CASE STUDIES OF TENURE-TRACK SCIENCE PROFESSORS: EXPLORING
THE RELATIONSHIP BETWEEN TEACHING AND RESEARCH

A Dissertation in
Curriculum and Instruction

by
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Current STEM workforce issues and retention problems faced by postsecondary STEM education have renewed educational research efforts in this arena. A review of literature on STEM professors indicates that although this population reports difficulties integrating teaching and research responsibilities, there have not yet been any qualitative studies conducted to deeply investigate the complexities of the relationship between teaching and research. This study utilized a set of four phenomenological case studies to address the following research questions:

- What is the relationship between the teaching and research roles for individuals in a sample of tenure-track science professors at an RU/VH institution?
- What types of activities and experiences (particularly professional development) do participants engage in to support their roles as teachers? What types of activities and experiences impede their roles as teachers? In what ways do these activities support or impede participants’ roles as teachers?
- What connections can be made between the participants’ personal, cultural, and professional histories and the way they are currently experiencing the relationship between teaching and research?

The results of this study suggest that science professors might make decisions about the way they allocate limited time in an unlimited work environment based on their intrinsic, personal career goals and desire to help students. Furthermore, all of the participants in the study indicated that other than research training, they received little to no preparation for their jobs. These findings provide the field with points of interest for further study as well as the design of educational support and interventions.
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Chapter 1

Introduction

This study is inspired by science, technology, engineering, and mathematics (STEM) workforce issues in the United States. More narrowly, this work is concerned with student retention and the quality of STEM teaching in postsecondary institutions. In order to contribute to the scholarly conversation on student retention and the quality of STEM teaching in postsecondary institutions, I have focused on an understudied group of stakeholders in college science classrooms: tenure-track science professors at RU/VH institutions¹. My research answers the following questions:

- What is the relationship between the teaching and research roles for individuals in a sample of tenure-track science professors at an RU/VH institution?
- What types of activities and experiences (particularly professional development) do participants engage in to support their roles as teachers? What types of activities and experiences impede their roles as teachers? In what ways do these activities support or impede participants’ roles as teachers?
- What connections can be made between the participants' personal, cultural, and professional histories and the way they are currently experiencing the relationship between teaching and research?

¹ RU/VH is the Carnegie classification for Research Universities (very high research activity), previously known as R1 universities. For more information see http://carnegieclassifications.iu.edu/.
It is my hope that this work will lead to research aimed at supporting these individuals as teachers, thereby increasing the quality of their teaching and enabling them to excel within their careers and possibly to help alleviate the retention issues in their fields.

**STEM Workforce and Calls for Reform**

It has become commonplace for STEM education research and reform literature to reference “the STEM pipeline” when describing the progression of individuals from K-12 students to STEM workers. However, current political investigations, news commentaries, and academic studies question the validity of a linear pipeline model to represent STEM workforce issues in the United States (National Science Board, 2015; Teitelbaum, 2014; Xie & Killewald, 2012). It is clear that stakeholders disagree on several STEM workforce matters, including the current supply and demand of qualified STEM workers, anticipated changes in STEM workforce demand, and our nation’s ability to supply a sufficient number of STEM-educated individuals in the coming years (National Science Board, 2015). However, it is widely accepted that the increased technological demands of our society require that we become increasingly proficient in STEM-related skills. For this reason, contributors to conversations on K-16 STEM education improvement have begun to shift from the linear STEM pipeline representation to a more comprehensive “workforce pathways” model (Bradforth et al., 2015; National Science Board, 2015). This model acknowledges that graduates of the American education system are very likely to use STEM-related skills to such an extent that comprehensive STEM training is justified and even necessary, even if they do not pursue careers directly related to STEM fields. In fact, the National Science Board reports that according to data from the 2010 National Science Foundation (NSF) Scientists and Engineers Statistical Data System, only about 5 million
individuals were classified as having a “science and engineering” job, but nearly 16.5 million people reported having a job that “requires bachelor’s degree level science and engineering expertise” (2015).

In addition to the general STEM education demands anticipated by the workforce pathways paradigm, it is important to realize that many analysts do forecast an increased need for traditional STEM workers in the coming years. It is expected that from 2008 to 2018, the need for STEM occupations will have grown by 17 percent, compared to only 9.8 percent for non-STEM jobs (Langdon, McKittrick, Beede, Khan, & Doms, 2011). Some worrisome statistics suggest that American universities might not be able to provide a sufficient number of STEM graduates to keep up with this projected growth in the demand for traditional STEM workers:

- From 2000-2010, university enrollments increased, but the proportion of STEM bachelor’s degrees remained at approximately 15-17 percent (Association of American Universities, 2011; National Science Board, 2010b). The proportion of freshmen entering STEM majors has remained roughly constant at around 25 percent (Association of American Universities, 2011).

- 50 percent of students who begin a degree program in the physical and biological sciences and 60 percent of students in mathematics programs drop out of STEM fields by their senior year, compared with a 30 percent drop rate in social sciences and humanities (Committee on Science and Technology, 2010).

- The United States is ranked 27th among 29 developed countries for proportion of students receiving undergraduate degrees in STEM fields (“Rising above the Gathering Storm” Committee, 2011).
In light of these demands for a STEM-educated workforce, American universities have been renewing interest in the quality of postsecondary STEM education (Association of American Universities, 2011). As data mount about problems in undergraduate STEM education, various agencies and institutions have begun to call for reform (for a survey of these, see Table 1.1). Though these reports are issued from a wide variety of stakeholders ranging from government agencies (e.g., President’s Council of Advisors on Science and Technology, PCAST) to groups of professors and administrators (e.g., those tasked by American Association for the Advancement of Science, [AAAS], to prepare the Vision and Change report), there is a general consensus with respect to recommendations for improving undergraduate STEM education:

- Current research on teaching and learning in STEM fields supports a curricular emphasis on discipline-specific practices and overarching concepts.
- STEM colleges need more support to transform current teaching practices (including assessment) into ones more closely aligned with research on teaching and learning.
- Current and prospective STEM professors need professional development and training to learn more about research-based pedagogical practices.
- Proposed changes will only take place in environments supported by administration (“top-down” reform) AND faculty members (“bottom-up” reform).

All of these recommendations point to a need for more research on interventions that might improve STEM faculty teaching practices. However, well-designed interventions and subsequent studies must be based on a firm foundation of formal knowledge on professors’ beliefs and practices. My work contributes to filling this gap in the literature by providing a
deeper understanding of a set of science professors’ lived experiences, particularly with respect to the relationship between teaching and research.
<table>
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<th>Year</th>
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| 2010 | Preparing the Next Generation of STEM Innovators: Identifying and Developing our Nation's Human Capital | National Science Board (NSB)                   | - The NSB makes recommendations to “identify and develop…STEM innovators” (P. 2).  
- For each recommendation, the NSB proposes federal policy actions as well as research agendas.                                              |
| 2015 | Vision and Change in Undergraduate Biology Education: Chronicling Change, Inspiring the Future | American Association for the Advancement of Science (AAAS) | - This report summarizes and updates findings from a conference of the same name hosted by AAAS and the National Science Foundation (NSF).  
- Topics covered include student knowledge, progressive pedagogy, assessment, faculty professional development, institutional change, and supportive tools for change. |
| 2011 | Expanding Underrepresented Minority Participation: America's Science and Technology Talent at the Crossroads Committee on Underrepresented Groups and the Expansion of the Science | National Research Council (NRC)                | - The NRC makes recommendations on improving diversity in the sciences by starting in K-16 education.  
- Postsecondary suggestions include improving access, affordability, and academic and social support.                                   |
| 2011 | Five-Year Initiative for Improving Undergraduate STEM Education      | Association of American Universities (AAU)     | - The AAAU announces the formation of an advisory committee to address the following goals: develop a framework to assess STEM teaching and learning, create pilot program for tools in development, design faculty training and rewards programs, and disseminate effective programs and strategies. |
| 2011 | Rising Above the Gathering Storm, Revisited                         | National Academy of Sciences (NAS)             | - This report revisits recommendations made in a 2005 report of the same name in order to renew funding for programs implemented under its counsel.  
- Many of the reports’ recommendations focus on providing funding for science research and scholarships.                                  |
| 2012 | Engage to Excel: Producing One Million Additional College Graduates with Degrees in Science, Technology, Engineering, and Mathematics | President’s Council of Advisors on Science and Technology (PCAST) | - This report to the president focuses on ways to provide a larger STEM workforce.  
- Major recommendations include supporting pedagogical reform and creating new pathways to STEM careers.                                        |
| 2013 | Adapting to a Changing World - Challenges and Opportunities in Undergraduate Physics Education | NRC                                            | - The recommendations in this report are based on the assumption that due to connections between physics and other STEM disciplines, focused physics education reform will have broader impacts. |

Table 1.1. Survey of recent reports on postsecondary STEM education.
The Link to Teaching Practices

In addition to the statistics reported above, recent studies have been investigating STEM attrition issues. In a report by the Higher Education Research Institute (HERI) at the University of California, Los Angeles (UCLA), it was revealed that freshman STEM majors are more likely not only to change majors, but also to withdraw from college than their non-STEM counterparts (2010). Indeed, less than 50% of students intending to major in STEM fields complete a STEM degree within five years (Committee on Underrepresented Groups and the Expansion of the Science and Engineering Workforce Pipeline, 2011). As mentioned previously, other indicators show that it is unlikely that the United States will be able to meet upcoming demands for STEM specialists and is falling behind other countries’ production of STEM graduates. These data have drawn a great deal of attention from postsecondary educators, administrators, and policy makers, leading to investigations of potential reasons for these shortfalls. Though there have been no comprehensive studies linking undergraduate attrition with professors’ teaching, one extensively cited study by Seymour and Hewitt showed that a staggering 90% of students leaving STEM majors cite poor teaching as one of their concerns (Graham, Frederick, Byars-Winston, Hunter, & Handelsman, 2013; President’s Council of Advisors on Science and Technology, 2012; Seymour & Hewitt, 1997; Ulriksen, Madsen, & Holmegaard, 2015). This publication sparked a movement to investigate the quality of college STEM teaching as one possible target for improvement to both generate more STEM graduates and to alleviate overall college attrition rates.

As some educational researchers continue to investigate the link between teaching quality and undergraduate retention in order to strengthen the case for teaching reform, STEM professors who are actively engaged in improving undergraduate education are making a
different argument. These practitioners argue that it is not necessary to establish that traditional teaching practices contribute to student attrition; indeed, they assert that as the science of teaching and learning has revealed new and effective teaching methods, responsible educators must respond to these findings by modifying their practices (Bradforth et al., 2015; Eddy & Hogan, 2014; Freeman et al., 2014).

Reasons for the persistence of traditional teaching practices at the college level remain speculative in the literature. The Association for American Universities (AAU) proposes that universities’ emphasis on research over teaching could partially explain this phenomenon (2011). In a 2010 survey of university professors (Savkar & Lokere, 2010), 48% of respondents indicated that for a new professor hire, “a star researcher with significant research publications but who has no significant teaching experience” would be favorable over applicants with either balanced teaching/research experience or “superb teacher[s]…with no significant research projects.” Forty-one percent of respondents felt that their institutions valued research over teaching. Given the lack of data on these types of phenomena, it is impossible to construct comprehensive explanations for them. One might speculate that institutions view teaching as an easily attainable skill, a craft best learned by informal professional development, or even an unimportant component of a professor’s job. However, some literature suggests that professors interpret this type of data as evidence that institutions prioritize research over teaching (American Association for the Advancement of Science, 2010, 2015; W. A. Anderson et al., 2011). Bradforth and Miller add that “research universities rarely provide adequate incentives, support or rewards for the time that faculty members spend on improving teaching” (2015) – a sentiment that is repeated throughout similar commentaries.
Indeed, lack of support for faculty professional development is clearly reported in the literature (Myers & Kircher, 2007). This is in contrast to the fact that 77% of respondents in Savkar and Lokere’s survey indicated that teaching and research were equally important missions of their schools (2010). Discrepancies such as this underscore the need to support professors who are dedicated to improving educational outcomes for STEM students, especially in large, research-intensive universities. For a more detailed discussion of related work, see *The Scholarship of Teaching and Professional Development* in Chapter 2.

**Research Problem**

It is clear that educational stakeholders in the United States have a strong desire to increase the number of college students entering and being retained by STEM disciplines. Professional and government agencies agree that the quality of university science teaching is a priority for targeted improvement (see Table 1.1). Furthermore, STEM professors who publish educational research and commentaries on postsecondary STEM education assert that their peers should implement research-based teaching methods as a matter of professional excellence. To that end, educational researchers must begin to investigate new ways to train and support STEM professors as teachers. A logical starting point for the thoughtful design of pedagogical interventions is a thorough understanding of the current state of professors’ professional lives. Current literature lacks this type of research, and this study contributes to the literature by analyzing one major component of science professors’ careers: the relationship between their roles as teachers and researchers.
**Purpose of This Study**

Given the practical and scholarly interest in improving postsecondary STEM teaching, this study seeks to understand the current lived experiences of science professors. This study should lead to more empirical studies as well as theoretical work that might examine teaching interventions, professional development programs, novel theoretical frameworks, and so on. Through these four case studies, I

- Describe the relationship between my participants’ roles as teachers and researchers. How do my participants describe this construct (the relationship between teaching and learning)? How can I interpret my participants’ descriptions of this construct, utilizing the qualitative methods described herein?

- Identify and describe factors that influence this relationship. How do factors such as personal and professional experiences and culture affect the relationship between teaching and research? What other factors affect this relationship?

- Explain the evolution of this relationship through my participants’ lived experiences. How has this relationship developed? How does it change over the course of the study?

- Identify themes and trends in these participants’ professional lives that provide a starting point for future work such as larger-scale theoretical and experimental research and pedagogical interventions. Where should educational researchers begin to focus future studies to improve college science teaching? How can professional development (PD) experts begin to aid professors as further research is underway?
Research Questions

A better understanding of tenure-track science professors’ roles as teachers and researchers could lead to innovative methods to support their teaching. Thus, this research answers the following questions:

- What is the relationship between teaching and research roles for individuals in a sample of tenure-track science professors at an RU/VH institution?
- What types of activities and experiences (particularly professional development) do participants engage in to support their roles as teachers? What types of activities and experiences impede their roles as teachers? In what ways do these activities support or impede participants’ roles as teachers?
- What connections might be made between the participants' personal, cultural, and professional histories and the way they are currently experiencing the relationship between teaching and research?

Initial Expectations and Assumptions

My personal experiences in the field of STEM higher education have given me unique insight into this area. I entered this study as a researcher and participant observer but also as a practitioner. For this reason, I began with some initial expectations about what I might find. Qualitative methods, particularly phenomenological analysis, require the researcher to acknowledge and bracket her initial expectations and assumptions in order to more fully understand the phenomenon being studied through her participant’s experiences, rather than her

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2 See Chapter 3 for a discussion on my personal experiences and the validity of this work. Also see the Appendix for my autoethnography.
own. Additionally, it is helpful to disclose these expectations and assumptions to the reader to maintain transparency and bolster methodological validity.

First, in my own experience and from past informal conversations with colleagues, I expected that my participants might experience the relationship between teaching and research as a tension. That is, the activities associated with research and teaching are not, in the culture of a typical RU/VH institution, aligned in such a way that one can easily integrate both components of the profession. Furthermore, I anticipated that my participants would report that cultural norms and expectations within science departments would tend not to support teaching activities. Second, I expected that among the wide variety of activities in which these professors participated, few of those activities would be intended to support their roles as teachers, either implicitly or explicitly. In fact, I felt it was conceivable that my participants would encounter a variety of cultural and perhaps personal impediments to their growth as teachers. I imagined that most of the PD activities that my participants did engage in would be informal (e.g., consulting with colleagues). Finally, I expected that the relationships between each participant’s personal, cultural, and professional history and his current career decisions would be complex and subconscious. In other words, I did not expect my participants to be readily able to explicate these relationships, as I expected that STEM professors do not often consider these matters within the normal courses of their daily lives. For further discussion of these initial expectations as compared to actual findings, see Chapter 5.

Throughout this text, male pronouns will be used when discussing study participants because all participants are male. See Chapter 3 for a discussion of recruiting efforts and gender disparity in this study.
Chapter 2

Theoretical Framework and Literature Reviews

The purpose of a theoretical framework and literature review is best described by Willis and Trondman in their “Manifesto for Ethnography” (2000). They explain that theory for its own sake is not of use to ethnographic researchers. Instead, we utilize theory which relates specifically to our ethnographic evidence, sensitizes us to our participants’ issues, and aids us in “teasing out patterns from the texture of everyday life” (p. 7). In this way, this chapter represents the culmination of iterative literature study in which I engaged throughout my research. This review begins with my own general theoretical framework of social interaction (i.e., sociocultural) and ends with topics which pertain to my participants’ stories (e.g., the relationship between teaching and research).

Sociocultural Theoretical Framework

This research explores the relationship between teaching and research for a sample of tenure-track science professors at an RU/VH university. Above all, my work is informed by a sociocultural understanding of the way individuals experience the world. I do not view my research participants as isolated subjects but rather as members of complex social settings with rich personal histories. Sociocultural theoretical frameworks originate from the work of Lev Vygotsky (1978) and are based on the idea that people learn and develop through complex social interactions embedded in social and cultural
activities. These activities generally take place within “communities of practice” (Lave, 1991) in which new members of communities are able to participate in culturally valued activities with the purpose of preparing them for “mature participation” (Rogoff, 2008).

Rogoff describes sociocultural activity from three different but connected perspectives which she calls “planes of focus” (2008): apprenticeship, the personal plane of focus; guided participation, the interpersonal plane of focus; and participatory appropriation, the community/institutional plane of focus. The apprenticeship metaphor is reminiscent of Lave and Wenger’s “legitimate peripheral participation” (1991). In my work with science professors, my participants at times act as apprentices or as mentors to apprentices. For example, an early-career professor might often feel or act as an apprentice within his department, particularly if he reaches out to a colleague for teaching or other career advice – informal professional development. However, that same professor in his research lab would almost undoubtedly be acting as a mentor to undergraduate and graduate students as well as post-doctoral fellows, technicians, and other personnel. The guided participation concept offers a more fine-grained understanding of the social interactions that occur within communities of practice, and Rogoff stresses that in this term “guidance” refers to the “direction offered by cultural and social values, as well as social partners” (p. 60). Here, it is conceivable that professors in my study have been guided by a number of cultural and social influences ranging from departmental and institutional norms to peer and even student expectations. With respect to teaching, this becomes an interesting social phenomenon because professors do not typically experience each other’s teaching, but tend to only hear or understand cultural norms through anecdotal discussion and previous experiences as
students themselves. Finally, Rogoff’s participatory appropriation is intended to describe “how individuals change through their involvement in one or another activity” (p. 60). Interestingly, Rogoff speaks extensively about the importance of *time* with respect to this concept. She explains that one must not view the past, present, and future as discrete time periods; rather the past informs the present which guides individuals towards the future. This holistic view of life events has been a key component in my study of science professors because I asked them to make connections between their previous and current professional and personal experiences as well as their future goals.

As I engaged in the work described herein, I developed multiple visual models to aid my conceptual positioning of the various components of professors’ lives. Figure 2.1 is one such representation in which I have highlighted the embeddedness of various phenomena within one another. I show here that my participants’ personal values and cultures provide the backdrop for their professional experience, including the way they experience the relationship between teaching and research. This visual aid underscores the logic in utilizing ethnographic methods to understand the larger picture of participants’ lives by showing that the relationship between teaching and research is embedded in a person’s professional experiences and personal values and culture. Ethnography honors this sociocultural embeddedness.
Epistemological and Ontological Considerations

Because my work focuses on the specific phenomenon “the relationship” between teaching and research, some epistemological and ontological concerns could be raised. Beyond the deeper meaning of this relationship which my research uncovers, I initially approached this work with the dictionary definition of “relationship”: “the way in which two or more people or things are connected” (“Relationship,” n.d.). With regard to whether or not this relationship exists at all, teaching and research are both responsibilities which comprise portions of professors’ jobs. The existence and characterization of connections beyond that basic relationship vary for each participant.
and are described in Chapter 4. My belief that the complexities of the relationship between teaching and learning can only be known through the lived experiences of my participants is consistent with a phenomenological philosophy (Kafle, 2013).

The Relationship between Teaching and Research

Balancing teaching and research

The essence of this project is to examine the relationship between teaching and research roles for science professors at a major research institution. This is a relatively novel area of interest for educational researchers, with the earliest publications in the field arising in the 1970s but not gaining popularity until the late 1990s. For this reason, and because it is a component of innately complex human lives, the nature of the relationship between teaching and research is not well understood. Work that examines this construct tends to focus on the concept of balance between the two components of professors’ careers, particularly with respect to time management. There is general agreement in the literature that professors typically experience a tension between these two components of their career, but for now it is unclear how or why that tension is felt.

Existing research suggests that professors feel pressured to emphasize research over teaching in American universities. After conducting a survey of 450 university science professors with both research and teaching responsibilities, Savkar and Lokere concluded that “although scientists personally value education as much as research, they frequently align their decision making, both for themselves and on behalf of their
departments, with the needs of research rather than those of education” (2010). This study highlights an important question in the landscape of university science teaching. If professors’ time and resources are inequitably slanted towards research, is this phenomenon due to personal preferences, professional pressure, or some combination of those (and other) factors? When asked about the relative importance of teaching and research, 77% of the respondents in Savkar and Lokere’s survey indicated that the two components of their job (teaching and research) were equally important, and 16% reported that they considered teaching to be more important than research. However, when the survey participants were asked to respond to a hypothetical hiring situation, their choices were not consistent with their professed beliefs. The survey asked participants to choose amongst three possible candidates for a new professor position: “a star researcher with no significant teaching experience, a star teacher with no significant research experience, and a decent teacher and decent researcher who is not a star in either discipline” (p. 9). Forty-eight percent of respondents chose the star researcher – the option that would seem to contradict their formerly expressed favor for the role of teaching over research.

Although there is not an abundance of literature deeply exploring the relationship between teaching and research, existing work suggests that professors find it challenging to give what they consider to be adequate time and attention to their teaching due to the cultural climates of research universities (W. A. Anderson et al., 2011; Savkar & Lokere, 2010). Typically, researchers speculate that this imbalance is due to the institutional emphasis on research productivity, especially with respect to promotion and tenure (Bradforth et al., 2015; Leslie, 2015; Light, Calkins, Luna, & Drane, 2009; M. Wright,
2005). One particularly poignant account is coauthored by thirteen scientists who have all received science education funding from the Howard Hughes Medical Institute (HHMI) (W. A. Anderson et al., 2011). These individuals work in a variety of institutions from well-funded private universities, to larger, less financially endowed schools, and yet all of these professors unanimously report that “the reward systems at research universities heavily weight efforts of many professors toward research at the expense of teaching,” and that “departmental and university cultures often do not adequately value, support, and reward effective pedagogy” (p. 152).

At this point, one must wonder whether cultural pressures primarily stem from departments, colleges, universities, disciplines, or some other source. In a 2010 review of literature looking at discipline-based patterns in faculty performance standards at research universities, it was found that although some tenure and promotion considerations (i.e. the relative value of faculty roles) were inconsistent even within disciplines, many items were strongly influenced by discipline (Hardré, Cox, & Kollmann, 2010). For example, STEM professor evaluations focused heavily on items that could be measured quantitatively, explicitly defined “scholarship” as “research,” and in some cases “warned candidates against letting service or other pursuits get in the way of research productivity.” The NRC Discipline-Based Educational Research (DBER) report is in alignment with these findings and acknowledges that untenured science and engineering faculty engaged in educational research will face challenges associated with promotion and tenure committees which might not value time spent engaging in DBER activities (National Research Council, 2012, pp. 40, 188).
This apparent conflict between some professors’ professional preferences and those of their departments generates questions about how professors actually prioritize and balance their many responsibilities within research institutions, especially with respect to developing high-quality teaching programs in a research-centered culture. Over the last two decades, research on professors’ diverse research and teaching responsibilities has begun to accumulate. Some quantitative studies seek correlations between teaching excellence and research productivity (Hattie & Marsh, 1996; Horta, Dautel, & Veloso, 2012; Hurley, Bowling, Griffiths, & Blair, 2013; Marsh & Hattie, 2002; Zaman, 2004), but this work reports a range of findings about the relationship between teaching excellence and research productivity.

Hattie and Marsh (1996) explain in their meta-analysis of 58 quantitative studies on the relationship between research and teaching that there are multiple theoretical models that can be used to explain “many possible permutations relating the quality of teaching and research” (p. 508; also see Cherastidtham, Sonnemann, & Norton, 2013; Zaman, 2004). One might argue that the scarcity model would dictate that given a scarcity of available time and resources, teaching and research activities are necessarily oppositional. Other negative relationship arguments are supported by explanations drawing on differential personality (teaching and research requires different types of people to be successful) and divergent reward system (the two activities are supported by opposing reward systems) models. Alternatively, Hattie and Marsh describe theoretical models that support the idea that teaching and research are synergistic activities. The “conventional wisdom” model suggests that professors find teaching and research to be complementary simply because they believe it to be true by virtue of conventional
professional practice. Next, the “G’ model” dictates that similar personal and professional values are associated with good teaching and good research: “high commitment… creativity… investigativeness, and critical analysis” (Hattie & Marsh, 1996, p. 512). In support of zero correlation between research and teaching, Hattie and Marsh offer the unrelated personality model (opposing the differential personality model) which describes the idea that good researchers and teachers are different types of people, and there may be few personality traits in common… Researchers are more likely to be ambitious, enduring, seeking definiteness, dominant, showing leadership, aggressive, independent, not meek, and nonsupportive. Teachers are liberal, sociable, showing leadership, extroverted, low in anxiety, objective, supportive, nonauthoritarian, not defensive, intelligent, and aesthetically sensitive. (P. 514)

Additionally, the different enterprises model explains that research and teaching are driven by different, not necessary oppositional or cooperative, goals and professional traits.

Hattie and Marsh describe models that do not assume teaching and research must have an absolutely positive, zero, or negative relationship. That is, the two activities could be mediated by a complicated host of variables. Marsh’s compensatory model argues that whereas some components of a professor’s job, such as time spent on teaching and time spent researching, are necessarily oppositional, a positive relationship between other variables such as research and teaching ability could compensate for that loss in time. Similarly, Friedrich and Michalak’s intervening variables model posits that some variables such as knowledge, ability, intellectual involvement, organization, and
others can intervene and alleviate the tension between research and teaching (Friedrich & Michalak, 1983). These models have been taken into consideration throughout my own research with science professors as described in the coming chapters. For more information about how the models relate to each participant in my study, see Chapter 4.

The teaching-research nexus

One area of research on the relationship between teaching and research for professors that has gained some attention internationally is the “teaching-research nexus.” This concept was first introduced to the literature in the 70s (Jauch & Gentry, 1976) and has since continued to gain popularity, particularly in research on the Australian University system (Cherastidham et al., 2013; Geschwind & Brostrom, 2015; Horta et al., 2012; Neumann, 1994; Stappenbelt, 2013). This body of literature is parallel to that described previously in the sense that although there have been numerous theoretical publications addressing the topic, “a teaching-research nexus has not to date received much support from empirical studies” (Cherastidham et al., 2013, p. 3).

