professional development seminars in student success, present research explored influences of a future faculty seminar on engineering students' understanding of faculty work and preparation for roles of the professoriate using Austin and McDaniel's conceptual framework⁹. Based on their framework, future faculty must develop abilities and skills along four different dimensions:

- i. conceptual understanding of a person's discipline, history and types of higher education institutions, and professional identity as a scholar and professor,
- ii. knowledge and skills related to teaching and learning processes, research, service and institutional citizenship,
- iii. interpersonal skills such as communication and building collaborations with a diverse people, and
- iv. professional attitudes and habits related to ethics, lifelong learning, developing professional networks, passion and balance in life⁹ (slightly modified block quote)

Within this framework of abilities and skills, the following research questions were examined to determine how the future faculty seminar influenced students' understanding of faculty work.

The research questions that were explored in this study are:

- (1) How do doctoral students describe successful engineering faculty after participation in the preparing future engineering faculty seminar?
- (2) How do doctoral students' descriptions of successful engineering faculty change from participation in the preparing future engineering faculty seminar?

We posited that, after participation in the seminar, students' descriptions of successful engineering faculty would fall along the four dimensions.

Description of curricular intervention

A one-credit professional development seminar was offered to doctoral students who were enrolled at the Dwight Look College of Engineering at Texas A&M University in fall 2015 and had expressed interest in an academic career in engineering. During 14-week seminar, which met once a week, students explored competencies and skills required to apply for and succeed in academic positions at research extensive doctoral universities; the college is interested in priming students for starting careers at these types of universities.

The seminar was designed after a review of relevant literature to cover topics in three segments: developing an academic brand, preparing for job search and job application materials, and flourishing in an academic job. Specific topics included:

Segment 1:

- understanding the job and job market,
- creating a professional brand using an e-portfolio, and
- establishing positive professional identity

Segment 2:

- conducting a job search,
- developing research, teaching and service philosophies,
- acquiring interview and negotiation skills, and

- finding alternate career paths post-graduation (if unsuccessful in academic search)
- Segment 3:

- writing grants
- publishing, and
- dealing with difficult work issues

Each topic was addressed by an expert or a panels of experts in research, teaching, leadership, and/or service.

To receive credit, students were required to attend at least 12 of the 14 classes. In addition, they submitted pre- and post-surveys, a curriculum vita, teaching, research and service philosophies, questions for panels, course segment reflections, and e-portfolios. By the end of this seminar, students were expected to (a) describe realities of the academic job market, (b) articulate their professional aspirations and competencies, and (c) develop materials to compete for and succeed in the academic job market.

This seminar and its evaluation emphasize development of doctoral students' understanding of faculty work in engineering through its exclusive topical focus on multiple job search and on-the-job skills. The emphases of this seminar may be contrasted with descriptions of other future faculty programming that emphasize development of either amalgamation of skills needed throughout- and post-graduate school⁹ or just teaching skills in students^{12,13}. Even though the seminar did not explicitly aim to improve students' understanding of faculty work, current research explored influences of seminar's topical focus on students' descriptions of successful faculty and their preparation for faculty work using a qualitative case study methodology.

Methods

An instrumental, single holistic case study approach^{14, 15} was used to explore participants' descriptions of successful faculty and influences of the seminar on their descriptions of successful faculty after receiving appropriate permissions from the Texas A&M University's Institutional Review Board (IRB). In this context, the holistic case is defined as descriptions of successful engineering faculty for a group of students who participated in the previously described future faculty seminar. Students bracketed out their existing descriptions of successful faculty prior to week 2 of the seminar. They responded to the research questions (1) and (2) after participation in week 14 of the seminar. Understanding the research case is instrumental to design of future versions of the seminar and research studies that explore the roles of the seminar on engineering students' preparation for academic careers.

Data collection

A retrospective approach was used to collect data after obtaining consent from participants from the target population (n = 19). Participants' demographics were obtained from a post-seminar survey, which consisted of six categorical questions, three Likert-type questions with items on a four-point scale and six open-ended questions. Only the categorical questions on demographics are reported herein. Likert-type and open-ended questions are not relevant to the research questions asked in this study. Demographics questions included the six categorical questions: gender, residency status, year in PhD program, department, and post-graduation career options. Qualitative responses to what it means to be a successful faculty and influences of the seminar on

participants' descriptions of successful faculty were obtained from their pre- and post-seminar reflections.

