Exploring the role of institutional climate in preparing engineering doctoral students for academic careers

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Abstract

To support doctoral students’ preparation for academic careers, many institutions have established programs that provide opportunities for these future faculty to learn about educational theory and participate in mentored teaching practice. Yet, many of these programs are disconnected from the discipline-specific requirements and must be completed in addition to research and other responsibilities. When considering how to further support doctoral students’ professional development, designers of these and similar programs need to account for the effects of particular components of the institutional climate on students’ pathways and teaching experiences. Institutional climate in this context considers perceptual and behavioral dimensions of the higher education environment such as departmental climates, the influence of advisors, and the role of peer support. A case study methodology was designed to explore the experiences of alumni from a program that prepares students for academic careers and to examine the role of institutional climate on their experiences. Multiple sources of data from these program alumni were collected concurrently and analyzed using a modified analytic induction approach. The analysis presented here focuses on data from a subgroup of the alumni population, specifically those alumni from engineering disciplines. Results of this study indicate the effect of departmental culture on graduate students’ abilities to secure teaching opportunities or obtain support for professional development in teaching. “Champions” from within these departments, however, support students’ introduction to the program and their overall experience. Finally, the participants discussed the role of the program’s learning communities in facilitating the development of their instructional practices while in the program and after. Results of this study support the continued improvement of career preparation programs by taking into account the effect of institutional climate on doctoral student preparation for diverse career pathways. In addition, these results complement existing literature about the graduate engineering student experience and the development of future faculty.

Introduction

To support doctoral students’ preparation for academic careers, many institutions have established programs that provide opportunities for these future faculty to learn about educational theory and participate in mentored teaching practice. The aim of many of these programs includes closing the gap between students’ pedagogical training in graduate school and their entrance into faculty life. The students who participate in these programs engage in new ways of thinking about teaching and learning and explore potential new avenues for their future career as university faculty with teaching responsibilities. Since these programs often focus on strategies appropriate for teaching undergraduates, they can also serve as a mechanism for improving the quality of undergraduate education.

Yet, many of these programs are disconnected from doctoral students’ discipline-specific requirements and thus, must be completed in addition to research and coursework. When considering how to further support doctoral students’ professional development, designers of these and similar programs should consider the various levels/sources of support students will need in order to engage successfully in the program. Institutional level support considers whether the climate is one in which teaching is highly valued. Furthermore, structural and
Experiences of Engineering Graduate Students in Academic Career Preparation Programs

Many studies in the last decade have explored professional development approaches that may support the preparation of engineering doctoral students for academic careers or other careers that include teaching (e.g., Austin and colleagues1,7). These studies highlight key factors that may affect a program’s impact on a graduate student’s overall experience within the program and after. The use of learning communities1,7,13 and opportunities to network with faculty members3, for example, have been shown to support students’ development as educators and their overall preparation for academic careers. In addition, research has identified areas for improvement in these programs, including a need for increased mentoring6,14, more explicit feedback1, and additional autonomy in the classroom13,15.

However, similar to how the effectiveness of a product depends on the context in which it is used16, the overall impact of these programs can be affected by their educational setting (i.e., the people involved, the institution, etc.). For instance, doctoral students may receive conflicting messages from faculty, program staff, and their peers regarding career pathways and the necessary preparation for those pathways1,8. “Advisors, particularly in STEM fields, may urge [their graduate students] to avoid spending too much time on teaching preparation in order to ensure sufficient attention to research” (pg. 85)1. Doctoral students may also shy away from career opportunities at non-research intensive institutions due to faculty (or their peer’s) perceptions of the career path5 or misunderstandings about the environment at a research intensive versus a non-research intensive institutions6,14. In addition, many institutions are requiring students to take teaching appointments to serve as instructors or lecturers15, which many view as less prestigious when compared to research appointments1. Thus, it is important define the impact of the environment where these programs are being implemented. The study presented in this paper complements existing literature by isolating particular components of the environment that affect an engineering doctoral student’s experience within an academic career preparation program and their overall preparation for an academic career.

Defining Institutional Climate

The term ‘institutional climate’ is often used in educational studies focusing on diversity, persistence, and retention11,17 for a wide range of student and faculty populations. Still, studies aimed at exploring the role of institutional climate on graduate students’ experiences are limited and have focused mostly on disciplines or programs outside of engineering12,18,19. For example, Solem and colleagues (2009) examined the role of departmental climate on geography graduate students. The results highlighted the critical role of dynamics in the department environment and the overall culture of the discipline and institution on the professional development of the graduate students in that population.

The conceptualization of ‘institutional climate’ used in this study is based on the definition from Hurtado and colleagues related to diversity11,17,20. Institutional climate is expressed using four dimensions11: historical, structural, perceptual, and behavioral. The historical dimension captures
an institution’s legacy, while the structural dimension characterizes the social and ethnic group characteristics on a campus, typically using objective measures (e.g., size, selectivity). The perceptual dimension illustrates “an individual’s perception of institutional responsiveness” to the issue being explored (p. 165)\textsuperscript{17}. Finally, the behavioral dimension describes the social interactions across groups within an institution. When applied to the context of doctoral students’ professional development and programs for preparing future faculty for academic careers, these dimensions can be described as follows:

- **Historical dimension**: The legacy of an institution (including its mission and policies) with regard to the value ascribed to graduate student professional development, support for preparation for diverse career pathways, and the availability of, and support during, teaching opportunities
- **Structural dimension**: The size and composition of programs that prepare students for academic careers, including, but not limited to measures of diversity of students enrolled, diversity of post-graduation plans, and frequency and duration of teaching experiences
- **Perceptual dimension**: A doctoral student’s perception of peer, faculty, departmental, and institutional support for his/her career preparation and professional development
- **Behavioral dimension**: Interactions among graduate students, program staff, and faculty

For the case study presented here, the focus of the analysis will be on the perceptual and behavioral dimensions. Future work will focus on the analysis of institutional climate using all four dimensions.