The main point of difference between work on the teaching-research nexus and other research on the relationship between teaching and research is that studies focusing on the teaching-research nexus tend to ask questions associated with whether or not engaging in research and teaching simultaneously improves the quality of teaching. The limited empirical data that exists points to the notion that researchers do not make better or worse teachers (as compared to professors who do not engage in research; Norton, 2013; Stappenbelt, 2013). This work has limited applicability to my current study in that I
only seek to better understand the way research professors experience the relationship between teaching and research. However, this literature does serve to make one important point connected with my research. Some stakeholders have suggested that one way to improve undergraduate education might be to increase the number of lecturers (professors who only engage in teaching and not research) and decrease students’ engagement with research professors (Norton, 2013). Given the understanding that lecturers do not necessarily make better teachers, it is essential that educational researchers investigate ways to support all types of professors as teachers. The work I describe here has been designed to contribute to further work that supports research professors as teachers.

**Miscellaneous empirical studies**

In addition to the work already described, there is an abundance of studies that discuss the relationship between teaching and research but do not deeply investigate the relationship between teaching and research. Colbeck’s (1998) study uses observation and activity logs to measure the amount of time professors spend integrating teaching and research activities. This type of data is interesting but lacks information about the complexity of professors’ goals when engaging in various activities, as well as the reasons behind those goals. Russell’s (2009) commentary on the multiple roles science professors take on is autobiographical and does not draw upon any formal research techniques. Barrett and Milbourne’s (2012) regression analysis of data from 37 public Australian universities reports that research environment (measured by research output,
income, etc.) has “a negative effect upon perceptions of good teaching…[and] a positive effect on…full-time employment, progress rates and retention rates” (p. 77). This is an interesting point for further study, but the data reported by Barrett and Milbourne is insufficient to construct explanations for why the relationships they uncovered exist or how those relationships are experienced by individuals in Australian universities. Indeed, a host of similar studies might be described (Figlio, Schapiro, & Soter, 2013; Galbraith & Merrill, 2012; Hurley et al., 2013). Each one contributes to the field’s understanding of professors’ careers in its own way, but all lack the deeply descriptive power of a case study or ethnographic analysis. Deep qualitative work with professors will help researchers: uncover aspects of professors’ careers that matter to professors; determine which aspects of professors’ professional lives serve as interesting topics of further quantitative study; and answer questions which could not be answered by quantitative methods (such as the research questions in the study described herein).

Implications

Several considerations for my study have been inspired by this body of literature on the relationship between teaching and research. First, some literature reports that professors typically experience the relationship between teaching and research as a tension. However, there are few empirical studies to support this notion and no studies that deeply probe the way individuals experience this relationship. Thus, I looked for evidence pointing to the actual nature of the relationship between teaching and learning for my participants, aware that it would be important to justify any characterization of
this relationship with details of the participants’ lived experiences. Furthermore, since some literature suggests that the cultural climates of universities, colleges, or departments might play a significant role in the way professors experience the relationship between teaching and learning, I was alert to stories and details that my participants provided about such climates.

Second, research on professors’ careers often highlights the importance of time management since the job of a college professor is comprised of multiple roles and responsibilities. In fact, time management issues were the only data-supported explanation for the reported tension between teaching and research in the literature. This literature heightened my awareness of my participants’ stories relating to time management, particularly with respect to “time cost” (see Chapter 4).

Finally, there are not any comprehensive theoretical frameworks to describe or explain the relationship between teaching and research, though some preliminary work suggests that a network of variables should be considered while studying the relationship between teaching and research. The lack of a theoretical framework did not discourage me from pursuing this topic of study. Instead, as I worked with my participants, I remained mindful of the fact that my participants’ experiences would likely be extremely helpful as the field continues to work towards developing theoretical frameworks for understanding the relationship between teaching and research. For further discussion of the relationship between teaching and research as a useful research construct, see Chapter 5.
The Scholarship of Teaching

The scholarship of teaching was first identified as one of four major functions of university professors (along with the scholarships of discovery, integration, and application) by Ernest Boyer in his special report to the Carnegie Foundation *Scholarship Reconsidered: Priorities of the Professoriate* (1990). Although Boyer clearly communicated that the scholarship of teaching was one of great importance, he still only gave the topic summary treatment, making the following points (pp. 23-24):

- Professors must, “above all,” be well-versed in their own content knowledge areas.
- Professors plan and constantly reexamine discipline-specific pedagogical activities intended to stimulate active learning.
- Professors are learners in the sense that teaching is “not only transmitting knowledge, but transforming and extending it as well.”

Over the past two and a half decades, the higher education community has continued to develop the conversation Boyer began on the scholarship of teaching. In a follow-up to this work, Hutchings, Huber, and Ciccone published the Carnegie Foundation report, *The Scholarship of Teaching and Learning Reconsidered* (2011). The modification of vocabulary here reflects a change that has taken place on a widespread level; the community has evolved from thinking of a university as a provider of knowledge to thinking of a university as a place of learning (Barr & Tagg, 1995; Hutchings et al., 2011, p. 4). As this understanding has been refined, so too has the community’s understanding of the ways in which this scholarship of teaching and
learning (SoTL)\(^4\) can be utilized. One of the most valuable applications for a scholarly approach to the role of teaching for science professors is improving their own teaching practices. Hutchings et al. hope the SoTL community can bring to higher education classrooms “a set of practices that have traditionally been missing…habits of inquiry, analysis, exchange, and knowledge building” (2011, p. 41) by challenging the assumption that the only preparation professors need to teach is expertise in content knowledge.

Unfortunately, research on professors’ teaching beliefs and practices is problematic, often either shallow or focused on a highly constrained area of teaching. For example, Gess-Newsome, Southerland, Johnston, and Woodbury (2003) report on three university professors’ beliefs about college science teaching. Their research findings indicate that one of the most powerful influencers of professors’ teaching practices is their own set of personal teaching theories. However, as the focus of the work was the phenomenon of change in science teaching, deep treatment was not given to the professors’ beliefs or goals in relation to their practices. As an example of other, more specific studies, Hutchins and Friedrichsen (2012) report that university science professors typically believe that inquiry-based science teaching is scientifically authentic and student-centered but is difficult to execute within classroom constraints. These types of studies make interesting contributions to the body of work on professors’ beliefs, but they lack a holistic understanding of professors’ experiences. This is in contrast to

\(^4\) Hutchings, Huber, and Ciccone explicitly chose not to utilize the acronym “SoTL” in place of the phrase “scholarship of teaching and learning.” Since they did not fully explain their reasoning, and I can only speculate about this, I will be using the acronym for the sake of brevity.
research on K-12 teachers’ beliefs, which is often supplemented by observation and analysis of their practices (Wideen, Mayer-Smith, & Moon, 1998).

Unfortunately, this lack of in-depth research on professors’ teaching beliefs and practices is a long-standing phenomenon. A 1981 review of literature on research seeking to improve college teaching (Levinson-Rose & Menges, 1981) found five categories of college teaching interventions: grants for faculty projects, workshops and seminars, feedback from student ratings, practice-based feedback, and concept-based training. Closer examination of literature claiming to support practice-based interventions revealed that these interventions were typically not situated in authentic environments but were described by Levinson-Rose and Menges as “microteaching and minicourses” (1981). Current reviews of research on teaching at the college level do not find significant progress in the area (Amundsen & Wilson, 2012). Kane, Sandretto, and Heath report that an abundance of literature makes claims about postsecondary educators’ practices based solely on the professors’ self-reported data – a research practice they label as “telling half the story” (Kane, Sandretto, & Heath, 2002).

This literature provided me with an understanding that insights about professors’ teaching beliefs and practices, an essential component of my participants’ experiences, could make an important contribution to this body of work. Throughout my interviews (as described in Chapter 3) I listened for cues that signaled what participants thought and felt about teaching. During observations of participants teaching, I made note of how their practices might reflect upon their beliefs. Thus, even though participants’ teaching beliefs and practices were not the main focus of this study, I was able to gain insight into participants’ teaching beliefs and practices.
Professional Development

One of the aims of this study is to investigate professors’ involvement in professional development activities, particularly those related to teaching. It has been long understood that effective K-12 teacher professional development is job-embedded and teacher-driven (Easton, 2008; Joyce, Wolf, & Calhoun, 2009; Wilson & Berne, 1999). A particular emphasis has been placed on these components of professional development by many researchers (Avalos, 2011; Easton, 2008; James & McCormick, 2009; Jurasaitė-Harbison & Rex, 2010; Sato & Kleinsasser, 2004). These works draw upon a greater body of literature which reveals that teacher education as a rule relies upon autonomous teacher expertise (Cochran-Smith, Feiman-Nemser, & McIntyre, 2008) and that learning in general is situated in “activity systems: complex social organizations containing learners, teachers, curriculum materials, software tools, and the physical environment” (Greeno, 2005). High quality professional development programs should fully consider individual teachers’ professional expertise as well as the situative and sociocultural nature of teachers’ job-embedded learning (Bredeson, 2000).

Unfortunately, application of the K-12 professional development body of literature to higher education is scarce. Amundsen and Wilson indicate that postsecondary, K-12, and medical science professional development literature all “remain in quite separate silos” (2012). Furthermore, though there has been a recent uprisng of publication in faculty development (Amundsen & Wilson, 2012; Levinson-Rose & Menges, 1981; Steinert et al., 2006; Stes, Min-Leliveld, Gijbels, & Van Petegem, 2010), “there has been a comparative dearth of research looking at the impact of these programs” (Light et al.,
Thus, publications in this field are typically restricted to reports on novel professional development programming efforts with an emphasis on program design. Embedded within a particular program design, one might find theoretical support such as: sociocultural (J. Brown and P. Duguid), faculty knowledge (L. Shulman), and constructivist learning environments (D. Jonassen; Amundsen & Wilson, 2012). However, there are not any overarching theoretical frameworks to support the larger issues of how and why postsecondary professional development for professors is or should be designed in any particular fashion. This problem was, in fact, the driving force for the 2012 literature review carried out by Amundsen and Wilson.

In Amundsen and Wilson’s conceptual review of postsecondary professional development literature, the authors determined that although there are not currently any major theoretical frameworks guiding this field, there are some emerging components of frameworks that can be seen as common threads through some “clusters” of published work. For example, professional development programming might choose to make a distinction in emphasizing either an outcome or a process. The former would intend to provide faculty with some measurable skill, whereas the latter would attempt to engage faculty in professional development processes without prescribing the outcomes for each participant. In a fully-developed theoretical framework, an author would likely explicitly choose – and argue for – one of these emphases. Amundsen and Wilson conclude that, although the field of postsecondary professional development research has gained coherence in the last 30 years, scholars in this field should begin to seek more collaboration with other, create more mature professional development fields, and practice more systematic building upon previous work.
There are some poignant implications of the state of this literature for my research described herein. My work has not benefited from the foresight of a well-developed field of study. However, I have been able to use the reviews described above to locate the pockets of literature connected to my observations. I have taken the advice of Amundsen and Wilson and drawn from multiple fields to build my understanding of my participants’ experiences. For specific connections between participants’ experiences and professional development literature, see Chapter 4.

**Professors’ Conceptions of Science**

When I first proposed this study, I felt that it was plausible that participants’ understandings of science itself could play a role in the ways they prioritize their professional activities. For example, professors who feel that science is embodied in the practices of science (as opposed to the knowledge produced by those practices) might find more connections between teaching and research. However, I am hard-pressed to find literature discussion of this type of conjecture. As practitioners of science, professors are found to have epistemological and ontological beliefs about science as a discipline that differ from those of philosophers of science (Abd-El-Khalick, 2012). Furthermore, one might expect science professors to present slightly different versions of their conceptions of science within the context of science teaching than they would in the context of scientific research. Unfortunately, this distinction (science for the classroom vs. science for the research lab) has not typically been delineated clearly in the literature (Wong & Hodson, 2009, 2010). In the absence of literature addressing professors’
conceptions of science, efforts to understand these topics has primarily been informed by work on scientists’ conceptions of science.

Certainly one of the most influential studies in this area was a Delphi study conducted by Osborne, Collins, Ratcliffe, Millar, and Duschl (2003). The 23 participants in the study represented a broad range of science experts, from scientists to philosophers of science. They were tasked with identifying key elements of the nature of science that should be taught in schools. Agreement was reached amongst the participants in nine areas: scientific method and critical testing, creativity, historical development of scientific knowledge, science and questioning, diversity of scientific thinking, analysis and interpretation of data, science and certainty, hypothesis and prediction, and cooperation and collaboration. Wong and Hodson (2009) note that this list is similar to that reported by Lederman, Abd-El-Khalick, Bell, & Schwartz (2002): “science is tentative, empirically based, subjective (in the sense of being theory driven), socioculturally embedded, and dependent on human imagination and creativity” (Wong & Hodson, 2009). Wong and Hodson’s interviews with 13 types of scientists over subdisciplines within physics, chemistry, and biology allowed them to recognize the vastly different methodologies utilized by individual scientists. The finding that scientists in different disciplines have different beliefs about the nature of science reinforces the idea that conceptions of science are socioculturally situated (at the very least by discipline, so perhaps also by application – teaching or research). This supports the need for a deeper understanding of professors’ conceptions of science as they are situated in their professional practices.
Knowledge of this literature was helpful throughout the study as my participants often referenced epistemological and ontological issues related to science. However, since several of my participants seemed to have different conceptions of science for teaching and research, I continue to assert that research which studies professors’ conceptions of science situated within the teaching setting would be useful to the field. Although this was not one of the primary goals of my research described herein, I was able to obtain some insights which might help guide further work in this area. See Chapter 4 for a more exhaustive discussion on each participant’s conceptions of science.

**Conclusion**

Each of these bodies of literature (with the exception of the sociocultural theoretical framework) represents an area of research that has exciting but underdeveloped applications to understanding science professors’ careers. Overall, there is a need in each of these fields to undertake work that considers the depth and complexity of lived experiences. In some ways, the lack of depth expressed in research on university professors is a mark of a budding field. That is, what area of expertise would one possess to undertake such study? Educational researchers are typically trained to work in K12 settings; university STEM educators are rarely trained in educational research. I believe that DBER scholars, who are typically somehow trained in both a STEM area and educational research (National Research Council, 2012), are the future pioneers of work that will illuminate many issues pertaining to science professors’ careers. The study described here is representative of such an effort. My dual training as
a scientist and an educational researcher has allowed me to conduct rigorous social science while still retaining a deep understanding of the culture I have been studying.
Chapter 3

Methods

This set of four case studies has drawn upon phenomenological and ethnographic techniques of data collection and analysis in order to obtain data from which rich social and cultural understandings are developed. Data collection began January 2015 and concluded October 2015.

Research Questions

This descriptive study addresses three research questions. First, what is the relationship between teaching and research roles for individuals in a sample of tenure-track science professors at an RU/VH institution? This relationship was primarily explored through interview and participant observation. As described in Chapter 2, the relationship between teaching and research for professors is not well understood by educational researchers. For this study, a better understanding of the relationship between teaching and research has been reached through an examination of participants’ attitudes and beliefs, time and resource allocation, professional practices, etc. Additionally, through interview and document analysis, I analyzed the cultural backdrop of the RU/VH institution and what role culture plays in the relationship between teaching and research. As I collected and analyzed data pertaining to this research question, I asked myself questions such as: How does this professor experience the relationship between teaching
and research? Does institutional culture play any role in the way this professor experiences the relationship between teaching and research?

My second set of research questions more closely examined the types of professional activities which support or impede teaching for science professors. What types of activities and experiences (particularly professional development) do participants engage in to support their roles as teachers? What types of activities and experiences impede their roles as teachers? In what ways do these activities support or impede participants’ roles as teachers? Participant observation and document analysis were used to gain insight into the way professors spend their professional time. However, understanding how and why participants choose to distribute their time arose primarily from interviews. As I reviewed this data, I asked myself: Do my participants utilize professional development resources on campus? Do they engage in informal professional development? If so, why do they do so and how do these activities influence them? If not, why not? Are my participants more likely to engage in discipline specific professional development activities?

Finally, my third research question addressed participants’ past experiences. What connections might be made between the participants' personal, cultural, and professional histories and the way they are currently experiencing the relationship between teaching and research? These connections and relationships were uncovered almost exclusively through participant interviews. This “bird’s-eye view” of one’s career choices is not typically a topic individuals think about explicitly unless prompted to do so, and I found that answers to this research question were found by thematic analysis rather than straightforward discourse. Throughout this analysis, I asked questions such as: What
elements of my participants’ past have an ascertainable influence on their current careers? What is the relationship between the participant’s teaching and research goals and his institution’s teaching and research goals (as he perceives them)?

Methodological Frameworks

This research draws upon several traditions of qualitative inquiry to answer the research questions above. I chose my research paradigms based on my answers to the three fundamental questions posed by Guba and Lincoln: the ontological question, the epistemological question, and the methodological question (1994). In response to the ontological question, I assert that reality is based on subjective experiences of individuals. That is, there are no objective truths to be studied when matters of personal experience are concerned; a person’s reality can only be understood through the lens of her subjective experiences. As for the epistemological question, I recognize myself as a knower who is influenced by my own experiences and beliefs. Thus, my understanding of my participants’ experiences will be affected by my subjectivity to some extent. Finally, methodologically I can only learn about the phenomenon I am researching by asking my participants to share their stories, experiences, and artifacts with me.

Primarily, this project is a set of case studies supported by techniques from both phenomenology and ethnography. These frameworks, which are described in detail in the following paragraphs, are in alignment with my epistemological, ontological, and methodological beliefs described above. Additionally, since I imagine projects after this
work might include grounded theory, I have kept this methodological tradition in mind to better inform future research.

**Case study**

The primary methodological framework for this research is case study. According to Creswell (1998), a case study is “an exploration of a ‘bounded system’ or a case (or multiple cases) over time through detailed, in-depth data collection involving multiple sources of information rich in context” (p. 61). For the work described herein, each case being studied is a tenure-track science professor at an RU/VH institution who teaches science and also leads an active research group. The descriptor “tenure-track” denotes that the professor is either pursuing or has attained tenure within his current position.

Science fields targeted for this study included all physical and biological sciences, basic or applied. For the sake of obtaining information about how the professor engages with his research group, I chose to include only participants who had at least two researchers (e.g., post-doctoral researchers, graduate students, or undergraduates) in their groups (i.e., an active research group). All of these qualities contributed to defining bounded systems such that this work meets Creswell’s criteria for a case study. Additionally, this research meets Creswell’s criteria because it was conducted over time (10 months) and utilizes multiple sources of data (interview, observation, and documents) for deep and thorough analysis.

I chose to engage in case studies for this project because this method (supplemented with features of others mentioned previously) would give me the most
holistic understanding of my participants’ lives while still giving me access to the
detailed data necessary to answer my research questions. By “holistic understanding” I
mean that I not only obtained data directly related to my questions, but also collected an
abundance of related data which deepened my understanding of the sociocultural
backdrop for each participant’s experience of the relationship between teaching and
research. In other words, I sought to understand my participants as whole people with
rich stories of their professional lives.

**Phenomenology**

As indicated in my research questions, I am interested in the *phenomenon* of the
relationship between teaching and research for science professors. Because I examine
“the meaning of the lived experiences for several individuals about a concept” (Creswell,
1998, p. 51), and because I believe “that our experiences can be best understood through
stories we tell of that experience” (Kafle, 2013, p. 191), I utilize phenomenological tools
which are designed to deeply explore specific lived experiences. My study would not
necessarily be described strictly as phenomenology because I am using case study to
obtain a greater holistic understanding of my participants’ career experiences. However,
as Polkinghorne describes, I do wish for my reader to “understand better what it is like
for someone to experience” the phenomenon at hand (1989), and therefore I designed this
study to draw heavily upon phenomenological techniques – particularly with respect to
my use of the phenomenological interview. See the full section on interview below for
more detail.
Kafle explains that phenomenological researchers need not be confined to strict techniques and procedures (2013). He asserts that there are only six guidelines that one should adhere to in a phenomenological study: “commitment to an abiding concern [for human experience], oriented stance toward the question, investigating the experience as it is lived, describing the phenomenon through writing and rewriting, and consideration of parts and whole” (p. 191). These guidelines are honored by the techniques I have chosen (interview, observation, and document analysis; Starks & Trinidad, 2007).

**Ethnography**

An ethnography is an in-depth study of a group’s culture, typically carried out by the researcher’s immersion in the group, participant observation, group member interviews, and document and artifact collection (Creswell, 1998, pp. 58–59). The research proposed here is by no means a full ethnography as I do not intend to comprehend the full scope of the culture of tenure-track science professors. A pure ethnography would utilize more longitudinal work, participant observation, and many more hours of interaction with the culture being studied. However, as I am always examining my data through the lens of the sociocultural theoretical framework, ethnographic methodologies will aid me in seeing the issues at hand through my participants’ eyes (Spradley, 1980, p. 3). Specifically, I relied on ethnographic coding strategies to analyze field notes and interview transcripts (see the data analysis section). Incorporating the wisdom of ethnographic work must not be confused for the pervasive “contemporary disarticulations between ‘social being’ and ‘social consciousness’” (Willis
& Trondman, 2000, p. 8). I view my participants as autonomous individuals, but I simultaneously recognize that their beliefs and behaviors “must be understood in relation to the conditions of existence within which [they] act, work, and create” (Willis & Trondman, 2000, p. 8).

**Grounded theory**

A grounded theory study is carried out to generate a new theoretical explanation for a social phenomenon. It is typically characterized by a large number of interviews (20 to 30) which provide a rich source of data for saturating categories in a novel theoretical framework (Creswell, 1998, p. 56). Though I have not carried out a full grounded theory study here, I am discussing the method because I believe that the results of my work will lead to future efforts in grounded theory studies. As described in Chapter 2, theoretical frameworks explaining the relationship between teaching and research for professors are often contradictory and lack the maturity and empirical support necessary for widespread acceptance. This research project is complete in its own right, but it is not a full grounded theory study. However, it lays the groundwork for subsequent studies which will use its results as the starting point for generating deeper understandings of the ways professors experience their careers. I was especially inspired by the coding techniques utilized by grounded theory researchers (Strauss, 1987, pp. 27–36), along with those developed by ethnographers (Spradley, 1980, pp. 112–121, 130–139). For more information on my coding techniques, see the full Coding section below.
Techniques

Interview

Participants were asked to engage in four 90-minute interviews (for a total of 7.5 hours or less) over the course of ten months or less. The first three interviews followed Seidman’s “in-depth, phenomenological interviewing,” a combination of “life-history interviewing…and focused, in-depth interviewing informed by assumptions drawn from phenomenology” (2006, p. 15). In this strategy, three 90-minute interviews are conducted three to seven days apart. In some cases, more than seven days passed between interviews, but only when it was absolutely necessary to accommodate for participants’ schedules. The first interview focused on the past professional and personal histories of the participants. The second interview focused on the current professional experiences of the participant. The third interview asked the participant to reflect on the meaning of the experiences discussed in the first two interviews. Seidman asserts that after the first question of each interview, subsequent queries should be derived more from the participant’s words than the researcher’s hypotheses. Thus, these interviews began with prompts such as, “How did you come to work at this university?” Follow-up prompts sought clarification or further exploration of ideas offered by participants. These prompts were asked in such a way to obtain the most detailed ethnographic data possible.

Examples of follow-up prompts include:

- Asked after a participant mentioned tenure: “Can you tell me more about the process of applying for tenure?”
• Asked after a participant used the phrase “different types of schools”: “Can you tell me what you mean by ‘different types of schools?’”

• Asked after a participant talked about using clickers in his classroom: “How did you come to start using clickers in your classes?”

• Asked after a participant mentioned his parents: “What do your parents do for a living, or what did they do?”

Additionally, Spradley encourages researchers to ask “contrast questions” which probe into components of a participants’ culture as well as the relationships between those components (1980). Examples of follow-up contrast questions are:

• “So how was this different from teaching the general section?”

• “You mentioned that there is a difference between expert and novice learning. Can you talk more about that?”

• “You’ve mentioned two identities so far, astronomer and engineer. What are the unique aspects of an astronomer versus some other type of scientific identity or career identity?”

The fourth interview took place at the conclusion of the study and was designed to allow for follow-up from the first three interviews (i.e. clarification or additional information for topics that were not fully explored) and member checking (Maxwell, 2013b, p. 126) selected preliminary results from any interviews or observations for that participant.

I chose to follow Seidman’s method for phenomenological interviewing in order to honor my participants’ own stories to the greatest extent possible without imposing my research questions on their words. It was my hope that their stories would naturally allow
me to answer my research questions. For this reason, I was tried to not pursue topics related to my research questions until my participants naturally mentioned them and to only ask clarifying questions to such an extent as was necessary for me to understand their stories. In cases where my participants did not mention topics related to my research questions at all, I briefly asked them to remark on such topics either at the end of an interview or during our follow-up interviews. Such instance are noted in Chapter 4.

The first three interviews were audio-taped, transcribed, and coded for all participants. Follow-up interviews were not recorded since they were not being transcribed and coded, but I took field notes during and after them. For more information on my coding techniques, see the coding section below.

**Observation**

Participants were asked to allow me to observe them engaging in typical professional activities on no more than ten separate occasions over the course of the study. These observations primarily acted as a way for me to triangulate data provided by participants during interviews and in documents. In some cases, less than ten observations were performed because I reached theoretical saturation. The number of actual observations performed for each participant is reported in Chapter 4. Each observation lasted one half to two hours and involved either a class session led by the professor who was teaching or some type of research group meeting/activity. It is important to note here that the original design of this study included observation of participants in other activities such as faculty meeting, seminars, and colloquia. However,
review of the Internal Review Board (IRB) proposal resulted in a request by the Office of Research Protections (ORP) for me to announce my presence as a researcher in each situation and identify my participant as the subject of my research study. I felt that this breach in confidentiality would be unacceptable for the ethical considerations of this study. For example, professors who have not yet attained tenure or various promotions might not feel comfortable with their peers being alerted to their involvement in my study. Therefore, that set of observations was removed from the study protocol. Also note that in cases where participants did not complete all ten of the observations described here, they all completed no fewer than four observations in each category (teaching and research).

The focus of each observation was determined by the development of an observation guide based on the study’s research questions and any data that was unique to the participant being observed (Mason, 2002a). A typical observation guide asked: In what activities is the participant engaged? With whom is the participant interacting? What is the participants’ demeanor? Immediately before each observation, I consulted my research questions and reviewed my observation guide. During observations, I took detailed field notes which I transcribed/expanded after the observation period. Field notes included: initial impressions and photos of the observation setting, notes on significant or unexpected occurrences, personal reactions, descriptions of how routine interactions take place, direct quotes from participants, and initial analytical ideas (Emerson, 2011; Spradley, 1980). Field note transcripts were categorically coded. As with interviews, data recording included informal interactions both before and after the designated observation
event to the greatest extent possible. I chose not to video- or audio-record observations in
order to minimize my interference with the regular activities of participants.

My participation in situations I was observing was kept to a minimum. At times,
participants and their classroom or research students would talk to me during
observations, and I would respond briefly and professionally.