Participant characteristics

Research participants consisted of all students (n = 12) who gave consent to use their post-seminar survey data and reflections from the professional development seminar. Of those who gave consent, two persons did not complete the post-seminar survey. Hence, demographics are reported for only 10 persons in Table 1. Twice as many males than females completed the post-seminar survey. A majority of participants were international students who were in advanced stages of their PhD careers. Three of the participants reported their residency status as domestic. The gender and residency status demographics were similar to those of the target population. A majority (n = 8) of the students were fourth year students. The remaining were either in their third year or fifth year and beyond of the PhD program. Students belonged to one of the following engineering departments: civil engineering; computer science and engineering; chemical engineering; electrical and computer engineering; mechanical engineering; nuclear engineering; and petroleum engineering. The frequency is stated in Table 1. Participants were primarily considering careers as tenure-track research faculty (n = 10), government or national labs professionals (n = 9), and tenure-track teaching faculty (n = 7). This interest was followed by interest in careers as non-tenure-track research faculty, professionals in industry or non-profit organizations (n = 4 each). Participants were least interested in non-tenure track teaching faculty positions (n = 3). Of those who gave consent, one person did not complete the post-seminar reflection. Therefore, qualitative findings are derived from a sample size of 11.

Table 1: *Participants Demographics*

Category	n
Gender (n=10)	
Female	3
Male	7
<hr/>	
Residency Status (n=10)	
Domestic	3
International	7
<hr/>	
Years in Program (n=10)	
3 years	1
4 years	8
≥5 years	1
<hr/>	
Engineering Program (n=10)	
Civil Engineering	3
Computer Science and Engineering	1
Chemical Engineering	1
Electrical and Computer Engineering	1
Mechanical Engineering	2
Nuclear Engineering	1
Petroleum Engineering	1

Data analysis

Participants' responses to descriptions of successful faculty and evolution of their descriptions were analyzed using content analysis on post-seminar responses.¹⁶ First, two persons independently reviewed all 11 responses; the typical number of participants for qualitative analysis is 8-10 persons.¹⁴ After reviewing participants' responses, the persons coded responses for text that described successful faculty and changes that occurred in participants' descriptions of successful faculty. Once majority of coded text was agreed on, the first author coded the text into four types of competencies expected of doctoral students and outlined in Austin and McDaniel's conceptual framework of skills and abilities essential of future faculty^{2,9}. The competencies include conceptual understandings, knowledge and skills, interpersonal skills, and professional attitudes and habits. After coding for types of competencies, factors within each competency were counted for frequency of observations. The frequency of observations (n) is listed next to each factor in the results section.

Credibility of research

Findings derived from data analysis on a small sample size (n = 11) may cause credibility concerns to reviewers. Qualitative research, however, "focuses on smaller groups in order to examine a particular context in detail" (p. 57)¹⁷; therefore, the sample size used in this research was appropriate for purposes of a preliminary exploration of influences of the professional development seminar on students' descriptions of successful faculty. Research credibility was maintained through peer debriefing of raw data and arrival of consensus during and after data interpretation. Participants' descriptions of successful faculty were also informally triangulated with their bracketed descriptions prior to participation in the seminar to check for consistency and variations in descriptions. Where possible, the researchers have provided thick descriptions (i.e., quotes from participants) so that the reader may arrive at his or her own conclusions about credibility of this research.

Results

Participants' descriptions of successful faculty in engineering and changes in their descriptions as a result of participation in the professional development seminar are described first. This is followed by description of course components which influenced participants' descriptions of successful faculty.

Descriptions of successful engineering faculty – roles

Participants explicitly identified three roles that faculty must serve to be considered successful. For example, one participant described the roles that include research, teaching and service and institutional specific meaning of success in roles as such:

I knew what the three main pillars were for being a faculty member (research, teaching, and service) and commented on how the time spent in these can vary from school to school, making it hard to exactly define what would be considered "successful.

While all participants (n = 11) identified research and teaching roles similar to the quoted participant, only nine (n = 9) of the 11 participants identified service roles. Only three

participants explicitly recognized that success in different faculty roles is dependent on institutional focus.

Descriptions of successful engineering faculty – characteristics of roles

According to the participants (n = 7), successful faculty in research have the knowledge and skills of running a research lab effectively. For example, they can set-up a research lab, recruit students to do research, do research themselves, secure funding and publish papers that further their fields.

In teaching, participants (n = 7) noted that successful faculty have knowledge and skills to teach effectively. This understanding is illustrated with a sample comment (below) that describes a participant's perception of ideal competencies of a "good teacher."

To be a good teacher requires preparing course goals and learning outcomes to make objectives of the course and each class clear to all the students, involving students into the learning process as much as possible, and last but not the least come up with good assessment and evaluation assignment.

In a service role, successful faculty have knowledge and skills (n = 4) to plan and manage projects, mentor students and promote student success. In both research (n = 6) and teaching (n = 7) roles, successful faculty also have the interpersonal skills to engage, motivate, inform, and communicate with students and persons outside of the university. In service, they have, for example, the skills (n = 4) to recognize opportunities to work collaboratively on a team.