**Methods and Data Sources**

**Research Site & Sample**

The academic career preparation program under examination, Program for Students Pursuing Faculty Careers (PSPFC), serves graduate students on the campus of a large, state-sponsored, research university with more than 20,000 students and more than 1,000 full-time faculty. The program, housed in the institution’s teaching and learning center, was created following the results of a survey in 2008. The survey findings indicated that graduate students at this institution were interested in pursuing academic careers, but did not feel adequately prepared for the associated teaching responsibilities. The design of PSPFC integrates elements from similar preexisting programs at other institutions, while also considering the particular context of this research university. As such, the program, which formally began in Spring 2009, aims to provide graduate students from all departments on campus the opportunity to participate in formal courses as well as workshops and consultations with teaching and learning center staff.

PSPFC utilizes a two-level (intermediate and advanced) certificate program to provide a series of scaffolded teaching opportunities. The certificate program is comprised of four credit-bearing courses designed to expose participants to educational theory and mentored teaching practice. The intermediate level certificate is achieved upon completion of a course on fundamental education theory (PSPFC 1001) and a mentored teaching practicum (PSPFC 1002):

- **PSPFC 1001**: Introduces graduate students to principles of learner-centered teaching and provides opportunities for students to design lesson plans, practice implementing those lesson plans through micro-teaching sessions, self-reflect on those experiences, and give and receive peer feedback. The course size commonly ranges from 16 to 20 students.
- For PSPFC 1002, students partner with faculty or staff mentors to teach 15% of a course often in their discipline. During the semester, students also meet weekly with a learning community of their peers, who are enrolled in either PSPFC 1002 or 1004. This learning community is facilitated by a member of the teaching and learning center staff and is designed to give students opportunities to give and receive feedback, reflect on their teaching practices, and learn from one another’s experiences. The course size for PSPFC 1002 ranges from 3 to 7 students.

The advanced level certificate consists of a second education theory course focused on the design of an entire course (PSPFC 1003) and a mentored teaching immersion (PSPFC 1004), where students serve as the instructor of record for a course, commonly in their academic discipline. Four to eight students are typically enrolled in PSPFC 1003 each term, with two to four students in PSPFC 1004.

The focus of this study is PSPFC alumni from engineering departments. Program alumni include both current doctoral students and recent graduates who received at least the lower-level (intermediate) certificate. Data collection began in the summer of 2014. At that point, the alumni population was 66, with 41 from engineering disciplines.

Data Collection

The purpose of this study was to investigate the role of institutional climate on the pathways of doctoral students within the context of an academic career preparation program. This study aimed to address two main research questions:

(1) How do program alumni from engineering disciplines narrate their experiences within this program?
(2) How do program alumni from engineering disciplines describe the role of institutional climate in their pathway towards an academic career?

A case study methodology was designed to capture the perceptions and experiences of PSPFC program participants. Data collection occurred between July 2014 and October 2014. Multiple sources of data from program alumni were collected concurrently: an online survey, course work, semi-structured interviews, and an online discussion forum. For these research questions, the data analysis focused on the qualitative results of the online survey, the course work, and the semi-structured interviews, which are described in detail in the subsequent sections.

Semi-Structured Interviews

Semi-structured interviews were designed to engage the participants in an exploration of their experiences within the program and how those experiences relate to their career trajectory. The interview protocol included six high level questions to maintain some consistency and allow for flexibility to delve deeper into particular experiences or perceptions. The questions were based on Schlossberg’s Transition Theory, which explores how individuals identify and interact with transitions in their lives. As an individual engages with a particular transition such as electing to participate in the PSPFC program, Schlossberg distinguishes three phases of engagement: moving in, moving through, and moving out. Thus, the opening questions aimed to capture participants’ intentions and perceptions at the start of their graduate studies and at the start of
their participation in PSPFC. For example, “Could you describe how you prepared/are preparing for your post-graduation career?” The interview protocol progressed through a participant’s experiences within PSPFC, including how those experiences related to their plans and preparation for a post-graduation career. Participants were asked, for instance, “Can you recall a moment within Tech to Teaching when you realized something had changed about the way you approach designing a lesson plan?” and “What advice do you have for future Tech to Teaching students?” Finally, the interview closed with a discussion of the participant’s current position.

Online Survey

The survey consisted of an adapted version of the Levels of Use of the Innovation framework to capture the extent to which program participants use the techniques and concepts from PSPFC within their current position. Each answer choice corresponded with a level of the framework and was associated with a particular set of open-ended follow-up questions. These questions asked participants to describe their reasoning for selecting a particular level of use and to share the extent of their use of the techniques and concepts from PSPFC. The questions also provided opportunities for participants to highlight supports or barriers within their current work environment that affected their level of use selection.

Course Work

As part of the mentored teaching courses (PSPFC 1002 and 1004), students reflected on major takeaways from their experience within a final report. For example, students are asked to describe the main takeaways from their participation in the observations of peers teaching. In addition, students include a discussion about the impact of the course on their future career goal(s) and their preparedness for their career goal(s). A review of this course work provided insights into students’ perceptions and attitudes during their mentioned teaching experiences and in the context of the campus climate.