**Document collection**

Before the study began and again during follow-up interviews, I asked
participants to provide any documents they felt were pertinent to their jobs (e.g.,
documents related to being a professor at their institution). I also retrieved publicly
available documents on my own. Examples include: participants’ graduate school, job,
and award application materials; partial tenure dossiers (within the scope of
confidentiality limitations); scientific publications; course syllabi; lecture notes and
slides; personal and professional websites and blogs; and departmental, college, and
university statements on teaching and research. Websites were catalogued using the
NVivo 10 for Windows\(^5\) addon NCapture which saves the websites as pdf files in the
project’s database. Documents were categorically coded with attention given to the
sociocultural situations in which they were constructed (Mason, 2002b). In other words, I
did not view these documents as isolated items but as artifacts of the professional lives of
my participants.

\(^5\) For more information, see
Data analysis

The transcription, storage, and organization of all field notes, interviews, documents, and photographs were carried out with the software NVivo 10 for Windows. Additionally, though I personally coded all data (rather than auto-coding with software), I used NVivo to organize codes and theoretical memos made during the coding process.

The categorical coding of all transcripts, field notes, and documents was utilized to answer and generate analytic questions, deconstruct data to manageable parts, uncover themes within and among cases, and contribute to answering the research questions stated herein. Because I wished to honor my participants’ stories in the tradition of phenomenological research, I chose not to engage in targeted coding to answer my research questions. Instead, I followed the coding procedures described below and then examined that data to answer my research questions. For this reason, the reader can expect that for each case I will first present a set of themes that naturally emerged from my data, and then I will follow those themes with a discussion of the research questions. Finally, I will present themes that emerge from a cross-case analysis of my data.

Coding procedures roughly followed an amalgam of those provided by Spradley (1980) and Strauss (1987). First, open coding (Strauss, 1987, p. 28) uncovered:

- in-vivo codes (Strauss, 1987, p. 30)/folk domains (Spradley, 1980, p. 90) – concepts labeled with vocabulary used by the participants themselves,
- sociological constructs (Strauss, 1987, p. 34)/analytic domains (Spradley, 1980, p. 91) – concepts labeled with vocabulary from existing literature,
and semantic relationships (Spradley, 1980, p. 89) – descriptions of the connections between coded concepts.

Second, NVivo software queries such as word count frequencies and word trees (diagrams which display a participant’s most utilized words as well as the phrases which commonly precede and come after them) were used to draw my attention to key themes I may have missed during open coding. It is essential to understand the role of these software tools in my analysis. The word frequency query is an excellent example of how a software tool can be used to aid an investigation without being relied upon blindly. When a standard NVivo word frequency query was run for Henry’s (Case 1) phenomenological interviews, the five most used words were: know, think, like, students, and mean. This list, if taken at face value, could have led me to immediately create new codes related to knowledge, thinking, enjoyment, students, and meaning. However, upon examination of Henry’s transcripts, it became apparent that the work “know” was mostly used as a filler word (i.e., “you know”) and that Henry often prefaced his opinions with the phrase “I think.” Upon removal of phrases such as these (with all modifications noted in analytical memos), a new list was generated with the top five words being: students, teaching, knows, people, and work. Even at that point, I did not create new codes based on Henry’s most frequently used words. I only used that list to direct me to reread excerpts of transcripts and ask myself if there was a new code I should add to my codebook.

Third, axial coding (Strauss, 1987, p. 32) was carried out for each code of interest uncovered in steps one and two. Axial coding intensely examines each code’s paradigm in terms of its conditions, consequences, interactions among actors, and strategies/tactics.
In short, axial coding allows the researcher to create a comprehensive description of major themes for each participant. Finally, codes were organized into a cohesive story line for the purposes of answering the research questions and communicating findings. This was done for individual participants but also for cross-case analysis. See Chapter 4 for these results.

I share the concerns of scholars such as Maxwell who caution that coding can decontextualize and dilute data (2013a). For this reason, I have given the themes described in Chapter 4 short descriptive labels (e.g., “students”) for the sake of brevity, but I have also reconstructed and reported my participants’ rich social interactions and personal stories through narrative (D. Polkinghorne, 1995), explanatory (Strauss, 1987, p. 258) configuration. Additionally, I have used member-checking interviews in each case to verify that my participants feel my analyses makes sense to them within the larger stories of their lives and careers rather than isolated answers to research questions.

**Analytical memos**

The NVivo 10 software allows researchers to create analytical memos that are linked to specific data sources. Throughout data collection and analysis, I kept detailed, dated records of my reflections as they pertained to the activities I was engaged in. For observations and interviews, I noted these reflections in my field notes and expanded upon them when I transcribed the corresponding data. During data analysis, I attached notes to my coding files within NVivo 10. This practice allowed me to capture my initial thoughts and reactions to situations and reduced the chances that I would forget
meaningful analytical responses to data. I also utilized analytical memos to track changes in the way I interpreted my data, a validity checkpoint.

Research Site and Participants

Research site

The research site, dubbed “Large University” throughout this report, is described by the Carnegie classification system as a large, four-year or above, public RU/VH institution in a primarily residential area. When asked to describe the campus setting, participants typically referred to the large student population and apparent homogeneity of individuals on campus. When asked to further define this homogeneity, participants explained that while most people on campus are “white,” there seems to be a range of socioeconomic statuses (from very poor to very wealthy). Participants also emphasized the scientific excellence of their university, often citing specific rankings for their specific disciplinary programs.

Participants

This report includes the case studies of four participants: Henry, Ben, William, and Pierre (pseudonyms). Detailed information for each participant can be found in Chapter 4.

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Only 40 U.S. institutions match this description, so further geographical data will not be provided in order to maintain participant confidentiality.
Inclusion criteria for participants in this study were: 1) tenure-track science (physical or natural, pure or applied) professor, 2) leader of physical or natural science research group composed of at least two researchers (post-doctoral researchers, graduate students, or undergraduate researchers), and 3) teacher of at least one physical or natural science class during the initial portion of the data collection phase of the study (Spring 2015). I defined tenure-track as pursuing or having already attained tenure within the professor’s current job. Although case studies do not typically consist of more than four cases (Creswell, 1998, p. 63), I chose to begin my study with six participants so that attrition would be less likely to negatively impact the progress of the project.

Participants were selected in three stages. First, a solicitation with a brief description of the project’s goals and time commitment was e-mailed to 50% of the tenure-track faculty members (randomly selected) within each department of the college of science. Next, purposive sampling was utilized by contacting potential participants known to have expressed an interest in educational research. From these two steps, 13 individuals agreed to meet with me to further discuss the project. Eleven of these were men, and two were women. One woman was immediately disqualified from the study as she was not going to be teaching classes within the project’s timeframe. Of the remaining 12 individuals, only one (a man) was the result of purposive sampling and the other 11 had responded to my initial solicitation.

Finally, I conducted initial meetings with each of the 12 potential participants. The only remaining woman in the study elected not to participate due to concerns related to confidentiality and promotion. Two of the men were willing to participate, but only with a sharp reduction in interview time as they had concerns about the time
commitment, and so I chose not to include them in the study. The rest of the potential participants were willing to continue with the study, so I had to reduce the pool from nine to six. I chose a range of cases in order to “select cases that show different perspectives on the” relationship between teaching and research for science professors (Creswell, 1998, p. 62). Thus, I made an effort to choose professors with varied scientific disciplines, years of experience, and progress through the promotion process. There were times when there were no distinctive features to aid me in choosing between one participant and another. In these cases, I randomly selected one blindly. Potential participants who were not selected for the study were asked if they would act as “backup” in the case that more than half of the selected participants dropped out of the study. All of them agreed to this, but it was never necessary. None of the participants voluntarily withdrew from the study, but one was eliminated after three months for failing to respond to scheduling requests. One other participant scheduled most of his data collection much later than necessary to be reported in this dissertation, but was not dropped from the study. Thus, four cases will be described herein (see Chapter 4), and case 5 (Santiago) will be available for subsequent publication. All four participants from the cases reported in Chapter 4 described themselves as white men. This lack of gender and ethnic diversity presents some concerns for my study.

There were no special recruitment efforts made to attract individuals from underrepresented groups of faculty for this project. I had hoped that by recruiting randomly-selected individuals, my participant pool would more fairly reflect the distribution at the university. Gender, racial, and ethnic inequality amongst science faculty is not a novel area of interest for researchers (Ceci, Ginther, Kahn, & Williams,
2014; Kaminski & Geisler, 2012; National Science Foundation, 2013; Sheltzer & Smith, 2014; Shen, 2013; Williams & Ceci, 2015; Xu, 2008), but I failed to predict that this issue would so heavily effect my participant recruitment. The time constraints of this study did not allow for a second round of recruitment, but future work will undoubtedly include targeted recruitment of female participants. For more information, see Chapter 5.

Each participant was asked to individually schedule five 90-minute interviews and ten observations averaging 90 minutes each, for a total of 22.5 hours over the course of ten months or less. However, due to theoretical saturation, not all participants completed all of these points of data collection. No participant completed fewer than four interviews or eight observations. Participants were not financially compensated for their time. Some participants received professional development benefits from being involved in the study, especially if they viewed the act of engaging in interviews enriching in some way.

Validity

This study faced several threats to the validity of its findings.

Sampling error.

Given the limited resources available to complete this study (especially research personnel and time), no more than six participants could be accepted. The decision to include some qualified volunteers while excluding others was not easy. Some characteristics which I attempted to represent diversely in this study have already been
mentioned (e.g., gender, race, scientific discipline, years of practice). As previously
explained, although I attempted to fairly sample the faculty at the research site, I failed to
recruit participants who would be considered members of underrepresented groups of
faculty. This error will be corrected in future work.

Beyond those factors, choosing amongst participants was influenced by more
logistical considerations such as which participants were more readily available for data
collection. Thus, as sampling was not fully randomized, additional opportunity for error
was introduced. For instance, perhaps participants who have more flexible schedules are
more or less focused on the competitive nature of certain aspects of their careers. My full
disclosure of the actual selection process will allow consumers of this work to judge this
aspect of validity for themselves.

**Personal and professional biases**

As a former chemistry undergraduate and graduate student, I have had many
positive and negative interactions with STEM professors, administrators, and institutional
entities. These experiences have allowed me to gain deeper insight into and
understanding of my participants’ environments, but they almost certainly presented
opportunities for subconscious bias to prevent me from taking an emic stance (Peshkin,
2001) in this work. In order to address and minimize this threat, I: bracketed my own
experiences by writing a brief autoethnography before engaging in this work (Appendix),
maintained mindfulness of my experiences as separate from those of my participants with
regular journaling, and triangulated my data interpretations with multiple data sources, including collaboration with colleagues and member-checking with participants.

As a current graduate assistant working in faculty development, I interact with a national community of STEM professionals. When my work brought me into contact with my participants outside of the context of the research project, I maintained an awareness that such contact could have influenced my impressions of those participants’ cases without the appropriate corresponding data collection and analysis. For this reason I did not accept participants with whom I already had extensive contact, and I avoided engaging in new projects that would create erroneous interactions with my participants.

**Political risks**

Professors do not engage in their jobs in isolation. Typically, they are involved in a national or even international network of colleagues. Because the social and political atmosphere of the professoriate can be complicated, I was aware that at times my participants were concerned about sharing specific attitudes, beliefs, and anecdotes with me. These concerns could be connected to general professional courtesy or two specific issues related to promotion and tenure proceedings. I knew that if they did not feel that their identities were adequately confidential, they might choose not to share delicate information with me. To avoid this, I fully disclosed to my participants every precaution I was taking to keep their identities confidential. At times, my participants would share information that they would ask to be kept off the record, and I always agreed to keep this confidence. Even beyond these explicit requests, I have been careful not to include
information in my public reports if I believed that the specific participant had such an expectation implicitly.

**Generalizability**

With a small, qualitative study, no researcher is able to generalize findings to a greater population in question. As I have analyzed my data and reported my findings, I have been careful not to overstate the generalizability of my work. I have focused on telling the complex and deep stories of my participants in the way only qualitative studies can. However, I am not discounting the “face generalizability” (Maxwell, 2013c, p. 138) of my cases; that is, there will likely be no reason for me or my audience to doubt that the experiences of my participants are fairly normal amongst the greater population of STEM professors at RU/VH institutions.

**Conclusion**

This research utilized phenomenological case studies to answer the following research questions:

- What is the relationship between teaching and research roles for individuals in a sample of tenure-track science professors at an RU/VH institution?
- What types of activities and experiences (particularly professional development) do participants engage in to support their roles as teachers? What types of
activities and experiences impede their roles as teachers? In what ways do these activities support or impede participants’ roles as teachers?

- What connections might be made between the participants' personal, cultural, and professional histories and the way they are currently experiencing the relationship between teaching and research?

Because I understand human interaction through a sociocultural lens, I believe that answering complex questions such as these requires research methods that respect participants as whole people who live their lives within communities and contexts – not in isolation. For this reason I chose to engage in ethnographic case studies to answer my research question. Case studies allowed me to experience a broader range of my participants’ lives (beyond just asking them the research questions directly), and ethnographic techniques allowed me to collect the data that would provide me with themes that were in alignment with my participants’ understandings of their professional lives.
Chapter 4

Results

Over the course of 38 weeks, I spent a total of 34.5 hours in participant observations and 22 hours in phenomenological and follow-up interviews with the four faculty members who participated in this study. All four of the participants indicated that they agreed to take part in the study because they enjoy assisting graduate students with their research and because they found this work to be interesting. In fact, all four participants have expressed interest in the results of the study including this dissertation and any subsequent publications that result from the data presented here in. Throughout the study the participants were responsive to email and phone communications and made efforts to schedule interviews and observations to meet the data collection schedule of the project. The participants’ classroom and research students were also accommodating to my presence throughout each observation during the study. In many cases, the students made efforts to make me feel welcome and even asked if they could do anything to help.

With respect to confidentiality, none of the participants expressed any concern with being identified through the details presented here. In some cases, I have taken additional efforts to obscure the identity of a participant, taking into account the unique circumstances of each case. In instances where I predict the reader might find this obfuscation confusing, I will include an explanatory footnote.
What follows is detailed description of each case and a fifth section describing my cross-case analysis. For each case I first provide a brief overview of the participant’s professional history and standing. Second, I list the themes that emerged from the coding analysis of the participants’ data as described in Chapter 3. These themes were not “mined” with the intention of answering my research questions but arose naturally as matters of importance to my participants. As I present each theme I also present the most poignant quotes from our interactions as well as descriptions of observations which led me to identify the given theme. Finally, I engage in a discussion of answers to my research questions for the case at hand.

In my cross-case analysis, I identify four themes which emerged across all four cases. These themes are used to discuss implication of this work and future research in Chapter 5.

**Case 1: Henry**

Henry (pseudonym), describes himself as a White, 44-year-old male physics professor. Simply stated, he is a teacher above all else. In his own words: “As a professor, I view education as my primary task. This may be an odd statement to make in a research proposal, but research is, after all, discovery learning at its best” [Henry, Award Application]. During our interviews he joked that perhaps being a teacher is simply a

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7 Bracketed citations represent references to transcripts, documents, and field notes.

8 To protect participants’ confidentiality, documents will be given generic labels that have been mutually agreed upon by the participants and the researcher.
matter of genetics because his parents, sister, some grandparents, and some aunts and uncles are teachers. The earliest memory Henry shared with me during our interviews was of a conversation with his father, a humanities professor:

I’m sure my father was a huge influence… He would spend every night reading essays and writing responses which are probably longer than the original essay, red ink all over the place and then typed notes, and yeah I remember this very clearly, and saying daddy why do you need to do this? And [he explained] why it's important that the students learn and that his feedback is really important to them. [Henry, Interview 2]

Henry’s focus on students will be described in more detail below. It was surprising to me to learn that Henry, a successful physics researcher, did not choose to become a professor in order to further his research career. On the contrary, he chose to study physics in graduate school in order to become a professor. He explained that he always knew he wanted to be a professor. As an undergraduate at a large, private, RU/VH institution, Henry double majored in physics and a humanities field. Going to graduate school and getting a PhD was something he did to become a professor; choosing his specific field of study was a secondary matter.

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9 There are instances in which participants’ quotes have been used in multiple sections in each case. This is an intentional practice that has been utilized to express the multiple meanings of the participants’ utterances.

10 The word “teacher” is used here because that is the vocabulary Henry used. Throughout this study, participants used the words “teacher,” “professor,” and “mentor” interchangeably. To the greatest extent possible, I matched my wording to that of the participant.
Henry enjoyed and endured a range of experiences as a student. When I asked Henry to talk more about his time as an undergraduate student, he described his undergraduate years with great fondness:

I loved undergrad. It was fantastic… I was a physics and [humanities] major, and I was doing philosophy and literature and just all this stuff and staying up late into the night and arguing about Kant and other stuff. It was fun. I had a great time. I think this is probably true for most people in their undergraduate days right? So very fond memories of it. [Henry, Interview 1]

This pursuit of happiness via multiple interests (described more extensively below) appeared again when Henry described his time in graduate school. It took Henry seven years to earn his PhD at another large RU/VH institution with a reputation (according to Henry and other participants) for producing STEM professors. During his first year and a half of graduate school Henry engaged in a wide range of activities: teaching, research, and service endeavors such as writing gradebook software and setting up a Web server for the department. At that point, Henry’s PhD advisor told him, “It’s great that you're really involved in a bunch of different things. In five years, if you keep doing what you're doing now, you're not going to be near graduation and you're going to hate me, and so you need to stop doing all these things” [Henry, Interview 1]. Following that conversation, Henry focused solely on research until he graduated.

Immediately following graduate school, Henry spent two years as a postdoctoral researcher in a government lab. During this time, he wrote research publications and proposals for faculty positions. He explained that the government lab was “a fantastic place to work… It’s a very different culture than an academic culture… They believe that
people should go home and be with their families” [Henry, Interview 1]. In the same interview, Henry explained that his time in the lab was “a short two years” but he gained from the experience a better appreciation for the lab’s cultural focus: “Come, be organized, get things done efficiently, and focus, and then go home and play and let your mind relax.”

Henry’s first faculty position was at another RU/VH institution in the Northeastern United States. Even though the school is also classified as “large” by the Carnegie classification system, its student population is only about one fourth that of Large University. During this time, Henry became involved with a large-scale physics curriculum reform effort in collaboration with his colleagues. The program focused on bringing research-based teaching practices into introductory physics courses. This was Henry’s first exposure to education research, and he greatly enjoyed the experience. At the same time, Henry was developing his research program and participating in service activities. Henry did not receive tenure during this first faculty position. During our first interview, I asked him, “When you were describing your time at [your previous institution] it sounds like you were doing a lot of things outside of your research… Do you think that hurt your tenure process at all?” Henry responded:

No. I mean, the number of people who came to me and said… you need to just focus on research, it's the only thing anyone cares about, just buckle down, do research, get it done, certainly I had that conversation multiple times with department heads, other faculty members. So I would say they probably think

11 This program was organized by a physics professor who was actively engaged in educational research. Henry explained that today this professor might be referred to as a DBER researcher.
that's the case. I don't think that, I mean this comes down to the question of what my advisor in grad school told me to do, right? Essentially they're saying the same thing that he's saying which is, do one thing and focus on it and do it really well, and then you can get tenure, and then what? And then you keep doing this one thing? I don't wanna do one thing. (Laughs) I wanna do three things. I wanna teach, I wanna do service, I wanna do research. So when I hire my grad students I tell them that I'm a very hands off advisor. I think that part of my training you is training you to be an independent scientist and so I will mentor you, I will help you figure out what questions are good, and when you write papers help you edit them and offer my advice on what research directions we should take. But in the end if you think that something's really cool you should go after it. And I think that worked well for the students that I had. Maybe it's not the most brilliant - if I had been in there doing the research myself, would it have gone faster? Sure, in the end I think that the thing that I was really interested in is what we ended up studying and it's what I would have studied anyway and the fact that it was controversial and a lot of people didn't believe in it at the time would have still been the case whether I was in there doing the research myself or not, so I don't honestly think it would have really made a difference. Maybe would have had more papers out, but I don't know that that would have changed anything. And I was a lot happier this way, so there's a lot to be said for happiness.

Even though Henry did not achieve tenure at his previous institution, he stayed for one additional year as a lecturer. He attributes the institution’s willingness to keep him on in this capacity to a petition signed by his undergraduate students demanding that the
institution retain him as a teacher. He then spent one year as a visiting scholar at a large, private, RU/VH institution before applying to Large University and being offered a position with tenure. He has been an associate professor at Large University for almost 5 years.

At Large University, Henry teaches introductory physics courses; in fact, he has only ever taught introductory courses throughout his entire career. He explained that although he has been interested in teaching other courses at times, he truly enjoys teaching introductory physics and working with freshmen. Furthermore, he recognizes that it is rare for faculty to enjoy teaching introductory courses as much as he does, and so he is happy to continue doing so. In addition to his teaching, Henry leads a research group composed of researchers ranging from the undergraduate to the postdoctoral level. His group studies basic physics research – that is, research that does not necessarily have a direct application to solving any immediate problem but can be used in the development of such technology. When I asked him what drew him to basic rather than applied research he explained:

You have no idea what discoveries are gonna be made in a basic research lab that are going to change the world thirty years from now. And so that's sort of the view that I take. I enjoy playing and exploring more than being under a time deadline of oh you know this product has to go out next week, we've gotta make this thing work. And so I'm willing to have my work maybe thirty years down the road lead to something cool. [Henry, Interview 3]

Finally, Henry is involved in several types of service activities: the advisory board for the university’s STEM-specific teaching and learning center, a committee which
seeks to support and develop introductory courses in physics, a diversity committee, and others. In our interviews, he expressed that he participates in committee work in order to support the department and improve the culture of the community.

I spent 14 hours with Henry during this study, spread over 29 weeks. I observed Henry teaching introductory physics three times, meeting with his classroom students for office hours one time, and engaging in meetings with his research students four times, for a total of roughly 9.5 hours. I conducted three phenomenological interviews with Henry, totaling four hours, and one follow-up interview which lasted approximately half an hour.

Themes

After my analysis of all of the data connected to Henry’s case (as described in Chapter 3), I uncovered four major themes that occur throughout Henry’s professional life: students, happiness, collegiality and collaboration, and inquiry stance. Soon after my analysis, I engaged in a member-checking interview with Henry, and he verified that all of these were in fact major themes of his job. Furthermore, he expressed that he did not feel that I was missing anything in my analysis as I presented it to him. Full descriptions of each theme with supporting evidence from my interviews, observations, and document analysis associated with Henry’s case are presented here.
Students

A focus on students unifies every area of Henry’s professional career. During my first visit to Henry’s second semester physics classroom, I almost felt disoriented. I could not tell where the “front” of the room was: there was no lectern, projector screens were located on multiple walls, and instead of chairs and desks facing in one direction, the room was full of round tables with four to five chairs each. I made my way to what I could only guess was the “back” of the room so that I could observe the class and take notes without distracting the participants.

As Henry stood directly in the center of the room, setting up a projector that projected to screens on three different walls, students filed in and took their places at the tables. Henry displayed a “pre-class sample exam” on the projector screens, and students immediately started to discuss the problem in their groups. Each table had a small dry erase board and markers, and the groups used these to make notes and work out equations. Henry, a teaching assistant, and a learning assistant walked around the room from group to group, checking on each group’s progress. Henry would regularly sit with a group and discuss their ideas with them. His role in these discussions seemed to be more that of a facilitator than anything else. At one point I overheard him moderating: “Don't give up so easy. If you believe what you're saying, say it with confidence… Push back” [Henry, Observation 1].

This type of interaction is common for Henry and his students. When he teaches, he does not typically lecture or give the students significant amounts of information. Instead, students are encouraged to work together to solve problems, and Henry tends to
limit his involvement to guiding them through this process rather than giving them answers. For instance, instead of telling the class why a particular answer was the correct one, he elicited, “Yes, someone give me two reasons why… Someone give me another reason why” [Henry, Observation 3]. Henry’s student-centeredness is explicitly described in a teaching philosophy he shared with me:

Through studies and experience I have developed a philosophy of teaching that may be summarized as follows: in order to learn, a student must be interested and engaged; in order to teach, one must know whether the students are in this state, and, if not, how to get them into it. [Henry, Faculty Application]

This statement is entirely centered around students’ needs and experiences. Henry consistently represents his teaching philosophy in such a manner:

- I guess my general statement of what a good teacher is is someone who helps students learn. [Henry, Interview 1]

- The primary thing that I cared about was improving student learning. [Henry, Interview 1]

- I spend a lot of time trying to follow up on students, make sure they understand what's going on. If I see someone is having a problem, I'll send an email and say, you know, it looked like you were having difficulties with this, let me know if you need help. [Henry, Interview 2]

- My personal goals as a teacher are to figure out how to teach the class in such a way that the students learn the most and come away with the most enjoyment of the material, in that order. [Henry, Interview 2]
- I feel that's what teaching is about, is for students to learn, I mean I guess I mean there are other things like student growth and student enjoyment of materials and students learning about themselves - that's still student learning… I think learning is why we're here. [Henry, Interview 2]

- To my classroom students hopefully I'm getting them enthused and teaching them about physics so they can go on. [Henry, Interview 3]

I consistently observed a similar student-centeredness between Henry and his research students. Henry stated:

In the laboratory I have placed a tremendous emphasis on student involvement, both because I believe it is very important for students at all levels to see the joys (and difficulties) of real physics research, and because the students who I have had the pleasure to work with are a tremendous asset to our research program. [Henry, Award Application]

Throughout my observations of Henry’s meetings with his research students, I noticed that he asked questions and listened more often than he offered his own opinions or directives. He did not ask his students questions that he already knew the answers to; he treated them as colleagues, valued their opinions, and was honest about the limitations of his own abilities. In short, his research group meetings were a place for him to collaborate with his students rather than tell them what to do. It was common for him to ask his students questions such as, “How can we test this idea?” [Henry, Observation 8].

When I asked Henry what his goals for his research are, he described his interest in “understanding how things work,” and added that he wants “to help other people learn how things work because you can't do it by yourself…you know training new, the next
generation of scientists, that's a big part of it” [Henry, Interview 2]. When I asked him what impact he believes his role as a professor has on other people (without specifying which people), Henry immediately described his relationships with his classroom and research students. With respect to his research students, he explained, "I'm their leader and you know trying to help them get through this time and learn and have fun and let them have the fun that I had when I was a graduate student” [Henry, Interview 3].

In our third interview, I asked Henry to reflect on the relationship between his goals for teaching and his goals for research. He explicitly described this student-centered theme:

Well…they're similar right… I want to help these students get to where they want to go, right? And my graduate students are here because they know they wanna be physicists, they know they wanna be, you know, researchers, in some sense anyway, and so helping them become independent researchers is my goal for them. And for my students in the classroom they, maybe they don't know they wanna learn the material. They know they wanna survive the course…they know they wanna, you know, succeed and learn the material and maybe get some idea about what physics is like and so that's my goal for them, to help them get to where they're trying to go. And with them maybe a little more than my graduate students help guide them in the direction in which they wanna go to inform what direction they should want to go but that, that's a similar right, similar aims, helping people basically [Henry, Interview 3].