Participants (n = 7) also identified many professional attitudes and habits that they considered essential for success as faculty in all three roles. While there was no consensus among students on essential attitudes and habits, the following characteristics were mentioned: driven by convictions and visions of the institution, have the ability to work independently and collaboratively, are persistent, adaptable, efficient, and have a good work ethic. Participants were also aware that successful faculty are also good at managing their different roles and have an awareness of their responsibilities towards society.

Differences in descriptions of successful engineering faculty

Majority of participants reported differences in their perceptions of successful engineering faculty after participation in the course. Their ideas about what it means to be a successful faculty were refined (n = 2), clear (n = 2), structured (n = 1) or realistic (n = 1). For example, one participant described differences in perceptions of successful engineering faculty as such:

[After participation in the course] I still believe that research, teaching and service are the most important pillars, but I think I can sum up my beliefs about being "successful" in a faculty role more succinctly now: a successful faculty member is one who can make a lasting, positive contribution throughout their career to their university and beyond in the areas of research, education, and service.

Participants experienced changes in conceptual understanding of faculty work (n = 8), increases in awareness of knowledge and skills required of faculty (n = 5), and gains in knowledge of professional attitudes and habits (n = 5) typical of successful faculty. Example responses are presented below.

Conceptual understandings

Changes in participants' conceptual understanding of faculty work were related to their understanding of purposes of higher education and identity as a professional in the field. For example, a participant's understanding of the purpose of higher education shifted from a focus on external criteria for success (tenure) to intrinsic purpose of faculty work (education) after participation in the seminar. The participant stated:

I essentially came into the course thinking that if you were successful in your role as a faculty member, you consistently met or exceeded the criteria for making tenure throughout your career. I still think that tenure is a decent measure, but the purpose of a university is education... and if you are not educating students in some fashion, I do not think you are successful. To sum it up, I now prefer to take a longer view than tenure as to what makes a faculty member successful - their contributions to education and all that comes with it.

Another participant came to the realization that that a professional identity of faculty would require acquisition of skill-sets different than that of graduate students.

Knowledge and skills

Participants claimed that they are aware of the steps required to become a successful engineering faculty after participation in the seminar. They now had knowledge and awareness of skills that are required to run a successful research program. For example, they gained knowledge about recruiting students, writing grants, and managing a lab. They also recognized the need to develop personal skills such as time-management, social skills and networking to become a successful faculty member.

Professional attitudes and habits

Some participants also recognized professional attitudes and habits required of successful faculty. According to them, success in a faculty position comes through passion (n = 2), hard work and devotion (n = 3) and/or continuous development of personal skills such as abilities to receive mentoring (n = 3) and time-management (n = 5). Recognition of hard work and time-management as essential habits of successful faculty is especially evident from the following statement:

Successful faculty members simply work harder and efficiently on improving teaching and developing research ideas. Moreover, I believe a key fact to become successful is to get the job done as soon as possible; leaving everything for the last minute will become extremely detrimental to the career in the long term. In my perception, successful faculty

members in the tiniest details: i.e. does he/she answers (sic) an email on a reasonable time frame? As a research advisor, does he/she provide the student with 20 min of his/her time to discuss the research project? These trivial tasks say much about how the good the person is in handling the job, more specifically handling time.

Influences on descriptions of successful engineering faculty

While the seminar influenced participants' descriptions of successful faculty in its entirety, the following seminar components were explicitly recognized from qualitative responses as contributors of changes in descriptions: faculty and panels of faculty experts (n = 6), seminar topics (n = 4), and seminar assignments (n = 1). The seminar topics that participants identified as influential include: job search and interviewing (n = 1 each), teaching philosophy (n = 1), academic service (n = 3), difficult topics (n = 2), and grant writing (n = 1). One participant said that drafting of research, teaching and service philosophies influenced his/her understanding of a successful faculty member.

Discussion

This study examined influences of a one-credit, fourteen-week seminar on engineering doctoral students' preparation for academic careers. Specifically, the study explored students' descriptions of successful engineering faculty as well as how these descriptions evolved. Results are expected to help revise the design of the seminar and inform future evaluation studies.

Participants' responses to questions posed in the study indicated that majority understand the different roles and expectations for successful engineering faculty. While some participants were aware of the three roles of successful faculty prior to participation in the seminar, others became aware of three faculty roles for the first time. One possible explanation for knowledge of the research, teaching, and service roles prior to the seminar is informal socialization of the participants¹ to these roles via interaction with their faculty in academic environments⁹ or through direct observation. The informal socialization to faculty roles may have occurred as students - majority of who were in advanced stages of their doctoral careers - progressed through their graduate careers. However, even at the conclusion of the seminar, not all students mentioned service as a role to be successful faculty. Service, especially, is a "hidden" element of faculty activities; therefore, its role may not have been evident to all students before seminar and seminar designers have concerns that some participants may be insufficiently informed about this role even after the seminar if they missed the session on academic service. Overall however, by the end of the seminar, the vast majority of the participants were aware of three roles of successful faculty (research, teaching and service).