Data Analysis

A modified analytic induction methodology was used to analyze and synthesize the data. Analytic induction is an iterative data analysis process that begins by formulating a hypothetical explanation of the phenomenon being examined. For this study, initial hypotheses were formed from patterns identified in a preliminary analysis of three semi-structured interviews. Specifically, these three interviews were initially coded by two researchers independently using open and axial coding methods, adapted from grounded theory to uncover themes within and across the data sources as they related to the research questions: participants’ narration of their experiences and the role of institutional climate. Following the initial coding, the three researchers met to define preliminary hypotheses based on the results. Considering both research questions, the researchers drafted 10 initial hypotheses that were used as a starting point for the remainder of the data analysis.

The next phase in analytic induction is to examine a new case, for this study that aligned with a new interview, final report, or qualitative survey response. The aim of this examination is to determine whether the hypotheses adequately describe the new case. If a hypothesis does not hold, the hypothesis is either (a) modified to capture the new case and all previous cases more accurately or (b) given bounds such that this new case is excluded from the hypothesis. The procedure continues for all of the cases within the data set. For the study described in this paper,
the researchers completed multiple iterations of hypothesis development based on the interview, course work and qualitative survey results. The hypotheses were reformulated based on the analysis of the new cases, and will continued to be modified in the future with the incorporation of the online focus group data.

**Results & Discussion**

Of the 41 eligible engineering PSPFC alumni, seven different engineering disciplines were represented. In addition, the alumni participated in PSPFC between 2010 and the summer of 2014, with some currently completing courses within the program. Twenty-two have completed their doctoral degree at the university, while 19 are still enrolled. Of the possible sample, 18 members of the population participated in at least one part of the data collection process, with 6 university alumni (33%) and 12 current graduate students (66%).

Alumni were permitted to participate in any combination of the data collection instruments. As a result, 13 participated in the interview, 17 completed the online survey, and 7 permitted the research team to review their course work. Table 1 lists the pseudonyms for each of the alumni, along with the data associated with their participation and their current status (i.e., graduate student, postdoctoral fellow, faculty, etc.). For example, Caroline participated in the program as a graduate student, but is now serving as a faculty member at another institution.

Table 1: Breakdown of Study Participants

<table>
<thead>
<tr>
<th>Pseudonym</th>
<th>Current Status</th>
<th>Interview</th>
<th>Online Survey</th>
<th>Course Work</th>
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<tr>
<td>Alice</td>
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<td></td>
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<tr>
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<td></td>
<td>X</td>
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<td>X</td>
</tr>
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<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Frank</td>
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<td></td>
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<td>X</td>
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<td>Grace</td>
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<td>X</td>
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<tr>
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<tr>
<td>Joseph</td>
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<td>X</td>
<td>X</td>
</tr>
<tr>
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<td>X</td>
</tr>
<tr>
<td>Zoe</td>
<td>Graduate Student</td>
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<td>X</td>
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</tr>
</tbody>
</table>

**TOTALS** | 13 | 17 | 7 |

*Moving In*

Each of the participants in this study elected to participate in the PSPFC and to complete at least one of the two certificates. The manner in which each participant prepared for, experienced, and changed in response to this *anticipated transition* provides a framework for exploring the narratives of each participant and the resulting three hypotheses identified.
Schlossberg describes the first phase of a transition as moving in, which incorporates how and why the anticipated transition began as well as other features of the transition itself. For most engineering alumni of this program, the catalyst for their enrollment in PSPFC were ‘champions’ from their own or other engineering departments.

**Hypothesis #1:** ‘Champions’ (e.g., advisors, mentors, other graduate students) within the different engineering departments support graduate students’ preparation for academic careers by helping them transition into and through PSPFC.

*Sample: Caroline, Emma, Grace, Isabelle, Patricia, Daniel, Ruth, Frank, Hunter, Joseph, and Nathaniel*

The interview data in particular highlighted how many PSPFC participants were unaware of the opportunities on their campus to participate in programs like PSPFC, and their decisions to enroll in PSPFC were directly influenced by particular ‘champions’ in their lives.

**Advisor**

One of the most obvious ‘champions’ is a graduate student’s advisor. For Caroline, one of the first students to complete the PSPFC’s advanced level certificate, her advisor was supportive of her participation in PSPFC:

As a result of me participating, a variety of other graduate students in my department ended up pursuing to some extent the [PSPFC], so it’s become supported by the department. I think I brought it to their awareness, basically. [*semi-structured interview*]

Patricia, who comes from the same department as Caroline, had the opportunity to be a teaching assistant for her advisor and realized, “how much you are influencing students and helping them out” in this instructional role. In both cases, the advisors provided a supportive environment for these students’ professional development, and as a result, facilitated the transition into the program for other students.

Yet, not all of the alumni in this study came from departments where this type of professional development was highly valued. Emma’s advisor, for example, supported her participation in PSPFC amidst a less supportive departmental culture:

She really wants us to really go for whatever we want to do, if that’s the career path that we want and then she wants us to excel in that. She wants us to improve ourselves…Our entire department is not like that. [*semi-structured interview*]

In this case, Emma’s advisor was ‘champion’ for Emma’s professional development, valuing these opportunities for her students. For other graduate students, however, the advisor can serve as a barrier to participation in PSPFC, preventing the transition from initiating until later in graduate school, if at all. Isabelle describes how her experience without a formal advisor for her first two years of graduate school provided without the same restrictions as many of her peers experienced.