This student-centered theme extends beyond Henry’s teaching and research. His goals for service work are to recruit successful students and to create a better learning
environment for students in the physics department at Large University. The two most prominent service committees in which Henry participates are an introductory course committee, which seeks to improve teaching for introductory physics courses in the department, and a diversity committee; Henry explains that he is interested in “helping to improve diversity and diversity-related issues in the department and…to improve the culture in the community” [Henry, Interview 3].

Because this student theme is pervasive throughout all of Henry’s work, I describe Henry as not just a student-centered teacher but as a student-centered professor. Student learning and success is his highest priority.

Happiness

The attainment of happiness through the pursuit of personal interests is of the utmost importance to Henry in every area of his job. Throughout my time with Henry, I was consistently aware that he seemed happy to be engaged in all of his professional activities. As I observed him teaching in the classroom, sat in on his meetings with his research students, and participated in interviews with him, it was typical for Henry to smile, laugh, make eye contact, ask questions, etc. In short, his body language and method of interaction with those around him gave me the impression that Henry was enjoying his work at all times.

Throughout our interviews, Henry emphasized the importance of being happy and pursuing his personal interests in all three of the major areas of his career: teaching, research, and service. In our first interview he told me that he applied for faculty jobs at
different types of schools. When I asked him what he meant by different types of schools he explained:

I could see myself being happy at a wide range of different places. I really love teaching. I wanted to be somewhere where I could teach, but, you know in terms of doing research, I like doing research with undergrads, I like doing research with grad students, so I was happy to consider a wide range of possibilities.

Later, he further explained that he enjoys all of the aspects of his job: “I don’t wanna do one thing. I wanna do three things. I wanna teach, I wanna do service, I wanna do research” [Henry, Interview 1]. When I asked Henry how it would impact his life if he could not be a physics professor, he said, “Oh that would be really sad. It’s hard to imagine what I would do if I weren’t a physics professor… Outside of the general realm of academia, it’s hard for me to picture myself” [Henry, Interview 3]. In the same interview, when I asked him if there was any emotion associated with being a physics professor, he laughed and replied, “I don’t know that there’s anything uniquely associated with being – I mean, happiness I [guess].”

Henry expresses immense enjoyment associated with teaching physics. He especially enjoys being able to implement research-based active learning strategies in his classes. As he described his involvement with pedagogy reform efforts at his previous institution, he explained that his colleagues “were gonna ditch the lecture hall…and do this thing called active learning…and I said wow that sounds really cool, I’d love to do that…and I absolutely loved it” [Henry, Interview 1]. In the same interview, I asked Henry where he developed his teaching skills.
I have no idea. My dad’s a teacher, my mom’s a teacher, my grandparents are teachers, some of them. Aunts and uncles are teachers. Maybe it’s genetic, I don’t know. Maybe you care about it and so you think about it. I don’t know.

This idea that teaching makes Henry happy because it is something he cares about is reinforced as he states, “Teaching and mentoring are important to me” [Henry, Faculty Application].

Henry also hopes to see his classroom students happy rather than just teaching them physics: “I love it. I think it’s the greatest thing… I love it when someone goes oh my gosh physics is actually cool” [Henry, Interview 1]. Furthermore, even though STEM pipeline issues are not at the forefront of his teaching concerns, he does consider them when thinking about how to make physics more enjoyable:

I think that if I have students learn and enjoy it, then that hopefully will directly contribute to the pipeline right? I mean, I teach the introductory courses. One of the things I really enjoy is when a student will come up to me – so this happened more at [my previous institution] because there I was teaching students from every major – non-STEM majors as well because everyone had to take physics. And when I had that, you know that linguistics major come and say, “You know what? I changed my mind, physics is fantastic, I’m gonna become a physics major,” – that’s great, that’s really exciting. It made me happy, and so yeah, I enjoy that… and I try to do things in order to increase the number of people who come into the class so they have the opportunity to enjoy it.

Henry also achieves happiness by pursuing his personal interests in his scientific research. He explained, “I like the field. I think it’s really interesting, so that’s what I
continue doing” [Henry, Interview 1]. As he described his research program to me, he
often used phrases such as “very interested,” “very interesting,” and “really cool” [Henry,
Interview 2]. When asked on various occasions about why he does not choose to reduce
his time spent on research to pursue other interests, he consistently offered explanations
such as, “I love it so I don’t wanna give it up,” “I enjoy doing it too much,” and, “I enjoy
playing and exploring” [Henry, Interview 3].

Henry explicitly teaches this pursuit of happiness to his research students because
he experienced an unhappy period in graduate school. For a time in graduate school,
Henry was required to focus exclusively on his research, and he reflected that it made
him unhappy. He explained that as a result of this experience, he tells his students:

In five years you are probably going to want to graduate, and so you need to
decide how you want to best spend your time in order to make that happen. I
personally think you should not drop everything. You should find something else
that you love doing and makes you happy so that when things aren’t going well in
the lab you’re not a miserable wreck, so that you have something to go and do to
unwind. And you should work as hard or not as hard as you feel you need to or
want to in order to get what you want. [Henry, Interview 1]

Later in the same interview, Henry adds that he advises his research students “on
what research directions we should take, but in the end if [they] think that something’s
really cool [they] should go after it.” When I asked Henry if his self-described “hands
off” approach to mentoring his graduate students or his equal focus on teaching and
research may have had anything to do with his failure to attain tenure at his previous
institution, he responded, “I don’t honestly think it would have really made a
difference… And I was a lot happier this way, so there’s a lot to be said for happiness” [Henry, Interview 1].

**Collegiality and collaboration**

Henry works collaboratively in all areas of his career: teaching, research, and service. As a teacher, Henry has engaged in collaborations with fellow faculty at both his previous and current institution in the following ways: designing new laboratory curricula, reforming existing introductory course curricula, co-teaching lecture courses, creating a pedagogy course for scientists, and meeting with colleagues to discuss research-based teaching and learning practices. I also witnessed Henry teaching collaboratively with other types of instructional support staff. Each time I observed him teaching an introductory physics course, he had both a teaching assistant and learning assistant\(^\text{12}\) present in the classroom, and both of these individuals moved freely about the room to assist student work just as Henry did.

In his research, Henry emphasizes the importance of collaborating with colleagues worldwide, as well as supporting a collaborative environment among the members of his own research group. He laughed as he explained, “I'm reaching out and collaborating with a bunch of different people in different departments and trying to find the hot new thing to do research on” [Henry, Interview 3]. He believes that scientists should cooperate and share data rather than competing with each other. For example,

\(^{12}\) Learning assistants are undergraduates who are trained to provide instructional support, particularly for courses which are historically challenging and utilize collaborative learning. For more information, see seminal work on this supplemental instruction model at [https://laprogram.colorado.edu/publications](https://laprogram.colorado.edu/publications).
when one of Henry’s collaborators asked him if he would approve of her sharing samples with another researcher, he responded, “Of course you should just share your samples with everyone, I mean, that's my general feeling of how it should work” [Henry, Interview 1].

This collegiality theme extends to Henry’s work with his research students. In his own words: “What problems my students and I will be working on ten or even five years from now is unclear, but…together we will contribute to their understanding” [Henry, Faculty Application]. As mentioned previously, he engages with his research group members as colleagues by asking them genuine questions, considering their suggestions for the group’s work, and listening to them when they speak (typically maintaining eye contact and engaged facial expressions). Henry’s inclination toward collegiality in the lab is connected to his student-centered approach to his job; as quoted previously: “I want to help other people learn how things work because you can't do it by yourself” [Henry, Interview 2].

Finally, Henry seeks involvement in service committee work that is even more collaborative than what I believe a professor might typically engage in. Though it sounds redundant to point to “collaborative committee work,” there is a wide range of collegiality possible when engaging in service. As mentioned previously, Henry’s main service undertakings are currently the advisory board for the university’s STEM-specific teaching and learning center, a physics introductory course committee, and a diversity committee. All of these involve extensive meetings and discussion with colleagues; this is in contrast to less collaborative work such as individual student advising or editorial work.
Henry employs collaboration in all areas of his career both for the purposes of effectively engaging with his students and producing high quality research. Whereas scientific collaborations are quite common, Henry also utilizes collegiality by co-teaching courses and seeking out service oriented committees.

**Inquiry stance**

In all areas of his job, Henry maintains what I call an inquiry stance. He is unlikely to maintain the status quo, does not hesitate to challenge cultural traditions when he has ideas for change, and maintains a constant curiosity not only about how things work but how they can be improved.

As a teacher, Henry is interested in using research-based practices to improve student learning. He explains, “I believe in scientific teaching. I believe in using what researchers have found out about how to teach and basing my teaching on those methods. That is still not I think the norm unfortunately, shockingly, I don’t understand it” [Henry, Interview 3]. In our second interview, Henry offered a detailed explanation of an instance in which he challenged standard teaching practices in his department:

When I first came here I wrote ahead and I said okay I’d like to teach the intro courses… I was the only one teaching the class… So I thought okay great then I can do this how I wanna do it. So I sort of sent along here’s a list of all the different things I wanna do… And the administrator of the course wrote back and said no, can’t do it… All of our courses are standardized… You can’t do anything new… Which just blew my mind. I just couldn’t understand this idea that the
formalism, this continuity or whatever, is so important to them… I have managed to sort of drag changes into the course, but it took a little longer than I had hoped it would.

Henry’s tendency to change teaching practices and systems extends as far back as his days in graduate school. As a PhD student, Henry “did this gradebook application so students could log in and see their grades and so the TAs could enter the grades online. [TAs] used to hand [grades] in on a piece of paper or something – seemed sort of backwards” [Henry, Interview 1]. In the same interview, Henry said that he “spent a lot of time…thinking about teaching, how to modify the classes so that they would be better…talking to other graduate students who were also really interested in teaching and making it better for the students.” About Henry’s first faculty job, where he participated in a collaborative project to implement active learning in introductory physics courses, he remarked,

You’re bound to make mistakes, not know how to organize the class so well, making efficient use of time… I learned a lot about what we were doing wrong and how to teach people how to teach and how to organize the class…[Henry, Interview 1]

Henry does not claim to be a perfect teacher. He is always examining his practices and studying student feedback in order to monitor the effectiveness of his courses. In our second interview he explained, “I spend a lot of time thinking about how to organize the material, how to get all the parts to work together.” He also administers standardized exams each semester:
I can see how they compare to previous students and see how changes we’ve made, if they’ve improved anything. And then I also do a lot of open-ended questions so I can get a feeling of do they get what’s going on, and that’s more sort of a gut level more than an actual quantitative thing... I try to ask for a lot of feedback from students. [Henry, Interview 2]

Even with this constant feedback, Henry feels that he will always be working to improve his teaching: “I have a feeling I’ll never get to where I want to go… One thing we’re always working on is figuring out how to better measure what we’re trying to teach” [Henry, Interview 2]. Beyond his personal reflections and informal interactions with colleagues, Henry also seeks formal professional development opportunities from the general and the discipline-specific teaching and learning centers on the campus of Large University.

Additionally, as Henry continues to improve the introductory physics courses he has been teaching since graduate school, he has plans to create new courses:

I have other things that I want to do. The first thing I want to do is make a joint physics math course…into a year-long joint class basically and re-organize the material so that they’re not seeing it at different times in different ways but in a sort of nice unified manner. [Henry, Interview 2]

It is clear that Henry’s motivation for maintaining an inquiry stance is that he wishes to improve the experiences of his students: “The primary thing I cared about was improving student learning” [Henry, Interview 2]. Furthermore, Henry wishes to pass his curiosity about the world to his students. Laughing, Henry explained that students tend to have a misconception about the nature of scientific knowledge
They kind of have this feeling that there is an answer and that [an] expert knows it, and if you just tell us then I’d be done. So knowing that that’s not how things work and being able to give them an idea that that’s not how things work by saying I’m working on a problem that there’ve been thousands of people working on for the past three decades and they still don’t know the answer, maybe that gives people an idea. I hope that’s not so crushing it scares them away. [Henry, Interview 2]

In fact, even though scientific research would seem to be inherently connected to an inquiry stance, Henry has exhibited even more scientific curiosity than most of his colleagues; his research program is one that was not accepted by his peers as worthy of investigation. He explains that when he set out to build a research program, “The thing that I was really interested in…was controversial and a lot of people didn’t believe in it at the time” [Henry, Interview 1]. In our third interview he explained:

My research is pretty basic. It’s not very applied. It’s unlikely that things I’m doing are going to lead to the cure for cancer in the next five years or something like that, or ever. But I feel it is somehow helping mankind learning new things about how the world works and how maybe we can make the world better. And that’s something I hope informs everything that I try to do.

This inquiry stance theme extends from the way Henry engages in research to the way he mentors his research students. When I asked him about his mentorship of his graduate students, he laughed and explained:

So this is something I’m still a big work in progress on… We talk a lot and try to talk about what they’re thinking. And I try to elicit ideas from them as much as
possible and get them to think about what’s interesting, how they are gonna try to test their ideas – those interesting things. [Henry, Interview 2]

In other words, Henry is not only trying to approach his mentorship with an inquiry mindset, but he is also trying to develop that mindset in his students. I saw this on multiple occasions as I observed Henry’s research group meetings and saw that he commonly questioned his students this way.

Henry engages in service committees which have the purpose of improving students’ experiences, including an introductory course committee, a diversity committee, and the advisory board for the university’s discipline-specific teaching and learning center. He often references utilizing these committees to bring about change in his department or college. For the introductory course committee he explained, “We’ve talked about all the different introductory courses and policy for that and what we’re gonna change about how we’re gonna teach them, argue about what textbook to use, that kind of thing” [Henry, Interview 2]. With respect to diversity issues, he described:

One thing I’ve been very interested in for a long time is diversity and how to increase diversity… Normally [at my previous institution] you sort of apply to the section of the department that you’re [interested in]… And usually you would only have people within that subgroup read your application. That kind of struck me… Since there are sort of the silos, you miss students who are good but maybe not so focused on one area. So I then made a point of reading all of the applications from women and minorities and making sure that anyone who was strong got brought up whether their respective subareas brought them up or not…
And then also became the diversity advisor for the department. [Henry, Interview 1]

Henry carried this interest in diversity with him to his current position. He described a situation he is currently working on changing in his department:

The main physics building… What you’ll see is a bunch of posters of white guys basically… It’s really a sad building… It’s not very colorful, it’s pretty institutional looking, and so I’ve been talking with the department head and various people in the department about sprucing it up a little bit, taking down the pictures of the white guys, replacing them with bright colorful pictures about the physics. You can tell the same story except focusing on the physics… Maybe getting more pictures of our groups… Just to make it a little more welcoming and vibrant place. [Henry, Interview 3]

Henry acknowledges that institutional change can be a slow process: “Centuries of history I guess to overcome, right?” [Henry, Interview 3]. However, he does not see this as a deterrent to making an effort; he is willing to continue to work on change for as long as it takes.

For Henry, an inquiry stance is a matter of identity even beyond the professional components. In his words: “I’m definitely sort of the professor type… I’m always trying to figure out how things work, and asking, and let’s do something cool, and like oh that’s neat let’s figure out what’s going on there” [Henry, Interview 3]. He explained that conversations with his children are often “just looking at things and trying to figure out how they work and talking about old that’s really interesting, why is that… Why is the sky blue? Well let’s talk about scattering” [Henry, Interview 3]. For this reason, it is easy
to imagine that Henry’s inquiry stance at work is an extension of his intrinsic nature, thus incorporating seamlessly throughout his job.

**Research questions**

I have utilized the themes identified above as well as other supporting information from interviews, observations, and documents to answer the project’s research questions for Henry’s specific case. These questions are

- What is the relationship between teaching and research roles for Henry?
- What types of activities and experiences (particularly professional development) does Henry engage in to support his role as a teacher? Conversely, what types of activities and experiences impede his role as a teacher? In what ways do these activities support or impede his role as a teacher?
- What connections might be made between Henry’s personal, cultural, and professional histories and the way he is currently experiencing the relationship between teaching and research?

**The relationship between teaching and research**

What is the relationship between teaching and research roles for Henry? I describe Henry’s relationship between teaching and research to be homogeneous (scientific pun intended). This characterization is evident throughout the themes described above. Both areas of Henry’s career are informed by his intrinsic goals of helping students and being
happy: “I want to help these students get to where they want to go, right? …similar aims, helping people basically” [Henry, Interview 3]. Thus, when Henry makes decisions about how to utilize his time and resources over the various areas of his job, his choices consistently support the pursuit of these goals. Furthermore, Henry’s behavior in both teaching and research is directed by his appreciation for collaboration and collegiality and his inquiry stance. Both of these themes are inspired by the very way Henry understands science and learning to be based on curiosity and partnership with others: “I want to help other people learn how things work because you can't do it by yourself” [Henry, Interview 2].

It is almost incomprehensible to Henry that someone could be a professor and focus on only teaching or research. When I asked him if he was a “research professor” at his previous institution, he laughed and replied, “A normal professor professor. I was doing research and teaching” [Henry, Interview 1]. He later explained, “I’m a teacher. That’s what a professor is. I’m a researcher, a physicist. I try to understand how the world works and explain it to other people” [Henry, Interview 3]. Henry’s dual teacher/researcher identity was evident as he described the relationship between his role in the classroom and his role in the research lab:

So clearly part of my teacher role is my research-teacher role, so my graduate student teaching role for example… If you’re talking about the relationship between my role as an introductory physics course teacher and my role as a researcher… I talk about what I do in class… And I think that for students were interested in doing physics that it’s cool. They’re like oh he’s doing physics and he actually knows what it means to do physics… When I’m mentoring my
undergraduate students… Being able to give them a perspective from being a researcher I think is helpful. [Henry, Interview 2]

In our third interview, Henry further explained this dual identity:

   Somehow being a scientist to me is being a teacher. I don’t see how you can be a scientist and not be a teacher really… If you’re a scientist you have to teach. You have to at least publish the paper’s which is some form of teaching… The way to get [researchers] to learn how to do research is by having them do research, just like getting [students] to learn how to do physics problems, you make them do physics problems. That’s generally how you learn to do things is by doing them.

   When I responded to Henry that I would describe that as “a content connection,” he corrected me:

     Yeah but it’s more than content… It’s the idea that physics – doing science – is different than sitting in a classroom and solving problems that we already know the answers to, right? And so explaining that and trying to get them to realize that research is going out and looking for problems that haven’t been solved, we don’t even know their problems yet, and that’s exciting but it can be frustrating. Sometimes there are problems that you don’t get an answer to and that yeah, that’s life, that’s how science works.

   Thus, it is clear that Henry sees teaching and research as coordinated components of his job. In the research lab, he sees it as his responsibility to teach his research students how to be researchers. He feels that by nature scientists are teachers and that one can only learn science by doing it. In the classroom, Henry utilizes content from his research
projects, but beyond that he hopes to help his students appreciate the excitement one can feel by engaging in the practices of scientific research. Henry only feels competition or tension between his roles as a teacher and a researcher in one aspect, and that is time management: “I do a lot of things. In order to do more things, I have to give up something. It could be sleep I suppose, but I’m already giving up a lot of sleep” [Henry, Interview 3].

Supporting and impeding activities and experiences

What types of activities and experiences (particularly professional development) does Henry engage in to support his role as a teacher? Conversely, what types of activities and experiences impede his role as a teacher? In what ways do these activities support or impede his role as a teacher? Over the course of our interviews, Henry described many activities which support his role as a teacher but very few which acted as an impediment to his teaching.

The themes described above again play a prominent role in understanding what types of activities support Henry as a teacher. He explained that he loves working with his students: “I love it. I think it’s the greatest thing. They come in and they’re excited and they don’t know to be jaded about things yet and it’s just – first semester freshman are fantastic” [Henry, Interview 1], reinforcing the themes of student-centeredness and happiness. The themes of collegiality and collaboration and inquiry stance are even more prevalent in this area. Henry explained that he informally converses with colleagues (other STEM professors) about teaching and engages in formal teaching
collaborations. In addition to this interaction and “thinking about all the different aspects of the class” [Henry, Interview 2], Henry also elicits feedback from students in order to be reflective as well as reflexive in his practices. He describes his evaluation process:

With standardized instruments and with problems that we’ve used over the years, I can see how they compare to previous students and see how changes we’ve made, if they’ve improved anything. And then I also do a lot of open-ended questions so I can get a feeling of do they get what’s going on, and that’s more sort of a gut level more than an actual quantitative thing... I try to ask for a lot of feedback from students. [Henry, Interview 2]

Henry also attends seminars and colloquia offered by Large University’s general teaching and learning center but is more likely to attend those offered by its STEM-specific teaching and learning center. When I asked him why he preferred the STEM-specific seminars and colloquia he explained:

I think there just may be more interesting… They’re bringing in stories of things that have been done in different ways and you sort of get the whole – I guess they’re more inspirational rather than here’s how you do something… So they give you broad brush strokes and show you some ideas and then you can sort of think about it as more fun. [Henry, Interview 2]

Henry also provided a short list of departmental guidelines that influence his teaching, though he does not necessarily see them as either a support or an impediment:

Rules being laid down on me, this is what needs to be taught, this is what we’re doing, this is the book were using, these are the times of the exams, all this sort of rules that obviously influences me. [Henry, Interview 2]
Finally, there is one factor which Henry sees as a challenge to implementing change, both in his teaching and in his service work. He described this challenge as “centuries of history to overcome” [Henry, Interview 3]. As described previously, this institutional inertia or resistance to change presented itself when he first began working at Large University and told the course administrator for introductory physics that he wanted to use collaborative learning strategies. He was met with resistance, and he explained, “I just couldn’t understand this idea that the formalism, this continuity or whatever, is so important to them” [Henry, Interview 2]. However, I did not get the sense that Henry felt this challenge was a true impediment. Instead, I imagined that he simply saw it as something to overcome, and he confirmed this sentiment in our follow-up interview.

**Personal, cultural, and professional history**

What connections might be made between Henry’s personal, cultural, and professional histories and the way he is currently experiencing the relationship between teaching and research? As I analyzed the data from Henry’s case, I was surprised to find that his professional history had very little impact on the way he currently engages in his job. All of the career decisions Henry discussed with me – choosing to be a professor, how to allocate his time in his current position, how to teach his classes, how to manage his research group, and more – are primarily informed by his intrinsic desire to be happy. It has been made clear thus far that Henry pursues a wide range of activities in his career,
spread over teaching, research, and service. As described previously, Henry has not allowed his colleagues’ advice to dissuade him from pursuing these activities:

I mean, the number of people who came to me and said… you need to just focus on research, it’s the only thing anyone cares about, just buckle down, do research, get it done, certainly I had that conversation multiple times with department heads, other faculty members. So I would say they probably think that’s the case. I don’t think that, I mean this comes down to the question of what my advisor in grad school told me to do right? Essentially they're saying the same thing that he's saying which is, do one thing and focus on it and do it really well, and then you can get tenure, and then what? And then you keep doing this one thing? I don’t wanna do one thing. (laughs) I wanna do three things. I wanna teach, I wanna do service, I wanna do research. [Henry, Interview 1]

In our follow-up interview, I explained to Henry that I interpreted his current goals and actions to be inspired almost exclusively by his personal and cultural history rather than his professional history. At first, he protested and pointed to his interactions with his advisor in graduate school. He asserted that being asked to focus exclusively on research made him realize that that was not something that would make him happy. I conceded to Henry that this experience may have reinforced the goals he previously had, but I pointed to his experience as an undergraduate as evidence that he was already inclined to pursue a variety of professional activities:

I loved undergrad. It was fantastic… I was a physics and [humanities] major, and I was doing philosophy and literature and just all this stuff and staying up late into the night and arguing about Kant and other stuff. It was fun. I had a great time. I
think this is probably true for most people in their undergraduate days right? So very fond memories of it. [Henry, Interview 1]

I also reminded Henry that before his advisor asked him to focus on research, his professional activities were once again widely varied:

I was doing a lot of not specifically physics activities, I would say. I was doing a lot of programming… Writing the gradebook and making sure it was secure… Thinking about teaching, how to modify the classes so that they would be better… A lot of time talking to other graduate students who were also really interested in teaching… I also was doing a lot of volunteering for the department… I was also working my black belt and doing things like that, so it was a full schedule.

[Henry, Interview 1]

After I presented this evidence to Henry in our follow-up interview, he laughed and agreed that he most likely would have pursued the same activities he does now even if his advisor had managed his graduate years differently. There were some cases in which Henry had “great teachers who I’ve tried to emulate… And then other faculty doing active learning… Role models” [Henry, Interview 2], but Henry’s personal and cultural histories far outweigh these interactions.

As described in the introduction to this case, Henry comes from a family full of teachers. He jokes that teaching is perhaps a genetic trait, but explains that he is sure that his father was “a huge influence” [Henry, Interview 2]. Henry also described being bused to schools in which he was a minority student during his K-12 education. When I asked him if that experience inspired him to pursue the service activities he currently engages
in, he explained that it is most likely a factor in that area of his career, but was never something he was explicitly aware of:

I know that that is a fact from my childhood, but I don’t specifically say I had this aha moment where I was like oh I feel this way, I’m going to do something about it. I can’t point to that. I just know that I’ve – for as long as I can remember – felt that this is important and something needs to be done about it. [Henry, Interview 1]

Case 2: Ben

Ben (pseudonym), a chemistry professor at Large University, describes himself as a white male raised in a small, primarily white community outside of the United States. During our follow-up interview, he emphasized the importance of his cultural history, particularly with respect to his understanding of educational systems. According to Ben, public schools in his country are well-funded and more rigorous than American public schools. He explained that due to this difference in schooling, he tends to misjudge his students’ prior knowledge. Ben also emphasized the significance of his own disciplinary training. This cultural theme will be revisited and described in more detail below.

When I asked Ben to describe Large University, he talked about the large student body and the scope of the academic programs ranging from undergraduate to PhD level. He also highlighted that “many of our science departments are very highly rated” [Ben, Interview 4], with chemistry ranking among the top 25 in the United States. Ben went on to talk about the prominent role sports play in Large University’s culture, citing specific
statistics about the size of one of the campus’s sports venues. Though Ben did not offer extensive commentary on this topic, he felt that it was important to recognize that sports programs might hold too much power across the campus and that this is vastly different from his experiences in his country of origin.

Above all, Ben is a scientist, and throughout our interviews, it was apparent that he has made most of his educational and professional decisions based on his desire to do great research. He described his family as “very blue-collar” and explained that he was “pretty much the first person in my family who went to university” [Ben, Interview 1]. In the same interview, he said that he “didn’t even think about going to graduate school, I didn’t even really know what that was when I started my undergrad.” However, a research experience as an undergraduate student ignited his interest in pursuing a science career, and all of his subsequent academic and career decisions have been governed by his efforts to join labs engaging in research of interest to him. These themes, scientist and research, appear throughout the data connected to Ben’s case and will be explored in further depth below.