Not all participant responses indicated understanding about how expectations for faculty success depend on the type and mission of the institution. This might be because participants study at a research extensive institution where research has the greatest influence on faculty success. Since seminar designers work at this institution, seminar objectives were tailored towards faculty preparation for institutions with similar characteristics. Participants who know how faculty expectations depend on the type and mission of an institution roles may have had experiences

with faculty or students at institutions different from Texas A&M University. Alternatively, occasional in-class examples of how faculty expectations depend on institution type may have influenced students' responses to questions about this issue. It is also possible that the participants just did not explicitly state this awareness in their responses.

Analysis of evolutions in participants' descriptions of successful faculty suggests the seminar positively influenced students' understanding of faculty work. Certain speakers, seminar topics (for e.g., teaching philosophy, academic service, and grant writing) and assignments, however, appear to be more influential than others at shaping participants' understanding of faculty work. Some participants' conceptual understanding of purposes of education and exposure to roles integral to identity of successful faculty at research extensive institutions was enhanced through the seminar. Many participants' responses indicated deeper awareness of knowledge and skills, interpersonal skills and professional attitudes and habits essential for succeeding in academic positions. These positive changes indicate that some participants' understanding of faculty work has improved through the seminar. Increased awareness of faculty work would hopefully have either prepared students or given them knowledge about skills they ought to acquire to be successful in various faculty roles.

Further, results show a non-uniform and low frequency count of text on all dimensions of faculty work. While non-uniformity and low frequency count of findings can be a result of the limitations of exploratory nature of this research (described below), non-uniform findings could also suggest that not all participants developed along all four dimensions of faculty work. This implies that the seminar topics, for example, would need to be broadened to include explicit discussions on characteristics of types of institutions and professional attitudes and characteristics of faculty. Assignments may also have to be changed or modified to include explicit instructions so that students have multiple opportunities for reflection on all four dimensions of faculty work.

Limitations and directions for future research

While preliminary results suggest that the seminar positively influenced students' understanding of faculty work to varying degrees, this exploratory study acknowledges methodological limitations. The retrospective approach to data collection did not allow researchers to determine if non-uniform and low frequency count of text on some dimensions of faculty work was a result of the research approach or a mismatch between the seminar's topical focus and outcomes related to improved student understanding of faculty work. Therefore, researchers should conduct future work proposed in this study to increase confidence in present findings prior to making changes to the seminar content and assignments.

Without resource limitations, a more extensive, nuanced, prospective, and targeted approach to data collection could provide a more comprehensive understanding of influences of the seminar on students' conception of faculty work. For example, future qualitative work could include interviewing of participants regarding changes in their conceptual understandings, awareness of knowledge and skills required of faculty, and knowledge of professional attitudes and habits

typical of successful faculty. Interviewing participants would give researchers opportunities to further probe participants' understanding of all four dimensions of faculty work. This would also allow researchers to re-check the credibility of preliminary findings and establish method and data triangulation. In addition to more extensive data collection at one institution, studies done at multiple types of institutions could also be conducted to understand how the topical focus of the professional development seminar influences students' understanding of expectations for faculty members at different types of institutions. Further, additional studies could be conducted to understand if demographics of participants has varying influence on participants' understanding of faculty work. These studies could help improve recommendations for seminar topics, speakers and when students in the doctoral program should be encouraged to participate in learning about these topics.

Conclusion

Doctoral student preparation for academic careers in graduate school is becoming increasingly necessary as expectations for faculty members continue to rise. To address this need, the Dwight Look College of Engineering at Texas A&M University implemented a one-credit professional development seminar to help students prepare to meet future faculty expectations of research, teaching and service both during the academic job search and in their roles as the professoriate. Although the seminar was designed using research for preparing future faculty members, seminar designers were uncertain about the seminar's influences on participants. Therefore, this study examined participant perceptions of seminar influences on their understanding of expectations for successful faculty to estimate their preparation for faculty careers in engineering. Students' self-reported descriptions suggested the seminar refined their understanding of what it means to be a successful engineering faculty. Specifically, it deepened students' conceptual understanding of faculty work, increased awareness of knowledge and skills required of faculty, and improved knowledge of professional attitudes and habits typical of successful faculty. The limitations of self-reported evidence have been acknowledged in the manuscript. Description of the seminar design and implementation and connections to student self-reported evidence may help individuals (e.g., graduate deans, faculty development professionals, and program evaluators) at other institutions design effective professional development seminars to prepare future engineering faculty at their institution.

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