I didn't have an adviser telling me how I had to spend my time. I spent my time how I wanted to, which meant that, yes, I did knock out a lot of my course work. I had begun research with an adviser who I was interested in, and I was able to do side projects like
More recently, Isabelle found a supportive advisor with whom she had previously worked as a teaching assistant. The relationship she has developed with her advisor has helped provide her with additional opportunities to further develop her teaching practices and explore approaches to improving the undergraduate engineering experiences in her department.

Peers

As previously noted, Caroline, with the support of her advisor, participated in PSPFC and helped create a supportive environment for individuals in her department who may have wanted to participate. For others in PSPFC, the catalyst to participate was one or more of their peers, many of whom came from less supportive departmental environments. Daniel explains how,

…it's a little bit department specific. There's an emphasis on research in our department and there's not much of an emphasis on teaching and I remember going to one of the heads of the department and saying how am I supposed to get this teaching experience and so that's when I had talked to one of my colleagues who had started participating in [PSPFC]. He told me about it. He gave me contacts for somebody here at [the teaching and learning center] and I came in and started asking about this program and how I can get into it and get started so I guess that was the genesis of that. [semi-structured interview]

Frank, a graduate student in Daniel’s department, participated in the program early in his graduate career, but as he explains his participation was due in part to one of the first PSPFC participants who came from their department.

I was talking to a previous year's teaching assistant, and he's the one that actually told me about [PSPFC], so it was through him that I ... Because I had not heard about it or maybe I had and just not realized it at the time, but he told me about it. I looked into it and I registered to take the first class. [semi-structured interview]

Around that time, Frank spoke with Nathaniel about the program and spurred his interest in participating. Nathaniel explained how,

Well in high school and actually a friend of mine, we didn't go to the same high school, we went to the same martial arts school and we both became instructors and we learned to kind of teach and interact with people in that way. So we're both here…now and he actually pointed out that there is this program towards the end of my masters and he was saying he was trying to get in to the class because at the time it was by, there were only a certain number of spots because it wasn't being offered to every intern. Towards the end of my master's, I really like teaching in high school and I didn't really do it during undergrad or anything, but during my master's I had to TA for a lab class, which in retrospect, I didn't do a very good job at. I thought I was but it was through the encouragement of my friend
to participate in the program and I thought this sounds interesting, this sounds good and it's something that I can engage in. [semi-structured interview]

In some cases, regardless of the culture within a particular department, participants were drawn to the program by groups of their peers. Grace, for example, learned about the teaching and learning center when she was an undergraduate TA at the university. Yet, it wasn’t until she met others in her department who were interested in teaching that she decided to participate in PSPFC:

There's a couple of other people in my department who are also more teaching focused and less research focused. We were talking a lot and decided that we wanted to take the [PSPFC] classes together.

It was kind of this joint thing. Hey, it exists. Yeah, I think I want to do it, but I don't want to do it alone because that might be weird. But oh hey, this guy in my department is also really excited about teaching, so we're going to do them together. [semi-structured interview]

Similarly, Emma was influenced by two of her friends and the newly founded ASEE Student Chapter on their campus:

I had one friend who’d finished, almost finished the program and then another friend who is just starting and both of them very much highly encouraged me. They really wanted me to participate and they thought and they saw it was a really good opportunity and so through their descriptions of what was going on and then also I saw one of the faculty members is in charge of the program. She presented at an [ASEE] meeting. [semi-structured interview]

The creation of the ASEE Student Chapter at this university provided additional opportunities for graduate students to come together and discuss issues about teaching and learning. For Ruth and Hunter, their participation in PSPFC was partially due to the opportunities that presented themselves after the establishment of the student chapter.

I think it was a combination of getting involved in ASEE when that student group first started at [the university], and then I participated in a seminar in spring of 2011 maybe, and it was just an informal gathering of about 12 of us once a week and we read articles about different teaching methods and learning styles and that sparked my interest in pursuing teaching and learning more about teaching beyond what I had just seen as a student, which from my perspective was mostly lecture styles. – From Ruth’s semi-structured interview

It all starts with an ASEE student chapter meeting. Somebody forwarded me one of the early meeting emails and said, "Hey, we're getting together." I'm pretty sure the director of [the teaching and learning center] was presenting about the various programs on campus, so I came and they were just talking about this formal process of helping people figure out what the classroom should look like and what you should be thinking about as an instructor and how that should play into how you plan lectures and all that stuff. – From Hunter’s semi-structured interview

The emergence of champions in this analysis also revealed barriers to students’ participation in PSFPC, as some students have no knowledge of the professional development opportunities
provided by the program. Hunter, for instance, is surprised by his peers’ lack of awareness about the program:

I wish there was more people involved in [PSPFC]. I think that's the main thing. I wish [PSPFC] was 200 people a year, not 20 or 40 or whatever it is. There's a lot of graduate students at [this university] and the only way you're going to help any of them try to get a job in academia is make them feel more comfortable about being good in the classroom…They can all do research. Everybody here can do research on some level. [semi-structured interview]

Isabelle had a similar perspective, but also wished to see awareness of the program spread outside of the university:

I wish that there was more advertising for it. It's something where I feel like there's a lot of people that still aren't aware of this program, even on the [university’s] campus…I sometimes still have to explain what [the teaching and learning center] is, and then I have to explain that I'm doing this program and they're not sure what it is or how it could benefit them. I feel like there are a lot of students here that could benefit from it. [semi-structured interview]

Grace comes from a department that, in her opinion, doesn’t openly communicate about these and other professional development opportunities. She noted in her interview that she believes that there are many students who could use the PSPFC and teaching and learning center resources, “even if they don’t want to teach, they want to be in R1 where it's 80 percent research and 20 percent teaching.” Emma suggested creating a smaller version of the program and reaching out to departments and students to find out who could benefit most from this abbreviated professional development opportunity:

If there was a way for us to work with the department at least and [I know one of them] has some type of facilitated thing but if we could work with these departments and identify the students that need the content but maybe don’t have the time. That would be really cool. I think it’s really important for them. [semi-structured interview]

For Frank, greater awareness of PSPFC needs to extend to faculty along with other students:

Right now I feel like there's some professors that don't have any knowledge about what [PSPFC] is. I mean they understand the concept because they've heard about it at a faculty meeting or something like that, and they think it's awful and they just they've made up their mind. They're just sold that way, and they're very loud and aggressive. I know when I went through to my immersion, I was told to go ask one professor just who... I think it would be nice for someone to take him aside and show him what the actual benefits of the program and explain more to him… I think helping to educate him and maybe getting him more involved or trying to show him some of the benefits of it would be very beneficial. [semi-structured interview]
Moving Through

These champions were found to not only support PSPFC program participants’ transition into the program, but also their experience moving through the program. From faculty mentors to other graduate students, these individuals supported the PSPFC alumni in developing their skills as instructors and preparing them for their (current or future) careers in academia.

Mentor/Other Faculty

Hunter’s experience with his teaching practicum mentor provided opportunities for him to grow as an instructor. In particular, he partnered with a faculty mentor who had previously worked with students from PSPFC. Thus, she was well aware of the program requirements.

It was a really great experience. I don't know if it was just how nice she was or the way we got along, but it felt a lot more ... It was a lot better of a relationship than your research adviser versus you. It seemed like we both had a common goal which was to make the class great. She was looking for my input to do that as well, which was really really great. It wasn't, "Hey, I know how to teach this class, just sit back and watch me," which made it really nice. [semi-structured interview]

In Daniel’s department, as was previously mentioned, there appear to be many barriers that exist for students interested in gaining teaching experience. Yet, one faculty member (Dr. Unnamed) recently created an elective course that provided students within the department the opportunity to gain some teaching experience.

That's a prerequisite to even start PSPFC and that again was something I never got an opportunity because I never worked for an advisor who really wanted me to be or needed me as a TA because again within our department really the only people who are TAs are people who are in between projects need to be covered with funding. I think that was my frustration because actually I was delayed in starting [PSPFC] because I didn't have that [pre-requisite] and the only way I got it was the fact that [Dr. Unnamed] made this agreement that the [elective course] would also count. By doing [this, the course] would also count as the [pre-requisite] so that I guess was the frustration is I wanted to teach and couldn't like literally was not allowed. [semi-structured interview]

This teaching elective served a catalyst for others in PSPFC to gain their pre-requisite requirements and mentored teaching practicum experience, including, but not limited to Joseph and Emma. The data describe how even though the grant that funds the PSPFC has the support of many academic units on campus, a “negative” disposition toward teaching often persists in some departments. For many program alumni in this study, their experiences differed in part to the culture of their home department. Analysis of the interviews and survey findings reflected this impact of departmental culture on students’ access to teaching opportunities.

Hypothesis #2: Departmental culture impacts students’ access to teaching opportunities.

[SAMPLE: Daniel, Joseph, Frank, Zoe, Patricia, Grace, and Isabelle]
Going back to Daniel, while completing the other PSPFC requirements, he grew frustrated that he had not yet “had the opportunity to employ any of the techniques [he has learned in PSPFC]” in a traditional course.

It has been difficult for me to convince my department to give me teaching opportunities, and this is a constant barrier that I need to work around. It is a matter of the chicken or the egg problem: how can I teach an actual course effectively if I don't have any experience, but how can I gain experience if I am never given the opportunity? [survey]

Yet, Daniel was not the only student in his department who noticed the challenges of obtaining these teaching experiences. Joseph, who comes from the same department as Daniel, noted how even though he was nearing graduation, he had never been a teaching assistant before.

Yeah, that's a great irony that there's no requirement to actually know how to teach to be a college professor at least research one institutions. I'm sure it's going to be hard enough starting out. I at least wanted to know what I was doing. I want to be a good teacher. I don't want to be one of those guys or gals that's only interested in doing research and clearly doesn't give a hoot about teaching...I've never really been a TA. [semi-structured interview]

Frank, who is from the same department as Joseph and Daniel, described his experience as the first graduate student to teach a course within the department,

It's not really an issue with PSPFC I think as much as it's an issue with my school. My school is extremely opposed to the PSPFC it seems like for some weird reason. I went through it, and it was a really big headache, but the whole time I was going through it everyone kept telling me, ‘Okay, you're kind of the guinea pig. You know, once you get through this, we know what the steps are. If you go through the [PSPFC] and you check all these boxes, you can teach a class [in the department].’...

Then the next student to come through it just completely got pulled from her [section] the day before class started. I'm not sure exactly why...We have another student, Daniel, who's trying to go through and finish his advanced certificate. He's probably not going to be able to teach a class [in the department] just because the school is so opposed. I don't know if it's something that [the teaching and learning center] could try to work with, with the school or if it's just an idea of, well, it's a lost cause...[semi-structured interview]

In her department, on the other hand, Zoe and her classmates are required to serve as teaching assistants (TAs) for two semesters following their qualifying exams.