Once Ben decided to go to graduate school, he did not apply to multiple institutions as is common for students at that point in their academic careers. Instead, Ben investigated research that interested him and applied only to the one school which housed the one research group he wanted to join. Because Ben lived at home as an undergraduate student, he said that his undergraduate years were “like an extension of high school” [Ben, Interview 1]. Thus, Ben explained that graduate school was a time for him “to grow up and become an adult” [Ben, Interview 1].
Ben did not immediately meet success in graduate school. Unlike most graduate students, he began his research as soon as he started graduate school. However, he initially was assigned to a research project which was unsuccessful and not as interesting to him as he had hoped. He described the transition from undergraduate study to graduate school:

That was hard, coming from being an A student to finally coming to do some real research, away from home, and nothing’s working. Thankfully [my supervisor] was a really good supervisor and saw what was happening and decided to put me on a side project… I really took to that and that was very successful, so that was good. But certainly graduate school was not easy. [Ben, Interview 1]

Throughout Ben’s time in graduate school (five years), he served as a teaching assistant and worked 60 to 65 hours a week in his research lab. He explained that although he was not required to TA for funding purposes, it was the culture of the University for graduate students to engaging teaching throughout their graduate careers. Ben described his time in graduate school as highly productive; he published approximately 10 journal articles as a graduate student and felt that he became an independent scientist during this time. As will be described later, Ben’s experiences in graduate school strongly influence the way he currently conceptualizes the purposes of graduate school as well as the way he manages his research group:

[My supervisor’s] philosophy has been let’s get the students doing research, our focus should be on research… That has also influenced my own thinking about at least graduate education, about where the focus should be, should be focusing on
research, because that’s what’s going to get you a job in chemistry. [Ben, Interview 1]

When it was time for Ben to start applying to postdoctoral research positions, he engaged in a search similar to that which he utilized for his graduate school search. Even though most scientists in Ben’s position would have applied for multiple postdoctoral fellowships, Ben decided to find one research group engaging in research which he found interesting and apply there. He ended up being accepted to work for a research group at a private, very small Bac/A&S\textsuperscript{13} institution in the United States. Again, Ben was not immediately successful in his new position: “it was a very huge steep learning curve, and there were moments there that I thought about quitting because it was hard” [Ben, Interview 1]. However, Ben eventually came to enjoy his time at this position:

The postdoc…can be a highlight of a young scientist’s life because they don’t have to take classes, they don’t have to TA… And so you don’t have all these other worries, and so for your postdoc you just focus on the research and just focus on your own research. [Ben, Interview 1]

After four years at his postdoctoral fellowship, Ben decided to start applying to faculty positions. Again, he searched for positions that would best match his research interests. Large University was the only institution that offered Ben a position, and he happily accepted because he felt that the school not only met his needs as a researcher, but he also believed that the surrounding area would be a supportive environment in which to raise his family. Ben is now in his eighth year of teaching at Large University.

\textsuperscript{13} Bac/A&S is the Carnegie classification for Baccalaureate Colleges--Arts & Sciences. For more information see \url{http://carnegieclassifications.iu.edu/}. 
and just received tenure during the course of this study. During many of our interviews, Ben talked about the challenges that are unique to being an early career chemistry professor, particularly the need to learn most of his job skills on the job and the drive to attain tenure. He explained that his job has changed from the time he began until now:

In the beginning of my time… I was much more in the lab more days doing science, doing science experiments, but as the lab grows you’re sort of more in charge of more and more people and as well at that point we have to take all the science experiments and start writing research papers, start writing research grants so that we can get money to do more research… The best person to write the papers and to write the grant is myself… Until recently I’ve gotten out of the lab more and more doing research experiments myself…spending more time just sitting at my computer and doing lots and lots of writing when I’m not worrying about my teaching obligations. [Ben, Interview 2]

In addition to research, Ben teaches undergraduate chemistry and engages in service committees. Currently, he serves on two main committees: undergraduate advising and an instrument steering committee. The instrument steering committee seeks to provide the department with guidelines and recommendations regarding a major piece of equipment shared by many of the researchers in the department. Ben chose this committee because most of his research relies on the use of this instrument.

Ben is clear about how he prioritizes the various components of his job: teaching, research, and service. Because he believes producing high-quality research is the most important component of his job, his priorities are “research number one, teaching number two and everything else number three” [Ben, Interview 4].
I spent 12.5 hours with Ben during this study, spread over 34 weeks. I observed Ben teaching introductory chemistry four times, meeting with his classroom students for office hours one time, and engaging in meetings with his research students four times, for a total of roughly 7 hours. I conducted three phenomenological interviews with Ben, totaling 4.5 hours, and one follow-up interview which lasted approximately one hour.

Themes

My analysis of Ben’s case (as described in Chapter 3), uncovered four major themes that occur throughout his professional life: research, scientist, early career, and academic culture. In my member-checking interview with Ben, he agreed that all of these were in fact major themes of his job and said that he did not think I was missing anything in my analysis as I presented it to him. Full descriptions of each theme with supporting evidence from interviews, observations, and document analysis associated with Ben’s case are presented here.

Scientist

Professionally speaking, Ben sees himself as a scientist above all else. In our third interview, I asked Ben how he usually answers when somebody asks him what he does for a living. He answered:
I would say that I am a scientist. If they ask me further what kind of scientist, I would say I’m a biochemist… I tend to sort of start at a very broad category before going deeper depending on what their sort of background is.

Although he describes teaching as one of the three main components of his job, he does not view it as the primary purpose of being a professor. In fact, he believes that this is a common misconception that the general public has about professors:

There are great divisions in what people think what a university’s for and what professors do. I think outside the university the general public generally thinks that the university is a place for teaching and learning and that professors are there primarily to teach whereas people within the university, especially at a large university like [this one], there’s a lot more emphasis on the research, getting grant money, so there’s this division of thought of what a university is for. [Ben, Interview 3]

Ben’s personal identity is closely tied to being a scientist. He explained that being a scientist is not “so much professional standing. It’s about the way that you view the world and the way that you go about looking at the world… It’s a way of viewing and testing the world” [Ben, Interview 3]. In the same interview, I asked Ben what it means to be a scientist, and he explained:

To do science, to think in a scientific manner, to be curious about the world and to approach it with trying to ask good questions and then based on those questions trying to come up with good experiments and then performing those experiments, interpreting the data, and seeing if our thoughts need to be changed in any way.
Even though Ben does not believe that in order to be a scientist one must have a specific professional standing, he does assert that “if I wasn’t doing science, if I wasn’t making hypotheses and experiments and then going through the scientific method, I would not be a scientist” [Ben, Interview 3]. In this way, Ben acknowledged that the essence of being a scientist is engaging in scientific practices. I asked him, “So the requirement then [to be a scientist] is not necessarily professional standing but actively engaging in the activity?” He confirmed, “That’s correct” [Ben, Interview 3].

During our third interview, Ben provided me with a list of scientific activities, most of which pertain to what he calls the “scientific method.” These include:

- thinking in a scientific manner, being logical and open-minded, limiting assumptions, being creative and curious, admitting when one is wrong, and changing hypotheses when necessary
- asking good questions and generating falsifiable hypotheses to answer those questions
- designing experiments, isolating variables, thinking about controls, and knowing the strengths and weaknesses of experimental techniques
- interpreting data

Ben mentioned all of these behaviors throughout our interviews, but the unifying theme was his scientific method:

I think science is about the scientific method, coming up with thoughts or hypotheses about how the world works and then developing experiments to test those hypotheses and interpreting that data to see if we need to change our hypotheses. [Ben, Interview 3]
In a document (not initially prepared for this study) in which Ben stated his teaching philosophy, he further clarified:

Science is not an encyclopedia of facts and figures, or a recipe book for performing calculations and chemical reactions. Instead, science is a social endeavor involving the exchange, evaluation and evolution of ideas through the scientific method.

Throughout my observations of Ben’s interactions with his students – both in the classroom and in research group meetings – the importance of these behaviors to Ben was clear. In my first observation of his undergraduate teaching, he described to his students an assignment in which they would be contributing to a scientific research project being conducted by a group of scientists at Large University. He repeatedly used the word “excited” to describe his own feelings about the project, and he explained to the students that “you will have a chance to have a real impact on people’s lives” [Ben, Observation 1]. He told the students that the project was similar to his own life as a scientist because he doesn’t “sit at a desk and look up MCAT\textsuperscript{14} questions,” but instead he reads and develops questions and plans experiments. His own research was a topic that he brought up frequently in class: “as you know by now I am a biochemist… [These molecules] are the focus of my lab’s research. I’ve been fascinated by [them] since I was an undergrad” [Ben, Observation 2]. At the end of the semester, I observed the students presenting the work they did for this assignment. The researchers from Large University who were engaged in the actual scientific research connected to the undergraduate students’

\textsuperscript{14} The Medical College Admissions Test, commonly referred to as the MCAT, is an exam taken by undergraduate students who wish to attend medical school. For more information, see \url{https://students-residents.aamc.org/}. 
projects were in the classroom for the presentations. The researchers engaged with the students throughout the class session by asking questions and occasionally informing the students that the researchers were going to be utilizing the students’ ideas in upcoming research designs. Ben also asked the students probing questions about their projects. This entire class session indicates that Ben highly values what he feels to be an authentic scientific experience for his undergraduate students.

On several occasions Ben also explicitly stated that he felt students needed to have a more authentic scientific experience as undergraduates: “I believe that the science we teach to undergraduate students fails to capture the true spirit of the science that goes on within our research labs… In my teaching, I strive to capture this creative spirit of science” [Ben, Teaching Statement]. He tied this sentiment to his own experience as an undergraduate student:

I think we have to do a better job of [undergraduate] science classes and how we introduce science. It can be difficult to try and communicate what is science like on an everyday basis. I enjoyed science and math but didn’t really fall in love with science until I got that research opportunity. [Ben, Interview 1]

Later, he reiterated:

What I wanted to do more is make those connections between these different topics. As an expert I already see all of those different connections and so I can bring in a variety of concepts from these different topics and bring them all together to approach some problem or understand some scientific paper, whereas it’s sort of hard to give the students the complete picture. [Ben, Interview 2]
In the research lab, Ben’s primary goal is to accomplish great science (see the research theme below for more information), but when it comes to working with his research students, his primary goal is to train them to become independent scientists:

I think a PhD is an opportunity to become an independent scientist, and that’s really what the goal should be, as opposed to students going up to their supervisor and keep asking well what should I do, what should I do, what should I do. [Ben, Interview 1]

I observed four research group meetings between Ben and his research students, and for each one his primary agenda was to hear an update from each student on research progress and then to question that student on all of the scientific activities described above. For example, Ben would often ask students to explain their reasoning behind various experimental designs, the fidelity of the control group, the strengths or weaknesses of one technique compared to another, etc. In short, Ben’s meetings with his research students serve as a time for Ben to train his students in what he calls the scientific method.

Because Ben not only strongly identifies himself as a scientist professionally but personally as well, it is not surprising that the scientist theme can be seen intertwined throughout all of the subsequent themes presented below: research, early career, and academic culture.
The research theme in Ben’s career is closely related to the scientist theme in that he envisions research to be the primary responsibility of a scientist. However, research remains a theme that is distinct from scientist because whereas Ben’s personal identity is closely tied to being a scientist, his role as a researcher is primarily tied to his professional identity. Ben’s attitude toward scientific research is perhaps best exemplified by his characterization of the postdoctoral research position as the “highlight of a young scientist’s life” [Ben, Interview 1]. He explained:

The postdoc is very different than doing graduate work. I think it can be a highlight of a young scientist’s life because they don’t have to take classes, they don’t have to TA… I had all this previous experience and background behind me, so I was more mature in understanding all these other techniques. And so you don’t have all these other worries, and so for your postdoc you just focus on the research and just focus on your own research. [Ben, Interview 1]

Ben’s interest in scientific research began when he was an undergraduate student, and this experience inspired him to pursue a research-based career:

The first time that I had an opportunity to really work in a research lab… Gave me a first indication of what day-to-day science was really like, so that got me really interested and prompted me to go to graduate school. [Ben, Interview 1]

From that point on, almost all of Ben’s major career decisions were primarily guided by his research interests. When he applied to graduate schools, he did not choose
schools based on ranking, geographical location, or any other common features. He explained:

So the way that I have done things in my career are not necessarily the way that most people do them. I think it is typical for a student thinking about graduate school to apply to a number of graduate schools and to get in, and once they get into think about a supervisor… I was looking for what research interested me the most. So once I found the person… I contacted this person and I said I was interested in working in their lab, and so they said well apply to our graduate school, and then I got in. [Ben, Interview 2]

This trend continued when Ben applied for his postdoctoral research position:
I had gone to a research conference, and I had seen a couple of talks by [two researchers], and what both their groups did was use this technique to study [my topic of interest]… So that really piqued my interest… I thought that was really interesting, and there were some questions that I wanted to answer that I thought that method would be fantastic at doing… So I started thinking about doing [that] in my postdoctoral work… It was kinda similar to what I did when I looked for graduate work… When I was looking for postdocs I guess I kinda looked around a little bit, but I decided I wanted to go work for [that researcher] and that’s it, whereas most people sort of apply to all sorts of places. But that’s not what I did. [Ben, Interview 1]

Finally, Ben’s applications for his first faculty position were also guided by research interests: “I did limit it in that I wanted to continue to do [this] research, and so [I focused] in on those positions looking for that type of person” [Ben, Interview 1].
Ben’s focus on research was reinforced by his graduate school supervisor’s philosophy on the role of research in academia:

His philosophy has been let’s get the students doing research. Our focus should be on research… That has also influenced my own thinking about at least graduate education, about where the focus should be, should be focusing on research.

Because what’s going to get you a job in chemistry is going to be what research you do, what you have, papers out there… No one really cares what you did in your classes. What they want, if you’re doing a PhD, is how many papers, where did those papers get published, so on and so forth. [Ben, Interview 1]

Additionally, the guidance Ben received from his graduate school supervisor allowed him to develop into an independent researcher:

I think a PhD is an opportunity to become an independent scientist, and that’s really what the goal should be… I had my own ideas about where [my PhD] project was going and my supervisor gave me the freedom to pursue those things, so I think I became much more independent guiding my own research… Whereas I don’t feel that is necessarily typical for all students unfortunately, but I certainly became more independent. [Ben, Interview 1]

This sentiment has been carried on in the way Ben mentors his own graduate students. Ben’s primary goal for his graduate students is to support their research productivity. Even though he did mention some of the social aspects of lab management, he related this to the research focus:

As a graduate student, as a postdoc, you’re sort of focused in on your own science. And yes there’s sort of relationships and so on, but my personality is I
don’t think I have an abrasive personality, I tend to get along with people, and I tend to be fairly quiet too. I’m just there to get my science done. As a professor you’re dealing with people that have a variety of different personalities… It’s also about science is hard, science is punctuated by very low lows when experiments don’t seem to ever be working. And there can be very high highs, where if you get this great great result you’re on a high… [I try to] encourage people, pick people up, have social activities… Just to sort of bring everyone together as sort of a team… Get everyone working on the same page, working as a team. [Ben, Interview 2]

Ben explained that he prefers not to micromanage his lab, but he does track his graduate students’ progress by their research results:

Some students need a bit more hands on, a bit more guidance, a bit more these are the experiments you have to do, ABCD. Whereas other students are a bit more hands off, but it’s my personality to not micromanage people because I don’t like to be micromanaged… I tell students that if they’re PhD students that it’s not the time that they spend in the lab… They’re not just a warm body doing whatever, that we’re very results focused. Saying that, I do tell students that I think for us to get those results they need to be committing about 60 hours a week in the lab. [Ben, Interview 2]

Later in the same interview, he clarified:

I really gauge it by how much research I think they have accomplished… I sort of give these guidelines, but in the end I don’t really keep track of how much time
students are in the lab. I keep track of how successful are they in getting research done and heading towards their goals.

Ben’s research focus strongly influences the way he conceptualizes and prioritizes the various aspects of his career: teaching, research, and service. With respect to teaching he explained:

I know that I do consider the research to be a little bit more important to get the grants written, getting more and more funding, supervising the lab and so on. And so sometimes I have to think about how I want to divide my time and what will push the science forward. And so sometimes again there are these time constraints. [Ben, Interview 3]

Ben frequently referenced these time constraints when we discussed his job activities during our second interview:

- “It takes time to really think about the types of activities you want students to do, and so the more time I use to think about those activities, the less time I’m spending on research and other parts of my job.”
- “The days that I don’t teach I might be able to dedicate more to research.”
- “During the summer I don’t teach and so I can dedicate more time to doing research.”

Beyond time constraints, Ben considers research a priority over teaching when deciding how to spend his mental energy:

In some ways I can go a little bit more on autopilot with the teaching. I mean there’s always little things that I could do with the teaching if something [with] the science has sort of stumped me or I don’t know how to explain this or what
experiment to exactly try next… It’s not necessarily the best approach to teaching, coming up with lectures – I mean it’s sort of more on autopilot and then thinking and writing about science. [Ben, Interview 3]

He clarified that he does feel that teaching is an activity that can be congruent with his role as a researcher in some ways:

I think teaching, especially teaching general chemistry and learning some of those things, relearning some of those things again, I haven’t really thought about in a while, it’s given me a greater perspective on how our research fits in the greater field of chemistry and outside of chemistry. So it’s given me a bit more perspective being able to teach has allowed me to recruit some students into my research lab. I have been involved [in] talking about teaching with other professors and how we need to approach teaching with the same rigor that we approach our science. I don’t think I’ve done that yet, but it’s certainly caused me to think more about teaching. So there can be a positive relationship, one feeding into the other. [Ben, Interview 3]

Finally, when I asked Ben how he chose his service commitments, the research team was again evident:

With the [instrument] steering committee, my group is heavily involved in doing [that type of] research, so it made sense that I would have a voice on that committee. With undergraduate advising… I mentioned before I did my bachelor’s degree at a small, primarily undergraduate university, and my first research experience as an undergraduate really made me fall in love with science to pursue this career. Obviously it’s been very important for me to not only give
those same opportunities for undergraduates in my lab, but as well… If they want to talk about finding a research experience… How would you go about trying to find a research experience in any lab. And so again it is part of that commitment to undergraduates. I thought it was a good idea to become an undergraduate advisor where I could give career advice to undergraduates. [Ben, Interview 2]

It is evident that Ben regards research as the central responsibility for his job. Not only does he prioritize research activities above others, but he makes an effort to use non-research activities to augment his research program.

**Early career**

Ben was in his seventh year of working at Large University, his first faculty position, during the course of this study. It was therefore not surprising to me that many of our conversations led to discussions of issues facing early career faculty members. These issues fall under two main categories: learning on the job and preparing for tenure.

Ben explained that with the exception of being taught how to engage in scientific research, professors do not receive training for their jobs:

[In] physical science you are taught your graduate work and your postdoctoral work primarily teaching you to be a bench level scientist. So coming in and becoming a professor you have all these things that there’s no formal teaching about. So I talk about being a manager of scientists, dealing with the social interactions, so not just thinking about the science but thinking about the people doing the science. But then there are things like coming up with a budget. No one
ever taught me how to come up with the research budget before I came here. And again coming in I never taught a full course before. [Ben, Interview 2]

He went on to explain that for this reason, new faculty are expected to exhibit vast improvement at the beginning of their careers:

I had some experience here and there with these different components but certainly know, I was never in charge of the course and so they just – here you are. I don’t know if that’s the same in other disciplines, but you’re not taught how to teach. You’re just taught how to do research on a bench, and then you’re given all these other responsibilities and hopefully you learn. So that’s why what they want to see is – you could come in as a very poor teacher, but as long as you are sort of improving over the years then that is favorable… I guess the same could be said about your research, that as long as you are on a positive trajectory that they can see you further improving. [Ben, Interview 2]

When I asked Ben how he learned things like creating a research budget, he described:

Well I learned it because there came a point in the lab’s life about two years ago where we ran out of money… So I had a long conversation, and not just one but a few conversations with the chair of the department, and we sort of worked out how I should be doing this and learning how other people do this, more senior colleagues. So it’s just a lot of these things are on-the-job learning experiences. So whether it’s teaching, whether it’s running a research lab, coming up with the research budget, a lot of these things are on the fly, learn why you’re doing it. [Ben, Interview 2]
When I asked Ben whom he would ask for help learning to teach, he replied that though he knew of various resources, his time constraints would make it difficult for him to utilize those resources:

The issue is I have a variety of different responsibilities, and maybe it’s an excuse, but I only have so much time in the day. If I really wanted to I think I would have to focus a lot more attention on what’s going on. I mean certainly we do have resources [here], like the [discipline specific teaching and learning center]. There’s other centers. I guess I could reach out to other departments. I know there’s reading through say Science magazine or Chemistry and Engineering News… I’m sure there’s more information within the education-based journals, but I just haven’t found the time to further search them. [Ben, Interview 3]

This allocation of time to research over teaching is consistent with Ben’s intrinsic research interests, but it is also supported by his drive to reach tenure. Ben had submitted his tenure packet shortly before the beginning of this study, and found out toward the end of our time together that he did indeed receive tenure. Many of our conversations turned to the official and unofficial requirements for achieving tenure in his department. Ben explained that applying for tenure, typically a six-year process, involves submitting a package that describes one’s teaching, research, and service activities to be reviewed by the department, college, and university as well as external experts in one’s field. With respect to his particular tenure process, Ben explained:

I think there’s a few keys. One is how many grants do you have, because that’s an indication of two things. One how successful you’ve been, two your ability to
write up what you’ve done and plan for the future and convince people that those research directions are worth funding. And then three having grants means that you can continue to do research because of course all these things cost money. So we had two grants… That’s actually really good to have two grants, so that worked heavily in my favor. Another important component was how many research papers you have and what journals they’re in. I had hoped to have a few more research papers in there, but we also got in a number of higher impact journals… So that was good. They evaluate research and teaching and service, but I think it’s kind of given that they consider research to have a bit more weight, especially with the external evaluators. But with my teaching I’ve gotten pretty good comments from students and pretty good student evaluations and [a teaching prize], so that was very favorable as far as that component. And then with the service as I said I don’t think they look too closely at that because they really want you to focus on getting your research up and running and improving your teaching. [Ben, Interview 2]

Since Ben’s intrinsic desire to focus on research is congruent with his institution’s focus on research for tenure purposes, it was difficult for me to determine how much of an effect the tenure process had on his daily decision-making with regards to allocating time and resources to the various parts of his job. During our follow-up interview, I told Ben that I imagine he might start to engage in more service work now that he has achieved tenure. He corrected me: “The focus will continue to be research number one, teaching number two and everything else number three” [Ben, Interview 4].
Academic culture

Finally, academic culture has played a prominent role in the way Ben experiences his career. Since he was the first person in his family to go to college, the way he has learned to interact with the academic community has largely been governed by cultural norms and expectations in academia.

As described previously, Ben’s ideas about the way an academic research group should run were largely inherited from his research supervisor from graduate school. During our interviews, he reflected on his time in graduate school and explained how that influenced him to mentor his own graduate students:

Certainly graduate school was not easy. I remember my first committee meeting… was let’s grill this student with questions, and I was not prepared at all for that. So that was pretty hard, but I’m not someone who gives up very easily, so I made certain that the next time that I would be prepared and I would continue to be prepared… It was a pretty devastating experience, but now looking back I know that my supervisor and my committee members were just doing it to look out for me, to see if I can continue to improve. And so for my own grad students, I tried to ask them good questions so that they realize what they don’t know and what they need to continue to work on. [Ben, Interview 1]

In this way, Ben is continuing the cultural norm of challenging his graduate students with difficult questions in order to prepare them for future endeavors, just as he was challenged in graduate school by his committee members. Similarly, Ben’s expectation for his students to work 60 hours a week in the lab is inspired by his own
history of rigorous commitment to lab work: “Most of my activities after the second year [of grad school] was research… I was working 65 hours a week” [Ben, Interview 1]. Later, he explained why he expects a similar work schedule from his own graduate students:

To get a PhD requires a certain time commitment. Not everyone can get a PhD, and that’s perfectly fine… To get a PhD requires a certain level of rigor and time commitment. It’s not something that we are just handing out for sitting at a desk for five years. So if someone came to me and said they only want to work 40 hours, to me that doesn’t sound like – it’s not the time, but it’s the attitude. It doesn’t seem that they’re here for the right reasons. It doesn’t sound like they have the dedication necessary to get through a very difficult PhD. [Ben, Interview 3]

The cultural backdrop of Ben’s department has also supported his prioritization of “research number one, teaching number two and everything else number three” [Ben, Interview 4]. He explained that while a professor is working for tenure, “the department really tries to, doesn’t try to overburden us with too many things so that we can focus on research” [Ben, Interview 2]. He further explained:

I think our department does a really good job of supporting assistant professors. So when we get tenure, they look at teaching, they look at research, and they look at service. But I mean it’s your research that is the major deciding factor, and so they try to limit the amount of service work. You’re still teaching, but they set you up with a course that you teach a few times to sort of help, so you don’t have
to come up with things all the time and so there’s quite a bit of support for these assistant professors. [Ben, Interview 2]

In our third interview, Ben reiterated that for the tenure process “it was made pretty clear through various, mostly informal discussions that the component that has the most weight in getting tenure is the research component.” However, he went on to clarify:

I think that is slowly changing, that there is more and more emphasis within our college on improving teaching. That can be seen in part by the creation a few years ago of the [discipline specific teaching and learning center] and other endeavors within the college, so I think people are focusing a lot more on improving education. I think in some ways [this university] is behind in part because it’s such a large institution and the emphasis has been on research for so long. And so I think as far as the institution or the department I think yes we do want to improve undergraduate education from first-year courses all the way to senior-level courses. [Ben, Interview 3]

In this discussion of Ben’s relationship with academic culture, it must be made clear that Ben does not see himself as conforming to this culture in a way that contradicts his intrinsic goals and beliefs. In fact, in our follow-up interview Ben claims that he is typically unaware of what is culturally expected of him. Instead, Ben feels that his personal professional agenda is naturally in alignment with academic culture in the science disciplines.
**Research questions**

I have utilized the themes identified above as well as other supporting information from interviews, observations, and documents to answer the project’s research questions for Ben’s specific case. These questions are

- What is the relationship between teaching and research roles for Ben?

- What types of activities and experiences (particularly professional development) does Ben engage in to support his role as a teacher? Conversely, what types of activities and experiences impede his role as a teacher? In what ways do these activities support or impede his role as a teacher?

- What connections might be made between Ben’s personal, cultural, and professional histories and the way he is currently experiencing the relationship between teaching and research?