You don't really have the option of delaying that or doing it earlier and there is also limited classes that, it's basically like a matching process sort of. I had already done one semester of TA and then my second semester is when I started of TA is when I started the PSPFC. [semi-structured interview]

For Grace, her department has a lot more graduate student instructors than the other departments on campus. Still, many student instructors don’t have easy access to support before and during their teaching experiences:
Our department isn't good about telling the grad students that, one, that [the teaching and learning center] is here as a support for the grad student instructors or really pushing, even just information about the [PSPFC] at all. [semi-structured interview]

Patricia participated in the mentored teaching practicum within her department, but noticed that both this and the immersion were challenges for some of her peers in PSPFC. She discussed the barriers to getting teaching opportunities were not only departmental, but also at the institute-level:

I don't know, most departments it sounds like it is very hard for...students to get to teach in. We had a person in the second class that was trying to figure out how to even get the position to do the advanced certificate and I think that it kind of forces your adviser to give you more teaching experience. Otherwise you would just be sitting there and you'd be like, "Can I teach this class?" "No." "Can I teach this class?" "No." I feel like most advisers do that. Not that my adviser does that a lot, but it is just very hard to break into the teaching world in here because [the university] is such a high school they want to make sure that the instructors are really good. [semi-structured interview]

Isabelle discussed how she would like to complete the advanced-level PSPFC certificate by teaching a course for the mentored teaching immersion. Her department utilizes a large number of teaching assistants, but is not known for having graduate student instructors.

In my department, I'm not aware of anyone who has been, graduate or undergraduate courses. It's something where I'm not sure how I'll actually make this work, I just know that at this point I've proven that I'm very invested in teaching, I'm very invested in the department, and I hope that both of those will allow me the opportunity to have a small group of students. It's not going to be a large class, but if I can even have thirty students to work with, that would be more than enough...[semi-structured interview]

She also noted that she could inquire about teaching a course for non-majors, but that also may not be an option. The perceptions of program alumni in Hypothesis #2 highlight a challenge for PSPFC and institution staff to consider new ways to support students from a variety of departmental cultures.

Program alumni participated in the mentored teaching practicum (PSPFC 1002) and/or the mentored teaching immersion (PSPFC 1004). In the interviews, final reports, and survey results, program alumni from both engineering and science fields discussed the impact the learning community of instructors and peers had on the development of their teaching skills and practices.

Hypothesis #3 - The PSPFC learning community (both instructors and students) contributes to participants’ development of their instructional practices.

[SAMPLE: Nathaniel, Veronica, Zoe, Frank, Daniel, Hunter, Isabelle, Patricia, Caroline, Blair, Grace, and Emma]

For Daniel, this learning community facilitated the construction of his conceptions of teaching and learning:
I found the perspectives of my fellow peers particularly interesting considering the
differences in our respective undergraduate and even our graduate backgrounds. Some of
my peers came from programs that promoted a lot of hands on training (like designing and
building robots), while my own program (at [the university]) featured more traditional
lecture-based learning and conceptual projects. This forced me to rethink the traditional
teacher-student relationship. [coursework]

Nathaniel described the overall value of developing yourself as an educator through this learning
community, as compared with only learning from experience: “The lessons that you would pick
anyway through experience I was able to pick up from [my peers] and through my own
experience as well.” [semi-structured interview]

Developing One’s Teaching Practices by Receiving Feedback

One of the main components of the mentored teaching experiences was the opportunity for the
participants to receive feedback about their teaching from the other members of the learning
community. Caroline, for instance, noted in her interview the benefits of the peer feedback
component of the course were “a wonderful motivation, because I needed more motivation, but
was a great incentive to continue with [PSPFC].”

Veronica specifically reflected on her experience in the mentored teaching practicum and how it
relates to her experiences as a faculty member now:

“I actually found the practicum to be the more useful thing because it's really, really nice
to have somebody, like have your peers and then someone whose been teaching for a long
time come watch you and then give you feedback and also watching videos of yourself was
really helpful… I think that in grad school you sometimes don't a ton of feedback or if you
do it's really negative. It was really helpful to know how to give feedback but also receive
it and use it. [semi-structured interview]

In her mentored teaching practicum final report, Isabelle made a similar observation about the
meetings immediately following the class the learning community watched her teach. “Often it
was in the debrief conversation that I learned the most – how others handled similar situations
and what options I had for different areas which needed improvement.”

Grace, in her interview, discussed the experience of working with her diverse learning
community from the initial lesson plan development phase through the debrief meeting. “Even in
different departments, to be able to see, oh, I really like the way they did this more detailed
breakdown of the structure and then getting feedback from both of our instructors in that class
who have a lot more teaching experience.” Both Zoe and Hunter, on the other hand, felt that their
experience in the practicum was negatively impacted by the lack of feedback they received from
their peers:

“I guess for the practicum, I didn't always get as much feedback from my peers in the class
as I would have wanted to. I would have been, hopefully I had my mentors feedback but
not always the other students.” – From Zoe’s semi-structured interview

We didn't get any feedback from the other students. I want feedback from people my age,
not somebody that's been teaching for a while. They have all the answers for them, but
they're not in my situation. They're not teaching just 4 lectures in a semester. It's a lot
different when that's the case... Teaching practicum, like I said I would've liked the community to be a little more helpful to each other as far as the other people doing teaching practicum and immersion. That was frustrating for me. I knew people that had gone through it the previous semester and they thought it was really great. They made really good friends and people were very supportive of each other and they helped each other a lot in there. – *From Hunter’s semi-structured interview*

**Discussing Problems and Asking Questions**

The learning community also became a place for the participants to ask tough questions and discuss problems they were having in their courses. Thus, they were learning from one another how to respond to a variety of teaching-related challenges. Blair noted in her final report from her mentored teaching practicum that “it’s nice to be able to get together with other people and openly discuss problem [she’s] encountered with [her] teaching experience, or hear problems other classmates encountered so that [she] could benefit from their experiences.”