**The relationship between teaching and research**

What is the relationship between teaching and research roles for Ben? Because Ben prioritizes research above all other professional activities, he tends to utilize his teaching to enhance his research, but he does not typically utilize his research to enhance his teaching. Thus, I would describe this relationship as unidirectionally complementary. This relationship is evident here:

Sometimes these things can be synergistic, sometimes these things can be antagonistic, meaning that again there’s only so many hours within the day. I know that I do consider the research to be a little bit more important to get the
grants written, getting more and more funding, supervising the lab and so on. And so sometimes I have to think about how I want to divide my time and what will push the science forward. And so sometimes again there are these time constraints. I think teaching, especially teaching general chemistry and learning some of those things, relearning some of those things again, I haven’t really thought about in a while, it’s given me a greater perspective on how our research fits in the greater field of chemistry and outside of chemistry. So it’s given me a bit more perspective being able to teach has allowed me to recruit some students into my research lab. I have been involved [in] talking about teaching with other professors and how we need to approach teaching with the same rigor that we approach our science. I don’t think I’ve done that yet, but it’s certainly caused me to think more about teaching. So there can be a positive relationship, one feeding into the other. [Ben, Interview 3]

Later, Ben specifically addressed ways in which his teaching can enhance the way he thinks about his research:

Whether it’s a general chemistry course thinking about topics I haven’t thought about in a while, getting a broader perspective on how the science we’re doing in the lab fits in with the field, but it also is in the senior level [chemistry] class where I’m always trying to change the course a little bit in part to keep my excitement level up for it. And so part of that is diving into the scientific literature and coming up with papers that students can read and answer questions based on it, and so many of these are again outside a little bit my particular focus, and so again it gives me a bit broader perspective of what’s going on. And as well with
that, if you are in a certain area, people have a certain way of thinking about things, and there is a danger of sort of everyone thinking the same about something. Whereas going outside your particular focus can give you new perspectives, new ideas, maybe new experimental techniques, to try on your particular system. So I think that has been important. [Ben, Interview 3]

While Ben did not explicitly state that he felt his research activities did not influence him as a teacher, there is a lack of data regarding this relationship. In other words, Ben simply did not talk about how his role as a researcher influenced his role as a teacher. Indirectly, one might return to the scientist theme and recall that Ben feels it is important to communicate the authentic activities of scientists to his classroom students. However, during our time together he did not make this connection directly from his own research to his teaching. During our follow-up interview, Ben agreed that he sees teaching and research as activities that compete for his time and that his teaching helps him think about scientific concepts and literature and helps him recruit students to his research lab.

**Supporting and impeding activities and experiences**

What types of activities and experiences (particularly professional development) does Ben engage in to support his role as a teacher? Conversely, what types of activities and experiences impede his role as a teacher? In what ways do these activities support or impede his role as a teacher? Even though the focus of Ben’s career is research, he takes undergraduate education very seriously and works to teach his classes in the best way he
can within the constraints of limited time and training. He does not feel that his experience as a graduate student prepared him to be a teacher, but as a faculty member he does now seek out both formal and informal professional development when he has time. Formally, Ben attends seminars provided by the discipline specific teaching and learning center on campus. Informally, he interacts extensively with colleagues through that same center. He explained that he has found great value in the centers support:

Through opportunities through the [discipline specific teaching and learning center], I think that’s been a very favorable source of information, getting other people to come in and talk… Sometimes we have just roundtable discussions. [And the center director] has been a great source of information and inspiration, and certainly other professors from other institutes coming in and giving their perspectives. [Then, Interview 3]

Ben also discussed the benefit of talking to undergraduate and graduate students about teaching and learning:

We’ve had learning assistants, these undergraduate peer mentors in [general chemistry], where it wasn’t just a one way relationship in that it wasn’t just me telling them what to do, but I was always looking for feedback on how they were thinking about how things were going in the course or approaching particular concepts. Trying to get their feedback is one of my favorite parts of having these undergraduate learning assistants. Even I occasionally have talked about teaching with the graduate students in my lab. [Ben, Interview 3]

Besides seeking discussions with others about his teaching, Ben is also a reflective teacher. He spends time thinking about ways to make his own teaching better:
There’s been some people that say you shouldn’t lecture at all, this whole shouldn’t be the stage on the stage, you should be the guide on the side. It’s hard. It’s something that I struggle with. I think every time I teach I learned something… I want to give people more time to talk to one another, to go through activities. I think that was especially apparent with the [general chemistry] class that I just taught this past semester. I think that I lectured way too much. And maybe I have to just give the students more opportunities. [Ben, Interview 2]

In this way, Ben engages in both formal and informal professional development activities related to his role as a teacher. His prioritization of research over teaching does not prevent him from making efforts to be the best teacher possible.

**Personal, cultural, and professional history**

What connections might be made between Ben’s personal, cultural, and professional histories and the way he is currently experiencing the relationship between teaching and research? As described earlier, Ben did not feel that he was trained to teach before his first faculty position. He did have the opportunity to TA in graduate school, and he described this as “sort of my first opportunity to write my own notes and come up with my own sort of lecturers” [Ben, Interview 1], but he made it clear during our discussions that acting as a teaching assistant is nothing like being in charge of full lectures. Similarly, Ben was not trained to lead a research group, although he was extensively trained to be a researcher. This lack of preparation for multiple areas of his
job has driven Ben to become self-directed and learning not only how to teach and lead of research group but in how to balance these responsibilities.

Though Ben’s graduate school training influenced the way he conceptualizes the purposes and activities related to mentoring his graduate students, there were not any experiences that obviously influenced the way he balances teaching and research. It is difficult to say whether or not Ben would approach the balance between research and teaching differently if he had experienced any explicit training in these areas previously. Generally, Ben prioritizes research over teaching because of his intrinsic desire to do so.

Case 3: William

William (pseudonym) is an astronomy professor at Large University. During the course of this study, William was in his sixth year of teaching at this institution. He had submitted his application for tenure shortly before the study commenced, and he received tenure several months into the study. During our follow-up interview, William indicated that he would describe himself as a professor of astronomy who does research, teaches classes, and advises students. He added that he is a husband and father, male, and “I don’t know if I’m middle-aged yet. Maybe I am” [William, Interview 4].

As will be described in detail later, William experiences a strong sense of personal and professional identity as an astronomy researcher. He does not come from a family of scientists, but developed an interest in astronomy in grade school through popular culture and science textbooks: “Discovery Channel, you know… I mean you read the kids’ science books and it says, ‘Astronomers know that…’ And there it is, that’s the
job I want. I want that job” [William, Interview 1]. He explained that even though he did not know what the day-to-day life of an astronomer was like, it was his goal as early as high school to become an astronomer: “In high school I took AP physics so that I could get ahead in physics in college and be a better astronomy major” [William, Interview 1].

As an undergraduate, he engaged in research and learned that he did indeed enjoy daily astronomy research:

I like to say I always knew I wanted to be an astronomer, but I didn’t know what that meant, and so it’s a good thing that it turns out I like it and I’m good at it. I got lucky in that I like it, I’m good at it, and I always wanted to do it. And that’s getting dealt a straight flush. [William, Interview 1]

As William went on to progress through his educational career, he continued to develop as a researcher with strong ties to his professional community. He attended graduate school at a highly-rated, public, RU/VH institution which he says is known for producing tenure line faculty members. He described his graduate school years with fondness, explaining that he and his incoming class were not only professional colleagues but friends as well. The combination of social and professional interactions in graduate school played a prominent role for William in his time there:

[My classmates and I] were all really driven to learn lots of astronomy.

We spent a lot of time together socially, but we also spent a lot of time together learning astronomy in our various fields, and so that was a very good environment to learn astronomy, how to do astronomy. We always bounced research questions off each other and tried to figure things out amongst each other. [William, Interview 1]
This sense of community also played a role in the development of William’s commitment to professional service during graduate school. He and his colleagues had “department chores” which, he explained, they had fun with but also took very seriously. As one example, William described the emails he and his classmates would send to the department announcing colloquia or social events:

We had themes and sent out these emails that were very elaborate… I probably put way too much time into it… It wasn’t a waste of time though because I was selling it. I was trying to convince people… And a lot of the skills I honed on that and got feedback… I think I still use in my proposal writing. I really think that that was good practice. [William, Interview 1]

In addition to his research and service, William engaged in teaching assistantships throughout his time in graduate school because he enjoyed teaching and knew that the experience would be good for future job applications. His first semester in graduate school he also took a pedagogy course designed specifically for graduate students in astronomy. He said that this was the only training he and his cohort received to become teaching assistants, “which is more than a lot of students get” [William, Interview 1]. He seemed almost amused as he recounted his first year of teaching as a graduate student:

I had no idea what I was doing. The first semester they just throw you in. I mean it’s crazy. It’s like you’ve been there two days, and you have your first section… So you’ve been there just as long as the freshmen have been there, and you’re supposed to start going over homework with them…that very first week. [William, Interview 1]
After graduating with his PhD, William spent approximately a year and a half as a postdoctoral researcher working for his graduate school advisor and then moved on to a postdoctoral research position at a private, RU/VH institution where he worked for a year and a half. During this second postdoctoral position, William described learning a lot about the details of doing astronomy: how to be shrewd about getting proposals accepted, how the money works, how money flows, what overhead is, and the things like that that I had no exposure to [as a graduate student]. [William, Interview 1]

This professional development is something that William currently tries to pass on to his own graduate students by presenting similar topics during weekly group meetings: “learning a new computer language…how do you get Hubble space telescope time…how do you make a good conference poster…the stuff you actually spend most of your time on” [William, Interview 2].

During his time in graduate school, William met Karen (pseudonym), who he married shortly after graduation. As will be discussed below, William’s relationship with his family played a significant role in the way he chose to apply for jobs after graduate school and continues to influence the way William manages his time as a professor now. When William described the process of applying for jobs after graduate school, he explained:

The two body issue guided everything. The only reason we stayed in [my graduate institution] and I stayed there as a postdoc working with my advisor was because Karen was [there] and there was money for me to do a job I knew how to do well. And the only reason we went to [another city] is because we both had
jobs there, and it was a step forward for both of us… And then [this job was] obviously a step forward to a permanent position where we both could be happy and so we took that. [William, Interview 1]

William is also more cognizant of his time management now that he has children. He explained that he chooses not to work between the hours of 4 PM and 7:30 PM because this time is reserved for his family. For this reason, William now manages his time in such a way that he does not engage in personal activities at work and only works at home after the children have gone to bed when it is absolutely necessary.

As for his current job responsibilities, William explains that he primarily engages in research, teaching, service, and interaction with the greater community of astronomical researchers:

I advise students and postdocs and research associates. I teach, and I do some service for the department sometimes, the college or university. Advising students is most of the research I do, but I do some research on my own… I also collaborate with other people and interact with the rest of the astronomical community… I think that hits all the main pillars of what I do. [William, Interview 2]

As will be described in detail below, William’s research program is the cornerstone of his professional life, and his identity as a researcher can be seen in all aspects of his career.

I spent 14.5 hours with William during this study, spread over 30 weeks. I observed William teaching graduate level astronomy four times and engaging in meetings with his research students four times, for a total of roughly 8.5 hours. I conducted three
phenomenological interviews with William, totaling 4.5 hours, and one follow-up interview which lasted approximately an hour and a half.

Themes

My analysis of William’s case (as described in Chapter 3) uncovered four major themes that occur throughout William’s professional life: researcher, community, family, and tenure. During my member-checking interview with William, he verified that these themes seem reasonable to him, and he did not feel that I was missing any themes that are important to understanding the way he experiences his job. Full descriptions of each theme with supporting evidence from my interviews, observations, and document analysis associated with William’s case are presented here.

Researcher

William’s personal and professional identities are closely aligned in that he sees himself as a researcher, particularly an astronomer. When I asked him how he came to be an astronomer, he explained:

I want to figure things out about the universe… I appreciated there are questions about the universe you are trying to answer, and you’re trying to gather evidence… on how the universe works. It’s not about counting stars and naming things… I like to say I always knew I wanted to be an astronomer, but I didn’t know what that meant, and so it’s a good thing that it turns out I like it and I’m
good at it. I got lucky in that I like it, I’m good at it, and I always wanted to do it. And that’s getting dealt a straight flush. [William, Interview 1]

When I asked William what he tells people when they ask him what he does for a living, he replied, “I tell them I’m an astronomer” [William, Interview 3]. Later, he further explained:

There’s an identity to it. There’s your job, and there’s how you perceive yourself. And so I mean an out of work astronomer is still an astronomer… Once you get your degree you’re an astronomer forever because you hold that degree. You’ve contributed to the field in an important way. [William, Interview 3]

Furthermore, William explicitly distinguishes his role as a researcher from his role as a teacher: “I have almost no training in teaching. I haven’t spent years of my life learning to be good at it. It’s definitely a profession and not an identity for me” [William, Interview 3].

William’s focus on research is evident throughout his academic and professional history; he knew he wanted to be an astronomer from the time he was in high school, and he crafted his experiences to prepare him to be a researcher. He explained:

I didn’t know what the life of a professional astronomer looks like. I had no idea. But I liked science, and I especially liked astronomy in particular, and I thought I’d be good at it. So in high school I took AP physics so that I could get ahead in physics in college and be a better astronomy major. [William, Interview 1]

I asked William how he knew he wanted to be an astronomer if he didn’t know what the career was like, and he replied, “I mean you read the kids’ science books and it
says, ‘Astronomers know that…’ And there it is, that’s the job I want. I want that job”
[William, Interview 1].

As an undergraduate, William majored in both physics and astronomy and engaged in research in order to prepare himself for graduate school in astronomy. When he applied to graduate schools, he looked for institutions that were “the best” [William, Interview 1] in producing research astronomers and providing supportive learning atmospheres. He explained that he chose his graduate institution because:

[It] seemed like a good place to go to school. It’s [a] very well-regarded, [high-ranking] department. It seemed like a really nice place to live. It seemed like a friendly and loose department. Other departments I visited…didn’t seem like the students were having fun. It didn’t seem like they enjoyed doing the science there.
[William, Interview 1]

As will be described later, William truly enjoyed the social aspects of his time in graduate school, but he also emphasized that as a graduate student he was well-trained and highly productive as a researcher:

[My classmates and I] were all really driven to learn lots of astronomy. We spent a lot of time together socially, but we also spent a lot of time together learning astronomy in our various fields, and so that was a very good environment to learn astronomy, how to do astronomy. We always bounced research questions off each other and tried to figure things out amongst each other. [William, Interview 1]

William’s years as a postdoctoral researcher were similarly characterized by research productivity but were also punctuated by training in how to lead a research group:
[My postdoctoral advisor] taught me a lot about how to be – a lot about the details of doing astronomy: how to be shrewd about getting proposals accepted, how the money works, how money flows, what overhead is, and the things like that that I had no exposure to [as a graduate student]. [William, Interview 1]

When I asked William how he knew he was ready to move from his job as a postdoctoral researcher to a faculty member, he explained:

It was kind of happenstance… I was following sort of the standard, most common route. And the opportunities that presented themselves [my wife and I] took.

There are too few jobs in astronomy to get your heart set on a particular path. You have to be willing to go where the job is… I wanted to do research astronomy… What I didn’t want to do is work at a largely teaching institution where I had very little time for research. [William, Interview 1]

As William talked about his current job responsibilities, his role as a researcher was the most significant component of his daily activities. However, he explained that at this point in his career, being a researcher has started to be more about meeting and training his group than about doing the actual research himself. He described the transition from graduate student to research professor:

When you’re a graduate student, you do all the heavy lifting yourself and do most of the research yourself. Then when you’re a postdoc you start to sort of transition. You’re doing a lot of work, but there’s opportunity to work with students and be more collaborative, to offload more of what you’re doing to other people, because maybe you’re part of a bigger group… But once you’re a faculty member, you start to shift into more of a managerial position, and you’re showing
other people how to do research, and you do much less yourself. So there are weeks where I don’t do any research… It’s just 100% management. [William, Interview 2]

In our follow-up interview, I asked William if this transition to management meant that he felt like less of a scientist and more of a manager. He explained that he is just as much an astronomer now as he ever was; becoming more managerial is just the natural progression of a research professor’s career. In our second interview, William described his daily activities and how they relate to the work of a scientist:

So instead of observing at the telescope, I’m writing proposals for my students to observe at the telescope. Instead of actually writing a paper, I’m telling them how to write up a paper. I’m writing proposals for funding to fund the students and make sure that they can do the work that I’d like them to do. Most of the heavy lifting is now done by my students and in some cases for the postdocs, they are advising students, and so I’m two steps removed from the advising going on and the research going on. I try to, especially in the summer, get a little bit of research done on my own… I enjoy that. But yeah, for the most part the research happens with the students.

Later, he reiterated this management role:

You move up, you get more and more managerial as you get more senior. You do less and less hands-on research, and there become more and more layers between you and people. So already I have advisees who have advisees… That’s what it means to move up the ladder. [William, Interview 2]
Similarly, William conceptualizes his success as a closely tied to his students’ success. When I asked him if he sees himself as being good at his job, he said:

In my field, I think I do now. I do now because the objective metrics say so. [This institution] is [highly rated] in my field, and I know my department appreciates having me here and considers me a big asset. My H index\(^{15}\), the fact that I write and my group write proposals for highly competitive programs…and our success rate is [very high] means that we’re doing really good science the community appreciates. So yeah I think my group is – my group – I’ve done a good job of attracting outstanding people, and so my output – when you’re research faculty most of your work is managerial. I don’t do a lot of data analysis anymore. I tell other people to go do it. And as a result they write good papers. My group is doing really good work… And so yeah I think, especially because of my group around me, that my group is one of the top groups in [my field]. [William, Interview 1]

Even though William’s responsibilities as a researcher have become more managerial as his career has progressed, he does still take time to engage in research on his own:

Sometimes I get a problem that interests me, but sometimes I’ll give it to a student to fiddle with, and sometimes I will take it myself… I typically have one thing I’m fiddling around with, and it goes slowly because I don’t have a lot of time to do it, but there’s usually one paper I’m writing… Usually it involves data

\(^{15}\) The H index is a research output metric. The index h is "defined as the number of papers with citation number ≥ h" (Hirsch, 2005). A high H index indicates that a researcher has published a large number of highly-cited papers.
analysis, or a lot of literature search, reading a lot of papers and putting things
together and trying to figure out where we are on something. And sometimes
those turn into projects for students, sometimes those turn into papers that I
publish on my own. [William, Interview 2]

William’s identity is so tied to his profession that when I asked him what job he
would be doing if he weren’t an astronomy professor, he had trouble coming up with an
answer. When I described this researcher theme to him in our follow-up interview, he
seemed almost amused and said that he wasn’t aware of this before but is “now that you
say it” [William, Interview 4]. Because this researcher theme is so prevalent in William’s
life, it can be seen throughout all of the other themes as well as the discussion of the
research questions below.

**Community**

During my first interview with William, I asked him to describe the work of a
research astronomer in graduate school. From his description, I formed an initial
impression that astronomy is isolated and individualized work:

> You sit in front of your computer, reduce the data, or work in the field – as in get
> on a plane, go to the telescope. You’re up all night, for three nights in a row or
> something like that, and you fly back, adjust your schedule for a day… Then you
> just continue to do something at your computer, so you sit in your office in front
> of your computer, and you reduce the data, and you figure out the data, and you
> print out plots, and you take them to your advisor, show them the plots and they
make suggestions, and then go back and you try that again. And eventually you have enough plots that these plots are the plots of a paper. And then you publish the paper. [William, Interview 1]

However, as I spent more time with William, I realized that for him astronomy really is a social endeavor. As he explained other aspects of graduate school life, he emphasized the almost familial atmosphere of his department:

The…grad students don’t really distinguish between work hours and personal hours. There’s always someone in the building… There was a lot of personal time at work. It was a very loose environment. But then, because you sort of lived in the office, you were there all the time, you were getting a lot of work done… You’d stop because someone would come by and say, “Want to go to dinner?” “All right we’ll stop for dinner,” and you go to do an hour for dinner and you come back and finish up what you were working on and then take the midnight bus home or something. The days were sort of structured around what your office mates and your fellow grad students were doing. Maybe they plan a baseball game to go see or do something, and it wasn’t so much a 9-to-5 thing. [William, Interview 1]

He further explained that a great deal of this familial atmosphere was due to his incoming class happening to get along together, although some students who were not in his cohort were also part of his social circle:

Sometimes students, a class, really gels, and they spend a lot of time together all the time. And that was my class. If we went out to go get beers, we went out with each other to go get beers. That was what we did. And then other classes didn’t
gel at all, and they were very fragmented and they hung out with the older students for the younger students or no students at all and have their own social lives. It just depends on the personalities of the cohort. [William, Interview 1]

Since William spent time as a postdoctoral researcher at the same institution where he attended graduate school, the social component of his work continued.

Laughing, he recounted:

And when I became a postdoc, I ended up attending a lot of the postdoc functions – the Friday lunch, which evolved from just the postdocs getting to know each other at lunch into a drinking lunch into Friday’s over at noon. The postdocs my final year had a reputation, but it depends on the cohort. [William, Interview 1]

As described earlier, the familial atmosphere William experienced during his graduate school years was not purely social. William and his colleagues assisted each other and learning how to become astronomers:

[My classmates and I] were all really driven to learn lots of astronomy. We spent a lot of time together socially, but we also spent a lot of time together learning astronomy in our various fields, and so that was a very good environment to learn astronomy, how to do astronomy. We always bounced research questions off each other and tried to figure things out amongst each other. [William, Interview 1]

Even with respect to research productivity and daily schedules, William remarked, “The faculty almost never came [to our offices]… There was very little supervision… The expectations were set by our peers” [William, Interview 1].

In addition to research activities, William and his classmates participated in service efforts such as buying food for colloquium and hosting prospective graduate
students. William even described these activities as “chores, department chores” [William, Interview 1], a direct reference to his familial feeling about his graduate school experiences. He explained that together, he and his classmates enjoyed their service work and that some of the work they did prepared him for some of the aspects of his current position:

We took that very seriously. We had a lot of fun with it. We had themes and sent out these emails that were very elaborate… I probably put way too much time into it… It wasn’t a waste of time though because I was selling it. I was trying to convince people… And a lot of the skills I honed on that and got feedback… I think I still use in my proposal writing. I really think that that was good practice. [William, Interview 1]

William’s connection to the research community has continued throughout his career. When I first asked him to describe the responsibilities of his current position, he talked about research, teaching, and service, but he included, “I also collaborate with other people and interact with the rest of the astronomical community” [William, Interview 2]. William uses social media and electronic communication to stay in touch with his colleagues:

Social media has helped. There’s an astronomers’ Facebook page. There’s a lot of astronomers on twitter, and a lot of people subscribe to your post on RSS feed or something like that and see it that way. And then we crosspost some things… Having an online presence really helps… You know, you don’t have to be a blogger, but you do have to have a page with a link to your CV and email address,
and things should be no more than six months old. So that’s something I think about. [William, Interview 2]

Later, he explained that the community of astronomy researchers is small enough that most people know each other, at least through mutual acquaintances:

If someone said, “I’m an astronomer too,”… If someone says that, the thing to do is to figure out what the connection is because it’s a small field that we’re in. It’s very small, and so if someone else is an astronomer you almost certainly have common colleagues you both know. It’s like being at a family reunion or something. You find the connection, and you figure it out, and you talk about the people you have in common. [William, Interview 3]

In the same interview, William added, “Or someone even more commonly will say, ‘Oh I know an astronomer. Do you know so-and-so?’… And that’s very reasonable to try to figure out who they are and whether you might know them… I’ve had that conversation for sure.” William further explained that this tightknit community helps decrease attrition from astronomy: “The younger generation of astronomers at conferences have made sure that everybody knows all the younger people coming up through the ranks and are just plugged in and know that no one’s getting lost” [William, Interview 3].

This community theme extends to the way William interacts with his own research group. He told me that for his group meetings:

I try to find professional development items that we can discuss and just provide a sense of community to the group so that they are comfortable working with each
other and asking each other for help on things. And then I try to meet with them each once a week for an hour when they need it. [William, Interview 2]

Later, he further explained why he wishes to foster a sense of community among the members of his research group:

Part of this is I want them to be able to ask each other questions, to offload some of the work. Part of it is that collaboration is important, to be able to work with other scientists and have your strengths complement each other, work together…

My grad school experience, there was a lot of community in my office, or among my year and even the younger years. And that created a really fertile environment for thinking of ideas and learning things, and so I guess maybe that’s part of it. So then we have that environment. [William, Interview 2]

William’s respect for his group members is evident as he explained that he often gives them the opportunity to run group meeting and quipped, “It’s not always me getting in the way” [William, Interview 2]. During my own observations of William’s meetings with his research group, I noticed that the atmosphere was in fact friendly, laid back, and collegial. The group members commonly expressed delight (smiling, laughing) while discussing research as well as professional development topics such as job applications and astronomy news.

Finally, William’s respect for his community can be seen in the way he talks about service commitments. William is not only involved in several service committees on his own campus, but he emphasized that he takes his service work very seriously with respect to the greater community of astronomy researchers:
There’s professional service. A colleague needs a letter for their tenure packet, or one of the big ones is a journal will send you an article and say, “Please referee the paper.” And I try to referee at least as many articles as I appear on, so I try to do a good job. I referee more than I write because I take it seriously, and I think it’s important. And every time I get a bad referee’s report I commit myself to writing a good one. [William laughs.]… It’s sort of giving blood or voting. It’s this thing you gotta do for the field. [William, Interview 2]

It is evident that the themes of research and community are closely related and prominent throughout William’s depiction of his past and current academic and professional experiences. These themes will be revisited later as I address the research questions for William’s case.

**Family**

Throughout our interviews, William made frequent references to his family and his home life. The family theme is evident in William’s career in two distinct ways: he has made large career decisions such as where to work and when to apply for jobs based on efforts to maximize his and his wife’s career opportunity simultaneously, and he manages his time such a way that he maintains commitments to his home life.

As William progressed from a graduate student to a professor, his wife Karen was also on a parallel academic career track. They met in graduate school, and Karen now holds a job in the same city as William. William described the process of applying for jobs throughout this process:
The two body issue guided everything. The only reason we stayed in [my graduate institution] and I stayed there as a postdoc working with my advisor was because Karen was [there] and there was money for me to do a job I knew how to do well. And the only reason we went to [another city] is because we both had jobs there, and it was a step forward for both of us… And then [this job was] obviously a step forward to a permanent position where we both could be happy and so we took that. [William, Interview 1]

In the same interview, William went on to describe that at one point he did receive a prize fellowship to work in yet another city, but that Karen did not have a position secured there yet:

We could’ve made a leap of faith, and could’ve taken that prize fellowship, and then Karen could have scrambled to try to find something in [that city], but we decided not to. We decided that we were fine where we were. We were both progressing. There was no need to make that jump. And so we stuck around, and a few months later…we got the job here – the jobs here.

In fact, throughout our first interview, as William described the process of applying for various jobs, he consistently used the pronoun “we”:

- We spent about half a year after she finished up.
- It was driving distance so we could go visit.
- We each put in job applications.
- We applied.
- The opportunities that presented themselves we took.
- The only reason we left is we both found a job somewhere.
William also talked about his family when we discussed his daily schedule, both in the past and in the present. As mentioned previously, William and his colleagues in graduate school did not keep a 9-to-5 schedule, but he explained, “Things got a little more regular when Karen and I moved in together. We’d leave together at six or seven or something like that and then probably headed in together at nine or 10 or something” [William, Interview 1]. This modification of his schedule for his family continued after he became a professor and had children:

And then when I got here, it wasn’t long before we had a kid, and the kid really, really fixes your daily schedule… I wasn’t working from home anymore, and once I stopped working from home I felt like the hours [at work] had to be super productive, and that has worked. I do very little personal stuff at work since she was born. And I take very little work home. Only when things really pile up do I work from home now…when the kids are in bed basically. [William, Interview 1]

When I asked William if he doesn’t work at home because he can’t or because he won’t, he explained:

I don’t think there’s a distinction. I mean, if I had to, like if I have a telecom that goes till 5… But if I really have to do that, Karen and I can work it out and she’ll handle it. But she knows that I’ll do everything I can to avoid that, and I know that it is a hardship on her to deal with it all because she’s leaving earlier and…we’ve designed our evenings such that we rely on each other… By evenings I mean 4:30 to 7. And so between 4:30 and 7, I’ve made the choice that that will be time where I’m completely occupied. So I can’t work on work then by choice. [William, Interview 2]
Furthermore, William limits his travel schedule because of his family commitments. For example, he explained that he is “not highly motivated to get a full professorship” [William, Interview 2] because it would require him to achieve international stature. He further explained, “International stature means a lot of travel to Europe, and my kids are young, and that’s just not something we really want to do right now” [William, Interview 2].