Hunter, in his interview, discussed how his instructor helped create a safe environment for asking questions during the third PSPFC course about course design. “If we came in with ideas and thoughts that we wanted to discuss, he was very open to fitting that into the structure that he had already built.” Frank described an instance, in his interview, where the learning community helped him resolve a particularly challenging case with one of his students:

> We talked about it a lot in my immersion because I just didn't know what to do. I had emailed the student and stuff like that… [The PSPFC 1004 learning community] were like, ‘Listen, you need to refer her to the dean of students. It's not like something that she'll get in trouble, but they can, you know, get in touch with like her family, maybe call the police to go out there, something, just to make sure she's okay, and then assess the situation,’ like if something needs to happen where she needs to withdraw from classes or she maybe needs more time for things…

**Bouncing Ideas off of One Another**

Participants saw value in using the learning community as a venue for bouncing ideas off of one another. Isabelle, for instance, noted, in her course work, that the weekly meetings in her mentored teaching practicum served as a place to share experiences. “I found that they variety of classes we were teaching helped lend itself to us being able to discuss various ideas related to each.”

The PSPFC alumni also engaged with the greater learning community within the program, outside of the boundaries of the individual courses. Emma, for example, discussed in the survey how she frequently exchanges ideas with one of her PSPFC colleagues. “Last semester my colleague asked me to help her facilitate group discussions about case studies. We also frequently discuss our teaching approach and brainstorm new activities for incorporating in our courses.” In his interview, Frank emphasized the value of speaking other PSPFC participants and the PSPFC staff:

> I think one of the things that stands out the most for me is this idea of a community of people I can bounce ideas off of. .... Emma and another PSPFC alum, I constantly bounce ideas off of them. It's just nice knowing that there's people that actually care
about teaching and being able to talk to them about stuff. I mean even other people in the [the teaching and learning center]. I've come and talked to [the Director and other staff] before with random ideas or also just for future job prospects, what I think I could possibly be doing and going on, and that's I think by far the thing that stuck out the most to me, but a lot of the other skills I think are very, very helpful.

Moving Out

While many of the participants described the learning community in the context of the specific course within PSPFC, the impact of the learning community appears to be more than temporary or isolated to a particular course. Participants reflected on the role of this community as they are continuing to develop themselves as faculty and future faculty. For Patricia, this development has occurred by expanding her network and incorporating engineering education research into her teaching practice:

I think also getting to network. I am currently doing educational study and it's something to be said about always publishing in engineering journals and not how to publish in education journals so it was very nice to get to meet two professors though the two classes I took that are in education. [semi-structured interview]

At the completion of her practicum experience, Isabelle reflected in her final report on the community she created with her peers in PSPFC 1002. “I know I could ask for advice on a teaching method or something related to the academia field and they would all be willing to give their thoughts.” Zoe, on the other hand, viewed the mentorship aspect of the PSPFC learning communities as an aspect that would continue as she moved out of her graduate student experience. “I feel like not only I was mentored during the classes but as like the continuation I feel like I can still ask those mentors for advice and for their help.” [semi-structured interview]

Nathaniel completed the program in 2013 and his currently finishing his doctoral work. In reflecting on his PSPFC experiences in the survey, he explained that he “continues to discuss with peers and others effective teaching strategies.” Looking ahead, Nathaniel noted that the learning communities [he has] become a part of will be “instrumental in [his] future career.”

Frank noted the role of these learning communities in his future career pathway within all of the data collection instruments. After his immersion experience, he described in his coursework how,

[he looks] forward to keeping in touch with everyone as [they] continue to develop as professors. [He thinks] the idea of having regular meetings with a group of people interested in teaching is the biggest benefit of this course and [the teaching and learning center] in general.

A year and a half later, during his interview, Frank reflected on his PSPFC experiences and his regular interactions with other PSFPC participants. Specifically, he described the role of this community on his own development as an instructor, but also on the development of the next PSPFC alumni:
I hope in the future there's an alumni connection, whether it's us keeping in touch with us just on our own or like the [teaching and learning center] organizing something every couple of years or something like that to help make sure that just the people that go through this program can stay in touch with each other and hear what the new people are doing because I know with [Daniel], he's an [engineer]. He stopped me the other day to ask about how he can get a class, how he can do his immersion and stuff like that. I was talking to him and I was talking about what he wants to do with it, like what are some of the activities he's planning on doing, and what classes would be best. I really enjoy that and I hope that that doesn't go away, that I don't just end up one day only caring about my research, that I'm always able to talk to some people about how are we impacting these students.

Discussion & Implications

Research emphasizes the relationship between doctoral education and improvements in undergrad education\textsuperscript{1,13} and draws attention to potential challenges doctoral students may face preparing for academic teaching careers\textsuperscript{1,13,14}. In this study, the effects of the perceptual (i.e., perceptions of climate by program alumni) and behavioral (i.e., interactions among program alumni, faculty, and others) dimensions of institutional climate on doctoral students’ career pathways and experiences in PSPFC were examined. The findings indicate that departmental culture affects a graduate student’s ability to secure teaching opportunities or to find support when engaged in a teaching opportunity. For some of the program alumni, the departmental culture existed only as another barrier to overcome, similar to qualifying exams, challenging courses, and the dissertation defense. Yet, for others, this culture delayed, and in some cases inhibited, the participant’s career preparation. In her interview, Isabelle suggested,

In my department, if you didn't come in with a funding offer, you may never be a TA. That's pretty much just because there’s too many graduate students and not enough courses, so I would love to see a paradigm shift of how are we actually going to promote that every graduate student should be involved with teaching to some extent. If you're not a formal TA, can we put them through a [PSPFC] or send them through something else, just so that when you come out of here you have a knowledge of what it's like to have decent teaching practices, above and beyond the professors that you work with that may or may not be up to date on the latest techniques. [semi-structured interview]

Daniel recommended setting up specific courses for PSPFC students to teach:

Within my department there's a lot push back against teaching required classes so I think the natural solution to that would be to set up some sort of undergraduate electives that would be necessarily taught by grad students and especially people that are doing the [PSPFC] and depending on the popularity, you might have that class be regularly offered. [semi-structured interview]

Hunter discussed a similar idea targeting individual departments:

Probably one of the main things you could do is you could ask individual departments to set up some kind of mentorship programs for people who want to be in academia and provide those students with extra opportunities to teach guest lectures or shadow a professor that actually wants them shadowing. Something. I think it would need to be more
Similar to the suggestions of program alumni, teaching and learning centers could begin to form partnerships with individual departments. The aim of these partnerships would be to raise awareness about these professional development opportunities and discuss ideas for further improving the teaching and learning center offerings. If partnerships are already established, the centers could explore ways to support those graduate students with teaching assignments, so they don’t feel undervalued when compared with their peers. Prospective graduate students would also benefit from gaining awareness of departmental culture, either to determine if the disciplinary program is a good fit for them and their career goals or to define strategies for obtaining professional development opportunities regardless of the culture (similar to Isabelle’s experiences). Finally, additional research is necessary to explore departmental culture and determine if the findings for the PSPFC are similar to those pursuing academic careers who are non-participants in the program.

The second key finding focused on the array of people who influence prospective faculty members, including their peers and faculty members. Specifically, the analysis explored the interactions among program alumni and ‘champions’ within their department and across the institution. These champions were advisors, mentors, and other graduate students who supported the participant’s transition into and through PSPFC. To support these champions and further increase the network of champions within the departments, the teaching and learning centers could provide awards for PSPFC mentors or PSPFC alumni for their outstanding service to the program and its participants. Graduate students on campus could also develop a list of advisors, mentors, and PSPFC program alumni that could be distributed or maintained on a website (similar to the Engineering Education Community Resources page – http://engineeringeducationlist.pbworks.com).

The interaction between departmental culture and the work of these champions is another potential area for future research. In his interview, Daniel reflected on the challenges of convincing a department to establish or participate in new programming:

> Sometimes it's not necessarily a coordination so much as a convincing because there are some people within these departments that are in favor of these ideas but there's a lot of push back against it as well. There needs to be some sort of set up, an enabler, for students in situations like I am.

Future work could also focus on the champions, their experiences within their particular context, and their transition into this role. How did they become a doctoral student’s champion? How have they been able to serve as an enabler in some of the departmental cultures described by the program alumni?

Finally, the program alumni’s perceptions of the PSPFC learning communities indicated a relationship between these communities and the development of the alumni’s instructional practices. The relationship was grounded on participants’ desire for feedback about their teaching and their ideas, along with a safe place to pose questions and discuss teaching-related challenges. For many, this relationship also extended beyond the learning environment of the PSPFC courses, providing a support network for alumni now and in the future. The interactions
with a learning community and other peers were consistent with findings from other programs. The relationship between the learning communities and the development of participants’ instructional practices creates an opportunity to examine the role of these communities in graduate students’ adoption of active learning techniques more explicitly. Future work could also explore the effects of the structural dimensions of the institutional climate (e.g., size, frequency of meetings, and diversity of membership) on these communities. Results would support the design and implementation of the learning communities in PSPFC and similar programs.

Limitations

Considering these results, it is important to keep in mind the limitations inherent in this study and its design. First, the results presented are based on the analysis of a small subset of students who self-selected to participate in PSPFC. Additional research of other similar programs as well as non-participants could further enrich the results and allow faculty as well as teaching and learning centers to better understand the role of climate in the pathways of doctoral students. With each hypothesis defined in this study, the entire sample is not represented. While analytic induction generally supports reformulating the hypothesis to describe the complete sample, a few of the participants did not explicitly discuss the topics related to the hypotheses. Since the design of the data collection instruments did not explicitly ask the participants about these hypotheses, it was not possible to determine whether the experiences of all participants could be adequately captured by each hypothesis. Therefore, the hypotheses are only valid for the sample listed in the previous section. Finally, triangulation across multiple sources of data and discussions between the two researchers were used to mitigate the impact of potential researcher bias on the results.

Conclusion

Many programs to support graduate student professional development are disconnected from the discipline-specific requirements and must be completed in addition to other responsibilities. To continue to improve graduate students’ preparation for academic positions, the study presented in this paper explored the impact of the institutional climate at a state-sponsored research university on doctoral engineering students’ pathways by examining the experiences of participants in a program that prepares students for academic careers. Using a case study methodology, the researchers collected and analyzed interview, survey, and coursework data from engineering program alumni. Through the analysis, three key findings emerged:

- Departmental culture impacts whether students have, or can find, teaching opportunities.
- ‘Champions’ (e.g., advisors, mentors, other graduate students) within the different engineering departments support graduate students’ preparation for academic careers by helping them transition into and through PSPFC.
- The PSPFC learning community (both instructors and students) contributes to participants’ development of their instructional practices.

These results fill a gap in existing research about the engineering graduate student experience and the development of future faculty, by providing insights into students’ perceptions of the effect of institutional climate on their experiences and career pathways. Results of this study support the continued improvement of career preparation programs by taking into account the effect of institutional climate on doctoral student preparation for diverse career pathways.
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