In our follow-up interview, when I described this theme to William, he explained that work life balance is something that is often discussed amongst astronomy researchers. He recounted a time that one of his graduate students came to him to say that she was pregnant but that her pregnancy would not interfere with her productivity in anyway. He said that he explained to her that having a child would affect her productivity, but that it would be okay. Finally, William told me that the extent to which family life plays a role in one’s professional choices is largely dependent upon one’s specific institutional culture. He said that the field of astronomy emphasizes the importance of productivity, but the departmental culture at Large University has supported his prioritization of his family.

Tenure

Because William had just applied for tenure before our data collection commenced, I was not surprised to find that several of our conversations turn to this topic. It was typical for William to relate work issues to his tenure application. For
example, when I asked him to explain what an H index was, he described its role in the tenure application process:

Certainly when you go for tenure, you have to find your H index and put it in your packet. You’re selling yourself to the university. There’s a section that says include your citation analysis here, so when you go for tenure you definitely know what your H index is. [William, Interview 1]

There were also multiple instances during our first interview where William made it clear that having a tenure line faculty position was a highly sought after goal amongst his colleagues:

- [My classmates and I] all did very well… The last of us just got a permanent faculty, tenure line faculty job.
- [My graduate institution] is one of the schools that produces tenure line faculty… And so, I don’t know, it works, whatever [the school] does.
- After five or six years [of working as a postdoc] the writing’s usually on the wall that you’re not gonna get a tenure line job. So then you have to decide whether you want to transition into a soft money researcher and give up on the tenure line track or find some other permanent position like a staff astronomer somewhere, which doesn’t come with tenure necessarily or if you want to leave the field and go to Wall Street and make real money or something like that.
- Most tenure line jobs want to see a postdoc away from your advisor on your CV… So for both of us it was a step forward.
When I asked him how the tenure process works, William explained his department’s tenure application process in great detail:

They do reviews, second year, fourth year – other places only do a third year review… It’s sort of a mini tenure dossier. Most of the big components are there… It’s divided into three sections: teaching, research, and service. And the department and the college review it and they give you feedback and tell you what you need to work on basically… And then there’s a process for deciding who’s going to write letters for you. It has to be disinterested parties, not collaborators. It has to be distinguished scientists intimately familiar with your work that you’ve never worked with. [William laughs.]… And those are the most important things. That is what the college will use to decide whether you are sufficiently distinguished in your field that they want to take you on with a lifetime contract. There are other things that can break the deal, but without those letters you can’t really, you know, if your colleagues don’t think you’re leading then the university will find someone else that is. Service and teaching, there’s a lot of lip service paid to it, but it’s kind of a threshold thing. As long as you’re competent, as long as you’re not embarrassing anybody, you’re fine. It’s not going to make or break anything. [William, Interview 2]

He further reflected:

There’s a cynical angle that says it’s all money, it’s just how much money you brought in. And the university tries really hard to make that not true… Now it’s hard to advise a lot of students and get a lot of papers out if you’re not funding the students, so it’s in there indirectly. But they want to see you active on all those
fronts… They want to see people that are clearly accelerating… They need to see a lot of growth, and they want to know that after you get tenure you’re going to continue to climb the ladder. [William, Interview 2]

To this end, William explained that his department was supportive of him furthering his research while he was working towards achieving tenure. They did this by minimizing his teaching and service commitments:

They protect the junior faculty. The pre-tenure faculty are busy earning tenure, so my department head was just very conscientious of not giving me too many new teaching assignments and not overloading me with committees and asking how things are going and making sure. But now that I have tenure you know they’re not gonna protect my time anymore when I’m supposed to be a fully contributing member. [William, Interview 2]

Later, when I asked him if his goals were in alignment with the university’s goals for his research, he responded:

I think they’re well aligned. I think they were pretty clear. Especially just coming from tenure, I have a good sense of what they appreciate. The university wants to see me having an active research group, publishing papers, graduating students, and getting citations. The university wants to see me bringing in grant money and supporting people, but they try not to make that a quantitative metric bar you have to clear. [William, Interview 3]

This concept is of particular interest because it indicates that William does not engage in his research activities in order to satisfy tenure requirements. Rather, his
intrinsic desire to build a successful research program is in alignment with the university’s tenure metrics.

Because of the focus on research activities for the tenure process, the research theme is again evident throughout the tenure theme for William’s career. The connection between the tenure theme and the community and family themes are seen more clearly as William talked about the next steps after tenure:

The promotion to full professor has a higher service expectation, and you’re expected to have higher visibility, so international stature… I was highly motivated to get tenure. I’m not highly motivated to get a full professorship… Because international stature means a lot of travel to Europe, and my kids are young, and that’s just not something we really want to do right now. [William, Interview 2]

**Research questions**

I have utilized the themes identified above as well as other supporting information from interviews, observations, and documents to answer the project’s research questions for William’s specific case. These questions are

- What is the relationship between teaching and research roles for William?
- What types of activities and experiences (particularly professional development) does William engage in to support his role as a teacher? Conversely, what types of activities and experiences impede his role as a teacher? In what ways do these activities support or impede his role as a teacher?
• What connections might be made between William’s personal, cultural, and professional histories and the way he is currently experiencing the relationship between teaching and research?

**The relationship between teaching and research**

What is the relationship between teaching and research roles for William? As described previously, William strongly identifies both personally and professionally with his role as a researcher but not with his role as a teacher. However, he does utilize his knowledge as a researcher to help him with some components of his teaching. Furthermore, he views some elements of his mentorship of his graduate students as teaching. For these reasons, I describe the relationship between teaching and research roles for William as loosely complementary.

When I asked William how his research and teaching related to each other, he responded by describing the relationship as it was situated within each class that he teaches. This is consistent with William’s situated views on appropriate teaching strategies: “There is no best way to teach (though there are many poor ways!). The particular class, students, and goals and aptitude of the instructor should guide the methods and style of a course” [William, Teaching Statement]. William has taught three different courses at Large University, and he explained how his experience as a researcher is related to each one. First, he described a general astronomy course (which is not intended for astronomy majors), explaining that it is unrelated to his role as a researcher:
The requirements to teach [general astronomy] at this university – well actually I think it’s just a master’s degree… It doesn’t require a deep expertise in the material because you are teaching the material at a very low level… You want someone with some degree and some background in it, but you’re not actually drawing on their expertise. Well you can. Some people make a point of having lengthy sections on the topic they know very very well, and the students sometimes appreciate learning about a topic from someone who is at the forefront of that field. I don’t do that though. Well, it’s my own spin, but I don’t focus on my research component when I teach it. [William, Interview 3]

Next, William explained that being an astronomy professor is related to some aspects of the seminar course he teaches for first year astronomy majors: “I have a lot more credibility talking about jobs in astronomy being a professor” [William, Interview 3]. However, this seminar seems to be more about informing students about the astronomy major in William’s department than anything else:

Explaining a lot about the major and making sure they go into [the core classes] with their eyes open, knowing what to expect, and make sure they’re aware of [their options], make sure they understand how much physics can be involved, and so my hope is that the attrition may get out of… the seminar is informed attrition, people that would’ve dropped out anyway, they just learned right away that this wasn’t what they thought it was. And I hope that we also bring people in and you know that were maybe on the fence and they say yes this is what I want to do, so I’m hoping it makes for more informed set of students. [William, Interview 3]
Finally, William described the relationship between research and teaching the graduate level course that he teaches:

They are tightly related. I’m teaching the course because it’s something I did research [on], and we talk about the latest papers in the subject. And there, that course is about training researchers, so they need to know why what they are learning is relevant to the jobs that they hope to have with a PhD in astronomy. Because the PhD is geared toward research astronomy, so that’s what we focus on. [William, Interview 3]

Later, he explained that he teaches the students in the graduate course to use a program that is actually used by astronomy researchers. Furthermore, he teaches his students to use the tool in the same way researchers do:

People who use it write papers based on the output of that code for various scenarios, and [the students] had to do a toy problem with it and try something. And we didn’t know where it was going to go. I had never run it in the ways that the students were running it. I didn’t know what it would do. We didn’t know if it would crash. And they had to find out, and they had to interrogate it and tell me if it worked or not. And those are the sorts of tasks that I would give a graduate student researcher. Explain those problems. [William, Interview 3]

In his teaching statement, William reiterated the sentiments he expressed about his graduate course during our interviews:

Graduate students are almost uniformly highly intelligent, motivated learners that are capable [of] completing broadly defined assignments with minimal guidance and handholding… I have recast the homework sets as a practical application of
useful research methods… I also wished to be sure that all students left the course with useful professional skills no matter their ultimate research area… Each student also prepared a lecture on a specialized topic of their choice… This develops and tests the students on these professional skills and allows them to find a connection between the course material and their own research interests. When I asked William if there is a relationship between the way he approaches his teaching and his research, he made a connection to the way he teaches his research students:

I guess so. Not explicit, but when I am working with my students, which is how I do most of my research, we talk about the research problem and how to attack it and will step back and think about the physics behind it and what we’re doing. And that’s similar to the approach in the class where I’ll ask them about what we’re doing and try and get an intuition of what we’re working on and connect it to things, so implicitly they’re similar in that way. [William, Interview 3]

William only expressed a tension between his teaching and research activities as those responsibilities both require him to spend his limited time resources on them. For example, he described his summer schedule:

Summertime is better. I tend to have more time on the whole because no teaching. Like this last fall was dead because I had to do new class prep, that just eats up all the time, so I got very little advanced on [my own research project]. [William, Interview 2]

Furthermore, the culture of William’s astronomy department seems to support the allocation of time resources to research activities over teaching activities:
The justification of the teaching relief is that you’re really busy doing research, and you don’t have time to do all that teaching… They don’t need you to be doing the teaching, then they want you to be doing research instead. [William, Interview 2]

Given all of these remarks, it is evident that William feels that his research and teaching are much more closely related as the level of the course increases. He does not see clear connections between his research and teaching until he reaches graduate level courses and interactions with his research students. He does not ever indicate that research and teaching are oppositional activities (except in the case of time management). For these reasons, I have characterized the relationship between teaching and research for William to be loosely complementary.

### Supporting and impeding activities and experiences

What types of activities and experiences (particularly professional development) does William engage in to support his role as a teacher? Conversely, what types of activities and experiences impede his role as a teacher? In what ways do these activities support or impede his role as a teacher? Given William’s a strong connection to his identity as a researcher, I was not surprised to find that most of his comments about professional development were centered around that component of his job rather than teaching. As described previously, William felt that his time as a postdoctoral researcher was highly beneficial to his professional development:
It was very good professional development. [My postdoctoral advisor] taught me a lot about how to be – a lot about the details of doing astronomy: how to be shrewd about getting proposals accepted, how the money works, how money flows, what overhead is, and the things like that that I had no exposure to [as a graduate student]. [William, Interview 1]

Similarly, William tries to foster professional development opportunities for his research students to help them become better professional astronomers.

With respect to teaching, William expressed that he has not experienced extensive professional development: “I have almost no training in teaching. So I haven’t spent years of my life learning to be good at it” [William, Interviewed 3]. The only formal training William spoke of was a pedagogy course that he took in graduate school:

We had to take a course in our first year… Which was just about pedagogy… We read an article on what makes teaching good, and it pointed out that a lot of people go into teaching because they really enjoyed being a student or they really enjoyed the thrill of learning stuff and they were good at being a student. And they become a teacher so that they can vicariously re-experience the thrill of learning really cool stuff. And they teach that way. They teach the students the stuff they remember learning and they remember maybe falsely because they were excited to learn it… And secondly most of our students aren’t us, was the other thing. Your students are not people that are going to go to astronomy grad school. In fact most of them aren’t even science majors. And a lot of them aren’t even interested in this topic, and so your experience as a student learning the stuff is totally different from theirs. And as a result if you teach as vicarious learning,
you might have a lot of fun but you’re not necessarily doing a good job. [William
laughs.] And that’s something I’ve become more in tuned to. [William, Interview
1]

Similarly, William described only one informal professional development activity
related to teaching that he currently engages in. He mentioned that his wife Karen teaches
a pedagogy course for scientists:

She thinks about these things all the time, and so I pick up a lot of the latest stuff
she’s working on just talking to her at home. And so I tried to think about whether
the way I teach is consistent with those best practices or not. [William, Interview
2]

Throughout our time together William did not describe any experiences that
impede his role as a teacher. Though time management always plays a role in that both
teaching and research draw upon his limited time resources, he did not express this as an
impediment to his ability to teach effectively.

**Personal, cultural, and professional history**

What connections might be made between William’s personal, cultural, and
professional histories and the way he is currently experiencing the relationship between
teaching and research? During our time together, William did not discuss his personal
history at great length. It is difficult to know whether or not his family had any influence
on his decision to pursue science and become a researcher. He told me that his father
“works at a printshop,” and his mother “has some position at a clinical trials management
company, and I don’t know exactly what it is” [William, Interview 1]. As mentioned previously, when I asked William what interested him in astronomy, he made references to popular culture and science textbooks: “Discovery Channel, you know… I mean you read the kids’ science books and it says, ‘Astronomers know that…’ And there it is, that’s the job I want. I want that job” [William, Interview 1].

As William described his professional history, there was always an emphasis on research rather than teaching, and this has continued in his current professional life. For example, in graduate school, William enjoyed close relationships with the colleagues in his cohort as they were all driven to learn more about astronomy and produce high-quality research:

We spent a lot of time together socially, but we also spent a lot of time together learning astronomy in our various fields, and so that was a very good environment to learn astronomy, how to do astronomy. We always bounced research questions off each other and tried to figure things out amongst each other. [William, Interview 1]

Additionally, the cultural expectations William learned in graduate school have also extended to the way he interacts with his colleagues and graduate students today. For example, William described that his graduate advisor tailored his mentorship style for various students:

For instance one of his students met with him regularly, at least once a week, more often usually to see how progress was going. And sometimes three weeks would go by before my advisor sort of wandered into the office… let me know
what’s going on, and we talk about progress or lack thereof. [William Interview 1]

Later, William described a similar variation in his own students’ work habits:
One [student] works in fits and starts. He’ll go a long time and I don’t see any progress… But his mean production is fine because when he does work he’s extremely efficient and he gets a lot done in a very short amount of time, so that’s fine. I’ve had students who just don’t seem to make progress… Some people work really efficiently and spend a lot of time in the office, and some people have personal things and can’t do as much. So within that window I try to say this isn’t enough or that’s not realistic… But ultimately they are students… I’m not really their boss… I try not to be a high-pressure advisor that makes them feel like – well, I try to be supportive. And I try not to advise negatively. [William, Interview 2]

The only mention of teaching in William’s professional history was his experience as a TA in graduate school and the connected pedagogy course he took his first year there. He said that at that time he learned that teaching was not just an activity one engaged in for fun:

I guess I knew intellectually but it took me a while to learn. Just because you’re enjoying it doesn’t mean you’re good at it. [William laughs] And so I think I mostly did it because I enjoyed it and I got good reviews, so I enjoyed being on stage and all that. [William, Interview 1]

William continues to approach his teaching as an activity he enjoys; he seeks to earn positive student feedback while increasing his incorporation of research-based
teaching methods: “I have aspirations towards much more active learning, but I am still primarily lecture based with healthy amounts of discussion” [William, Teaching Statement].

It is evident that William’s past experiences have primarily supported him to develop the research rather than the teaching components of his career. Given the extensive data presented above regarding William’s strong connection to his identity as a researcher, I concluded that his emphasis on research is less a product of his professional and cultural experiences and more an intrinsic drive that happens to be in alignment with those experiences. When I presented this conclusion to William during our follow-up interview, he indicated that he agreed with me to an extent but emphasized that departmental culture does play a role in some of his decisions, particularly with respect to work-related travel and service obligations. However, he agreed that, in alignment with his own professional goals, “the university values excellence in research…and adequate to good teaching and service” [William, Interview 4].

Case 4: Pierre

Pierre (pseudonym) describes himself as an early career interdisciplinary scientist whose research is a combination of laboratory and international fieldwork. He identifies himself as being a white male in his mid to late 30s. During the course of this study, Pierre was in his fourth year of teaching at Large University and was therefore not yet eligible to apply for tenure, though he is on the tenure track. Because of Pierre’s unique combination of fields of study, I will only refer to these fields as a humanities and a
biological science. It is important to note that Pierre more closely identifies with his humanities field that he does with his biological science: “Although [a biological science tool] is my primary research tool, I consider myself a [humanities researcher] rather than a [biological scientist], which I hope is apparent from my research approach” [Pierre, Document 02]¹⁶. Thus, throughout this case description, when I refer to Pierre’s field of study it should be assumed that I’m referring to his humanities specialization. Pierre is an assistant professor in both of these departments and advises graduate students from multiple disciplines.

As an undergraduate student at a medium-sized, RU/H¹⁷ institution, Pierre explained that he began his studies as an undecided major before switching to his humanities field:

I had no idea what I wanted to major in, the too typical case for people who get really excited about [my field]. I had never heard of it, and I took an introductory class. I was taking lots of introductory classes… And I was like, “This is just amazing.” I was so excited about it, majored in it, did honors thesis, did some research and so on. [Pierre, Interview 1]

Although Pierre was excited about research in his field, he decided to take a break from academia to work in a corporate job before attending grad school:

As an undergrad I did some research and got experience. I was like, “I think this is what I want to do for my career.” But I wasn’t ready to do it yet. I wasn’t ready

¹⁶ Documents associated with Pierre's case have been labeled with a generic numbering scheme instead of more specific identifiers as in other cases. This has been done to address a specific confidentiality concern unique to Pierre's case.

¹⁷ RU/H is the Carnegie classification for Research University (high research activity). For more information, see http://carnegieclassifications.iu.edu/.
to go to graduate school. I wanted some other experience first, and so I had a plan
even as a senior to work at another job for a couple of years and then go to
graduate school. [Pierre, Interview 1]

He worked as a consultant for three years and described the position as a “great
job, really challenging, worked with great people in a much more teamwork-oriented
environment than what you find in academia” [Pierre, Interview 1]. Finally, Pierre
decided to go to graduate school because “in the end it was about making money for
whatever company I was consulting for – giant amounts of money – and you know I
wasn’t passionate about that” [Pierre, Interview 1]. Pierre’s passion for his research
program is a theme that will be discussed in greater detail below.

Pierre began graduate school highly driven and motivated to succeed. Unlike most
students in his field, he initiated research during his first year of study: “I [wanted] to
learn things in the lab, so then I practically did that rather than as kind of a requirement or
a standard” [Pierre, Interview 1]. He explained that “having that break, that real-world
experience, really helps [you] then be motivated and focused when you go to graduate
school” [Pierre, Interview 1]. Pierre began graduate school at a large, public, RU/VH
institution focusing on his humanities field. His first year of graduate work involved
taking many courses, and it was through this experience that Pierre discovered his interest
in the biological sciences:

In graduate school I took a [biological science] class… We were reading these
new papers, and I was like, “Okay, this is the tool. This is a powerful tool to
answer the [humanities] questions I’m interested in. So I switched to that. [Pierre,
Interview 1]
Once Pierre’s research interests changed, he decided to switch advisors. Shortly after this switch, his research advisor was hired at a new institution, and Pierre agreed to follow her there. After beginning his studies at this new institution (also a large, public, RU/VH university), Pierre became interested in designing a project that would require collaboration with a biological sciences researcher from another school:

I developed a proposal for a project, not my dissertation research at the time, although it became one of the chapters in my dissertation. And I wrote this guy because he had published a paper that had some results related to [the project], and I actually wanted some samples from him. [Pierre, Interview 1]

To Pierre’s surprise, the researcher not only wished to collaborate on this project, but offered to fund the research if Pierre was willing to travel to the researcher’s lab for the summer. This collaboration ended up lasting for two years of Pierre’s graduate studies:

I didn’t realize at the time that the real limiting factor in good research is people. I think that in that conversation he saw that it was at least worth taking a flyer on me… So I went out there for the summer project, and it went well… He then convinced me to change my dissertation research topic to something that would align with his lab and funded me then to come for two more years after that and do my dissertation out there. [Pierre, Interview 1]

Pierre acknowledged that even though his graduate advisor benefited from this collaboration, it was still a great sign of generosity and support for her to allow him to engage in the project:
I had a very hands off advisor, so I had to be creative and whatnot, but my advisor was super supportive and always said, “if you need to go somewhere to get experience or do work that I can’t offer you here, do it.”… A lot of advisors would’ve been like, especially for a productive student, “No, stay here.” But she did give up some potential things that I could’ve done in her lab for me to have that opportunity, and I really appreciate that. [Pierre, Interview 1]

Pierre also explained that he understands that the ability to take the opportunities that were afforded to him in graduate school were a unique privilege:

The value and flexibility of picking up and moving… Is really valuable… That flexibility was good, but I have to keep in mind now with my students, others, and so on, that there’s a certain level of privilege that affords that flexibility. Not everybody would’ve been able to float around, take advantage of those opportunities. [Pierre, Interview 1]

Pierre’s tendency to be aware of cultural issues will be described in more detail below.

After graduating with his PhD in his humanities field, Pierre decided to pursue a postdoctoral fellowship in his biological science of interest because he wanted to learn new skills in that area of research. He took a position at what he describes as a large, well-funded lab at a private, large, RU/VH institution. Pierre indicated that overall, he valued the experience he gained as a postdoc because it helped him build the foundation for his career as a research professor:

In some ways the postdoc was really good… There were just some outstanding people, not just in the lab but in the department to interact with. My postdoc
advisor supported me in some ways that were beneficial towards setting up the things that I wanted for my career: some studies, some papers, some experiments that weren’t really for the benefit of his lab but were explicitly for me to be able to go on the job market. [Pierre, Interview 1]

As will be described later, building a research career has been of the utmost importance for Pierre since he was an undergraduate, and he explained that his postdoc position played a vital role in his plan:

For a job at this level or something close to it, I think a postdoc is a necessity… The extra time to have that process marinade that you can then implement and put in and set up something so that you hit the ground a little more running rather than starting out your one year developing your classes and all this stuff… That postdoc experience is perceived as important by a lot of funding agencies, having the time for your papers to come out, stuff like that you need to have happen in those six years of pre-tenure. The experience of a postdoc, the additional papers, the time for your papers in your dissertation to come out, the time for your thought process on what you are going to do and how you formulate your research program to mature is also valuable. [Pierre, Interview 1]

During a period that started in the last few years of Pierre’s graduate school experience and lasted into his postdoctoral fellowship, Pierre described what I have identified as an emotional connection to his work. He explained that a combination of his intrinsic motivation and external influences drove him to take on more and more work as time went on:
I was super passionate about what I was doing. I think those external circumstances contributed to me getting into that habit… I had some confidence because I knew that I was doing pretty well, but you never know. You start realizing how rare these jobs are, etc.… But then some of those habits… You never know if it’s enough. You never know if it’s enough to get hired. You never know if you’re doing enough… And that sort of realization seeps in and becomes this stress that reinforces more work, but it gets too much. [Pierre, Interview 1]

Pierre’s emotional connection to his work will be discussed in greater detail below.

Pierre’s decision to work at Large University arose from an opportunity to receive a joint appointment in both of his fields of interest. He described his motivation for becoming a professor:

Just the passion for the questions. I always wanted to, from the time I got into [this field] no more. I have these questions, and doing science and being an academic and so on, that was the way to answer this question. And I really valued, I wanted to make a difference in people’s lives. I think that was the motivation, just thinking about making a difference in people's lives, and I saw teaching as a way to do that. And I wasn’t thinking at the time about outreach and so on, and now I’m thinking more and more about that, but teaching is a way to do that in a way that my professor had made a difference in my life. [Pierre, Interview 1]

I spent 15.5 hours with Pierre during this study, spread over 38 weeks. I observed Pierre teaching interdisciplinary humanities courses four times and engaging in meetings with his research students four times, for a total of roughly 9.5 hours. I conducted three
phenomenological interviews with Pierre, totaling 4.5 hours, and one follow-up interview which lasted approximately an hour and a half.

Themes

My analysis of Pierre’s case (as described in Chapter 3) uncovered four major themes that occur throughout William’s professional life: research, students as scientists, cultural awareness, and emotional connection. Full descriptions of each theme with supporting evidence from my interviews, observations, and document analysis associated with Pierre’s case are presented here.

Research

The main focus of Pierre’s career has always been developing a strong and sustainable research program. As described previously, his first interest in a scientific research career was developed as an undergraduate student: “As an undergrad I did some research and got experience. I was like, ‘I think this is what I want to do for my career’” [Pierre, Interview 1]. Pierre explained that he entered graduate school with a more focused vision than many of his peers due to his experience in his corporate job: “I had a lot of drive and motivation to get stuff done and to develop my record and develop my scientific ability” [Pierre, Interview 1]. Thus, from his first year in graduate school he began to develop an independent research project:
A lot of people would take those classes for four years and then afterwards start thinking about research and their research project and then develop a proposal and then apply for funding and then have to go through multiple rounds of funding before that will come through. A lot of people in front of me were taking 10 to 12 years, and this is a common problem in [my field]… I sort of saw what was important in terms of getting going in the research, saw from an early stage and started doing my own research projects in the lab and making sure that those were turning into publications and developing my dissertation project much earlier than a lot of my peers… I was putting as little time as possible into classes even though I had a fair amount of them. [Pierre, Interview 1]

Pierre’s independent research interests propelled him through a highly successful graduate school career. The highlight of his development as an independent scientist was exemplified as he described the project he proposed for collaboration with the biological scientist from a different institution. Pierre not only took the initiative to reach out to the scientist, but he also proposed a novel set of experiments that combined the scientist’s expertise with the specialization of Pierre’s field. Pierre explained that the ability to integrate multiple fields of scientific study drives his interest in research:

The beauty of [my field] is this integrative perspective and the depth of the integrative perspective, being able to take multiple levels of information – all science at its best does this, but it’s maybe more formalized here and more standard in [my field]… To integrate this knowledge and awareness and background to make stronger inferences or advances about something very complex. [Pierre, Interview 1]
Pierre’s focus on research throughout graduate school was so extensive that he did not even engage in a teaching assistantship at that time. The only concern Pierre had about not having a teaching assistantship in graduate school was that it might prevent him from attaining jobs as a professor. He explained that his advisors encouraged him to focus on his research, reassuring him that teaching experience is not required for professorships:

I actually never TAed in grad school… My first year I was a bank teller as a part-time job, and I was paying my own tuition and everything. And then when my advisor moved she negotiated RA funds for me… Then another professor actually who was on my committee…hired me to be his RA… Then the [collaboration] happened… So I never actually TAed for that teaching experience. I was a little worried about that at the time. I said, “Is this something that’s going to hurt me when I apply for jobs?” And my advisor and advisors…were like, “No, not having any TA experience doesn’t matter. People are gonna hire you based on your research you’re producing, good papers, etc. Just keep focusing on that.”

[Pierre, Interview 1]

When I asked Pierre if this lack of teaching experience applied to his postdoctoral fellowship as well, Pierre explained:

Postdoc they don’t – you can’t – the fellowship that I had was not allowed to teach. I even [said] I would like to teach a course. The [funding agency] explicitly says that I cannot teach with my fellowship, and my advisor would not have been happy about it either. [Pierre, Interview 1]
In the same interview, Pierre went on to explain that he thought his lack of teaching experience did prohibit him from receiving interview offers from some universities:

I had success in the job market, but I do think there’s a couple places where I might have wanted to be where I did not get interviews where I feel like I should have been really competitive. And you never know on these things… I know who got these jobs and whatnot, and I should’ve probably been on that list, but they were emphasizing sending teaching statements and…the feedback forms and so on. And I didn’t have any of that to send, so I’m guessing that that actually did hurt me. So I think that was bad advice.

Pierre did not at any point indicate that his lack of teaching experience in graduate school caused him personal dissatisfaction. Instead, this issue is more connected to his ability to build his research career.

As Pierre has grown into his role as a professor, his focus has shifted from learning how to do research to leading and training his group and providing funding for his work:

I personally don’t really enjoy the lab work. To me it’s about the questions and so on. The lab work is a necessity to get that done. I’m not one of these professors who [says], “Oh I wish I could spend more time in the lab.” I’m like, “I don’t care.” I wish I had more time to think about projects and to work on the analysis that was testing hypotheses and so on. [Pierre, Interview 2]

Since Pierre was only in the fourth year of his position at Large University over the course of this study, he was able to describe this transition clearly:
I think that early career professors go through a process of change with the job until you settle into more of something where things are set up, they’re working… And now I can feel it starting to stabilize. My lab has momentum. [Pierre, Interview 2]

Later, he explained in greater detail:

To have a productive, sustainable lab I can’t do everything or really in some ways almost anything myself. That’s not quite true because there were a couple of years where I was doing the analyses, most of the writing, collecting data, a big part of it, to get everything established. But for long-term momentum and stability you need a lab where people in the lab besides yourself have skills that then they are able to work with each other and show the kind of collective lab atmosphere where there’s multiple students and postdocs and whatnot producing at a certain level where things are rolling out… And there’s a collective learning atmosphere. Without that I think you’re not going to be competitive on the national research level… It’s going to be hard to demonstrate that you are operating your lab at a level that warrants being funded or successful for tenure and that sort of thing. [Pierre, Interview 3]

Pierre referred to his lab’s momentum often throughout our interviews. One of his main goals is to support his lab in building enough momentum to carry on their research with long-term productivity and sustainability. At this point in his career, he feels that the best way to accomplish that goal is to train his students to be independent scientists (a theme that will be discussed in greater detail below) and to generate sufficient research funding.
Pierre explained that attaining research grants is of the utmost importance for early career professors:

You feel like you need to exhaust every possibility. That’s what I did the last two years. It’s exhausting… Submitting eight to ten grants a year is no joke… But you feel like you have to do that because you need funding. You need to demonstrate success in getting funding for tenure but also to continue your work. To get that momentum built you need to have some funding coming in for this stuff that we’re doing. Everybody’s feeling that pressure. [Pierre, Interview 2]

Pierre further explained that research funding is less difficult to attain as one becomes more established:

I think that once you get in that system and you get that established and you start having the proven track record then your proposal idea that might be just the same as somebody else’s or maybe not even as good but you have a track record of success and even success getting grants oddly enough, and then I think that that helps. They’re like, “okay we kind of trust this person. They demonstrated that they’re going to do good work. They are going to be productive with it.” I think that’s part of it, but you’ve got to get to that point… You sorta have to scratch and claw your way into it and take as many shots as you can. [Pierre, Interview 2]

Pierre has also used his excitement for research to augment his teaching. As a specific example, he described to me an intermediate-level course that he designed for sophomores and juniors in his major which is directly related to his research interests:

I really like the concept and it’s an area where I’m taking my research in some ways… I wrote a review paper called [the title of the course]. It was largely based
on I want to take my research in that direction, but it was largely based on a light of the reading and materials. I was like, “Okay I’m going to develop this course, it’s a lot of work, I’m reading hundreds and thousands of articles in putting this together. How is all this connected together, that kind of stuff, so I might as well write a review about it.” [Pierre, Interview 2]

He continued to describe how his students helped shape this research paper:

I wrote that synthesis review coming out of that framework of the class, and in that synthesis review in the acknowledgments I thank all the students who were in my first two iterations of the class for their creativity and insights. That helps develop a lot of the ideas, and that is absolutely true… Students can be really intuitive and you can learn a lot from them too. [Pierre, Interview 2]

Finally, when I observed Pierre teaching interdisciplinary science courses, his excitement about science was clear. He was often animated when he talked about science, using a variety of facial expressions and hand gestures. When talking about specific concepts, he would routinely use adjectives such as “fascinating,” “interesting,” [Pierre, Observation 1], “amazing” [Pierre, Observations 1 and 2], and “cool” [Pierre, Observation 4]. Additionally, I observed Pierre making comments such as:

- I just threw this [example] up here because it’s fun. [Pierre, Observation 1]
- This is just a beautiful science experiment. [Pierre, Observation 1]
- I like science the best when it’s integrative. [Pierre, Observation 2]
- That’s the beauty of science. [Pierre, Observation 3]
Pierre also made explicit references to his own research throughout the classes I observed him teaching by using phrases such as “another thing I study” [Pierre, Observation 1] and “a huge future area of research for me” [Pierre, Observation 2].

The research theme as described in this section is prevalent throughout Pierre’s description of his career and can be seen intertwined with all three of the other themes described below: students a scientist, cultural awareness, and emotional connection. Pierre’s research program is the foundation upon which all other aspects of his career are built.

**Students as scientists**

Pierre’s passion for science research motivates him to train his students to be scientists – both in his research laboratory and in his classroom.

When I asked Pierre to describe the main components of his job, he talked about research and teaching, but he explicitly identified training students to become researchers as a unique component in itself:

Training students is both an important part of the job as a research professor and educator. There’s classroom teaching, there’s research that you’re doing, but there’s also training students on how to become independent researchers themselves. It’s an important part of the job, but it’s also an important part of being successful, having a successful functional momentum, a research lab with momentum and capability. So it’s really intertwined – student training and postdoc training and everything is really intertwined with everything. And you
could say, “oh I’m doing this because this is part of my job. I need to show that I
can work with students and publish papers of students’.” But that’s really a minor
part of it… I guess it depends on the person, but that’s not really the motivation. If
you’re doing it because you have to then you’re probably not doing it very well.
[Pierre, Interview 3]

Pierre further explained his motivation for training students to become
independent research scientists:

I do really love seeing and observing and helping with the process of someone
learning how to be a scientist and learning how to do science and learning how to
write and seeing that creativity develop, the intuition, the scientific intuition
develop and so on. So that’s something that is highly personally important to me,
and I always look forward to, so that’s motivation. [Pierre, Interview 3]

As described previously, Pierre also feels it is important to train students to be
independent scientists so that his research lab can function with long-term capability and
productivity. However, because Pierre also emphasizes scientific training with his
classroom students, it is evident that his intrinsic motivation for training students in this
way arises primarily from the personal satisfaction he receives from the interactions.

Pierre explained that training students has been a more difficult aspect of his job
than he expected it to be:

It’s been more of a challenge than I probably thought that it would be coming in.
Every student is very different, and I knew that certainly coming in… There’s two
kind of extreme models for working with students… There are advisors or
programs that tend to say, “Figure it out.”… The completely hands off model.
And then there’s a model – I’m sure it’s different in every field, but it’s more common in biomedical science – where students are told what projects [to do]… You step into this project. You step into this kind of functioning lab… So what I’ve tried to do is kind of have a balance between the two. When I talk to each student and each student is different they may want totally different things.

[Pierre, Interview 3]

Pierre outlined the general process that he proposes for his new graduate students: They come into the lab for their first project to be something that I feel is a workable, doable project where I’ve got the samples, the funding, the study design, the idea. I can kinda train them in the process of doing research and then they, at an earlier stage, see what’s involved from end to end in the project and during that time they’re developing and reading and thinking of things that they want to develop for their dissertation. And then after that first project there is a more independent phase… So that’s been my strategy… I think it works to various degrees with different students and so on, but it at least initiates that process, forces it to start a little bit earlier. [Pierre, Interview 3]

This description only applies to Pierre’s graduate students. In addition to graduate students and postdoctoral researchers, Pierre also enjoys mentoring undergraduate researchers. However, this has also presented a unique set of challenges for him:

I really like working with undergraduates, but I only want to work with a certain type of undergraduate. And partly it’s the nature of my work, but I want them to have their own independent research project, so they’re learning things for a while. They are learning skills, but then you can do science that is publishable and
novel, etc. So all the students in my lab have to want to do that and then work
towards that goal… But there’s more who want to do that than what I realize I can
support, and I am really passionate about working with undergraduates. I like the
idea of it. So anybody who walked in and sat down and was passionate about why
they wanted to work in the lab and so on, I would say, “Okay.”… So it was
clearly to me getting to be too much, so I decided to limit [the number of
undergraduates]… It hurts me, but… I realize that to spend even minimal time
with the students and not have an undue balance in the lab that I can only have
[this number]. [Pierre, Interview 3]
Pierre is so passionate about training undergraduate students that he admits he
probably taken on extra stress in order to mentor more students:

I’m a softy. Like, it’s recognized. I accept some of the extra work stress because I
get so much out of the process as well… It’s tough… There’s opportunities for
people to do the groundwork in labs, but there are good students I feel who want
to do research who don’t get to. [Pierre, Interview 3]

The disappointment that Pierre feels at having to limit the number of
undergraduates in his lab as well as the stress he experiences as a result of mentoring as
many students as he does exemplifies his emotional connection to his work. This theme
will be discussed in greater detail below.

For both his graduates and undergraduate students, Pierre expressed that the
greatest challenge he has had in mentorship is encouraging his students to have the
motivation and drive he feels is necessary for productive scientists:
The biggest challenge that I’ve had with my students, speaking very generally, is the motivation or the drive or the push. The excitement is there, the interest is there, but then buckling down and doing what it takes to drive something forward… I don’t think that my expectations are too high in terms of observing the consistent drive and self-motivation and push to develop prolific scientific productivity. But those expectations have not – I don’t think they’re too high, but at the same time they’re consistently not met yet. And some of it may develop. It’s just that’s one thing where I don’t know how to teach that very well. [Pierre, Interview 3]

As part of the mentorship process, Pierre works to provide frequent and clear feedback to all of his students:

I try to give very direct feedback… Maybe sometimes my frustration might come out in certain ways that I don’t want it to, but I definitely want my students to hear it from me when I think that they’re not doing something up to their abilities or when they need to work on a certain skill. And I also want them to hear it when I think that they’re doing something really well, in both cases, both on an informal basis… [And] I also give formal feedback… There’s a process at the end of each year through the department where you have some feedback form where there’s like a small paragraph… I make that a bigger thing, like I give more detailed feedback, like a page of writing. And then also at the end of every winter semester I similarly give feedback… Because I just think that once a year feedback is just too little. [Pierre, Interview 3]
Pierre’s desire to train his students as scientists extends into his classroom, and he is passionate about this component of his teaching:

I make a strong effort in this class to emphasize the process of science and to engage students in its creative and logical parts. Specifically, the course challenges students to bridge disparate information in readings from [two fields of science] to develop novel insights…or to develop novel study designs that could do so – and the results have been invigorating. [Pierre, Document 01]

Even though Pierre emphasized his research program throughout our discussions, he was careful to emphasize, “I’m passionate about teaching” [Pierre, Interview 1]. Specifically, Pierre described being excited about the process of mentoring his classroom students in thinking scientifically in the intermediate-level course he designed:

It’s just a great course for seeing the students from the way that – there’s so much we don’t know, but there’s all these opportunities here, and how could we study this to learn, that kind of thing. Seeing the students develop that intuitive scientific sense through that – like how do we evaluate this evidence… You got to learn about [different fields of science] and then the process of fitting them together. It’s just meet to observe the students, and they’re so good. I learned things from them through the class from their questions and their ideas. [Pierre, Interview 2]

During my observations of Pierre’s teaching, he often made explicit references to thinking scientifically:

• That’s a very good point, and a very good question… And that’s the critical eye that we should be thinking about science. [Pierre, Observation 1]
• What does this mean? What can we infer? What does it tell us? [Pierre, Observation 1]

• How cynical are you? Do you think that’s what they started out doing, or is that just something that came up along the way? …You guys are good to be cynical and doubtful. [Pierre, Observation 3]

• Here’s what I want you guys to be doing as scientists. [Pierre, Observation 3]

• This is me with my skeptical hat, but I want you to have the same skeptical hat. [Pierre, Observation 3]

• It’s good when one article says something, and you can make a logical argument to disagree. [Pierre, Observation 4]

• Okay everyone, this is an outstanding first day of presentations. I learned a lot of new things, lots of fun… And coming out of here you’re all good scientist yourselves. [Pierre, Observation 4]

Finally, Pierre’s passion for supporting his students as scientists is evident in his choice of service activities. He explained that he engaged in more service than is typically expected of professors who are working towards tenure:

The advice is to completely minimize your service and whatnot, but partly because I felt like I was doing well on the research part and I got a couple of grants and that kind of stuff, I felt comfortable saying this is something that I really care about. [Pierre, Interview 1]

Pierre chaired a committee to redesign the undergraduate curriculum for his major so that students would have more flexibility to pursue the science they cared about,
“recognizing the integrative opportunities that are really what’s great about our field” [Pierre, Interview 2]. He also started to work with the department’s weekly seminar because, “I wanted to involve the graduate students more… Are graduate students weren’t getting to meet with visiting speakers” [Pierre, Interview 2]. Finally, Pierre undertook the task of modifying the department’s graduate candidacy exam. Though this is not an exhaustive list of Pierre’s service activities, it represents his commitment to improving students’ experiences as young scientists.

It is evident that Pierre is driven not only to build a successful research program but also to train undergraduate and graduate students to become scientific researchers. These are both intrinsically motivated goals that drive Pierre to make decisions about managing his time and resources for his career.

Cultural awareness

During our interviews, Pierre expressed attitudes and opinions which revealed that he was cognizant of the ways in which institutional and disciplinary culture affected his and his students’ work. He does not always see cultural norms as obstacles to be overcome. In fact, in our follow-up interview, he explained that he believes that to be successful in a culture one needs to understand it, recognize it for what it is, and work with in it. He added, “I would say I’m a practical idealist in that way. Fairness is very important to me” [Pierre, Interview 4]. Pierre’s cultural awareness motivates him to actively build a positive lab culture for his research group and to support a positive learning environment in his classroom.
Evidence of Pierre’s cultural awareness can be seen throughout the other themes described herein. However, moments of particular poignancy and clarity arose as Pierre discussed some of the negative aspects of scientific culture. Pierre explained that it was during his time as a postdoctoral researcher that he started to understand the broader picture of academic culture:

I think I was at the time seeing other realities of academia. As a graduate student I had this – academia is wonderful, you work hard, you publish papers, it’s a great system and so on. But [as a postdoc] I started to see some of the bad sides of science – students getting kicked out because [of] their advisors rather than the student, the effects that this had on people… Some people would get jobs who weren’t as good as people who did… All this sort of stuff, so it wasn’t this completely merit-based system. [Pierre, Interviewed 1]

Additionally, as described previously, Pierre is aware that as an early career professor, the cultural norms for funding scientific research are not working in his favor: “It’s the type of science I’m doing and the level I’m trying to do it at combined with the current climate out there… It’s a process that takes time, but it’s a little too ridiculous right now” [Pierre, Interview 2].

In one almost comical commentary on academic culture, Pierre rolled his eyes and remarked, “People can’t function in an academic environment without it being a committee” [Pierre, Interview 2]. For his committee work, he prefers a much more active and efficient process than what is typically expected:

Just do it, right? Rather than you meet about it, something’s gonna happen, then it happens right before the next meeting maybe, that kind of stuff. The committees
are necessary because it’s a way to kind of drag out the work for a really long
time rather than just doing stuff, and that’s why we have these once a year
meetings… These things don’t happen for years because of the kind of style of
doing things. [Pierre, Interview 2]

When I asked Pierre why he thinks such an inefficient style prevails, he
explained:

Because everyone is so busy. Because everyone is on the whole sacrificing too
much of their personal life for their job, their career, their university, and service.
And so it adds up, and it’s hard to quantify any one thing, and you’re doing eight
things at the same time… But I think people don’t want to do things, or there’s
this activation energy. Whereas if everybody just did the stuff they actually
wanted to do, it would probably be a really high functioning system… If you had
enough people who just did the stuff that they were passionate about and they just
did it – we are also capable, you know? Think what we could do. [Pierre,
Interview 2]

Finally, Pierre occasionally remarked on gender disparities within his field: “It’s a
slightly male-dominated field” [Pierre, Interview 1]. This was the only negative aspect of
scientific culture that Pierre discussed with his students. As I was observing one of his
classes, Pierre began to tell a story about a researcher and had this exchange with one of
his students:

*Pierre:* There was a guy who… Always a guy… We’re changing that. In the
future, we won’t always default to saying “a guy”…

*Student:* But we’re getting better. You have to think positive.
Pierre: I do. I think positive and critically at the same time. [Pierre, Observation 2]

Pierre is also aware of positive aspects of scientific culture, particularly with respect to relationship-building among peers: “The age of social media is good in a lot of ways, and you have other people sharing their experiences and advice and so on” [Pierre, Interview 2]. He acknowledged that other professors in his department as well as long-distance collaborators have been helpful in providing feedback for grant proposals and even advice on issues relating to research group management.

Pierre’s cultural awareness has motivated him to foster a positive environment for his research group. In addition to the supportive mentorship described previously, Pierre works to create an atmosphere of lightheartedness and fun whenever possible. He described his group meetings:

The last thing that I tried… Doing the weekly update thing, but rather than getting really droll and so on, everybody gets one slide to put their updates for the week, but the key is that each week the lab meeting has a theme that the students select. In fact they have made a list and then at the end of each lab meeting they vote from three choices for what they want to have for the theme for next week. So they can be bizarre funny things like Disney character or favorite Game of Thrones character or Game of Thrones character that you think is like you, and I mean weird stuff. Favorite tree – I was like, “What is that?” And I have a slide, and I participate in these things and whatnot… Some of these things are really creative, and it makes it fun and keeps it kind of interesting as we go through the updates each week. [Pierre, Interview 3]
As a participant observer in several of Pierre’s research group meetings, I witnessed and experienced the excitement that the students enjoyed each week as they chose and executed these themes. Additionally, many of the individuals in Pierre’s research group expressed their friendship with one another in other ways. One of the research group members brought home baked goods to each meeting to share with the entire group. At one meeting, one student added to her slide, “Anyone up for apple picking this Sunday?” and another student invited the group to go ice skating [Pierre, Observation 7]. Pierre was supportive of this social component in the group meeting, commenting as he left, “Have fun apple picking and ice-skating, but not at the same time” [Pierre, Observation 7]. Even though I had clearly identified myself as a participant observer, Pierre’s group members always made explicit efforts to make me feel welcome in group meetings by engaging in small talk before and after meetings and offering me baked goods.

Pierre also fosters a positive culture amongst his classroom students. When he was describing the intermediate level course that he designed, he remarked “Students can be really intuitive, and you can learn a lot from them too, if you do something in a way that is amenable to that. And the class material in the way I teach it I think is” [Pierre, Interview 2]. When I asked him how he teaches in a way that is amenable to fostering students’ intuition, he explained:

Making it clear that the class is about concepts and that you don’t know the answers… I’m happy when people ask questions and being excited about their input. I think that people see that, and it builds – when they see that I am
genuinely learning from their questions and their ideas, I think that’s how you encourage it more. [Pierre, Interview 2]

I observed this type of engagement between Pierre and his students during his classes, as he not only encouraged his students to ask meaningful questions, but he asked authentic questions as well:

- What are bird babies called, chicks? Or are only chicken babies called chicks? [Pierre, Observation 1]
- That’s a very good point and a very good question. [Pierre, Observation 1]
- Thanks for raising the question. [Pierre, Observation 1]
- I don’t know… That’s a good question. [Pierre, Observation 2]
- These are great questions. [Pierre, Observation 2]
- That’s a really good observation. [Pierre, Observation 3]
- That’s a pretty effing smart idea. [Pierre, Observation 3]
- That’s a great idea. [Pierre, Observation 4]

It is evident that Pierre not only possesses an awareness of cultural issues in his field and local environment, but that he also explicitly works to build a positive cultural climate within his research group and his classroom.

*Emotional connection*

During the time I spent with Pierre, he exhibited a strong emotional connection to his work. Enjoyment, happiness, and passion were things that he talked about often with
respect to both research and teaching. Similarly, he referenced factors in his job which negatively affect his state of mind by producing anxiety or stress.

Throughout our interviews, Pierre spoke of his career with great passion:

- I was like, “This is just amazing.” I was so excited about it. [Pierre, Interview 1]
- And that’s what I’m most happy about, about the work. [Pierre, Interview 1]
- I was super passionate about what I was doing. [Pierre, Interview 1]
- It feels good when I get a lot done. [Pierre, Interview 1]
- I’m passionate about teaching, and that’s the most important thing. [Pierre, Interview 1]
- I love teaching that course. [Pierre, Interview 2]
- I love the students and I want to support them and I want to help them and I’m honored that they ask me to write a letter. [Pierre, Interview 2]
- I’m happy when people ask questions and…excited about their input. [Pierre, Interview 2]
- I love going. It’s super important to go to the field. [Pierre, Interview 2]
- I do really love seeing and observing and helping with the process of someone learning how to be a scientist. [Pierre, Interview 3]
- I really love working with undergraduates. [Pierre, Interview 3]
- I am really passionate about working with undergraduates. [Pierre, Interview 3]
- Science should be fun. It should be something you’re passionate about. You should work hard and have fun at the same time. [Pierre, Interview 3]
- I really am doing what makes me happy. [Pierre, Interview 3]
• It’s amazing what I get to do, the questions that I get to ask with research, the novel things I get to do, the working with students, all that kind of stuff. [Pierre, Interview 3]

Pierre also appeared to be happy throughout my observations of him engaging in teaching and research activities. When he interacted with his students, he smiled, made eye contact, engaged in small talk, and generally maintained a relaxed physical posture.

Though Pierre clearly enjoys his job, he explained that there is also a cost to having this career path. Generally, this cost appears when Pierre works more than he feels he should be working to maintain what he calls a healthy balance. He explained that efforts to achieve this balance first began when he was a graduate student:

I’ve always worked too hard and too much… You start to have this – you start to either lose some of that passion or that efficiency, or you’re just working too much. You don’t have a life balance or whatever, so that’s been my challenge… I think this is a common thing… It’s ultimately not what I want, so I purposely focused on trying to step that backwards. [Pierre, Interview 1]

When I asked Pierre if working too hard was externally motivated, he explained that it was more an intrinsically driven phenomenon supported by his external environment:

I was super passionate about what I was doing… I think those external circumstances contributed to me getting into that habit… You never know if you’re doing enough… That sort of realization seeps in and becomes this stress that reinforces more work. [Pierre, Interview 1]
Later, he further clarified:

I think I naturally work hard and can get a lot done, and it feels good when I get a lot done. And then I recognize that I need to do a lot to be successful in this career because I’m aware of all this. And then the external environment and then how my mind works in terms of stress enhances that. [Pierre, Interview 1]

Pierre explained that he still works to manage his work balance:

[There] was more what I would consider a healthier balance, which I’m now getting back towards. You know, I see the light and so on. There are still months where I’m in that mode, and I’m in that mode now because I’m trying to finish a grant, going to [do fieldwork] on Friday, etc. [Pierre, Interview 1]

He feels that working at a high rate of productivity is worth the imbalance he described:

You do it because then you know you have this carrot that’s always in the future… I’m going to be able to do this for the rest of my life type of thing. And it’s true that I have it much more under control now than I did two years ago and much more under control than one year ago and next year… I’ll be in a better mental place, not that I’m in a bad mental place… I did that hard work especially because I knew it would set me up to now have things to where I don’t have to do it at that extreme effort level forever. [Pierre, Interview 2]

During our last interview, I asked Pierre if he was happy in his job. He explained his work balance in great detail:

I really am doing what makes me happy. I’m just doing too much of it. If you separated out any one thing and isolated that and I could do that in isolation
without all the other impending stuff… then the majority of things that I was doing I would be thrilled to be doing and feel super lucky to be doing… Too often it’s like trying to get too many things done at once and not enough sleep and so on. And that’s getting better, and I’m trying to manage that better so I can enjoy my job on a more consistent basis… But too often I think it lasts for too long a period of time you’re just doing too much of it, either self-imposed or because of the system to really enjoy it on a moment to moment basis. [Pierre, Interview 3]

It became evident that Pierre conceptualizes periods of stressful work productivity as the price he must pay to enjoy this career that he is so passionate about. He explained that he knew he would eventually get to the point where he enjoys the majority of every day:

There’s a personal cost to getting to that point that I can see here, that is expanding, or I’m enjoying more of it, less of the long-term anxiety, etc. There’s a personal cost to getting to that point… There’s also an opportunity cost, like to all the friendships that I didn’t develop because I was working so hard and investing. And just the things that I like to do or to feel like I’m – there’s too few moments where you’re enjoying and satisfied with your life at the moment because there’s this impending either future stress or all these intermediate ones that are part of that. [Pierre, Interview 3]

I asked Pierre if he felt it was absolutely necessary to pay this personal cost in order to achieve the success he has achieved in his career, and he responded:

In some ways I’m happy that I did what I did because now I’m not stressed about getting tenure. You know that would be a bigger stress and potentially a longer-
term one. And so I did what I did with my eyes wide open because I’ve kind of been that way since some point in my first year of grad school… I kind of figured out how the system worked… Do I think it’s absolutely necessary? No, but in one answer also is that the system should change in some ways, but I don’t know how to individually make that happen. We can talk about the ways that the system is out of whack with the ratchet on grant funding… increased pressure from universities and departments to show that you can get grant funding… If you want to be confident and comfortable about the tenure process I think that’s probably part of it for most people at the current state. [Pierre, Interview 3]

Pierre’s emotional connection to his work is manifested in both positive and negative ways. He loves his work and is passionate about being successful, but this same passion generates stress and anxiety for him. As Pierre matures in his career, he anticipates that he will continue to work to manage this aspect of his job.

**Research questions**

I have utilized themes identified above as well as other supporting information from interviews, observations, and documents to answer the project’s research questions for Pierre’s specific case. These questions are

- What is the relationship between teaching and research roles for Pierre?
- What types of activities and experiences (particularly professional development) does Pierre engage in to support his role as a teacher? Conversely, what types of
activities and experiences impede his role as a teacher? In what ways do these activities support or impede his role as a teacher?

- What connections might be made between Pierre’s personal, cultural, and professional histories and the way he is currently experiencing the relationship between teaching and research?

**The relationship between teaching and research**

What is the relationship between teaching and research roles for Pierre? As described previously, Pierre enjoys both the teaching and research components of his job, but the main focus of his career has been to build a successful long-term research program. This does not mean that Pierre does not take his teaching seriously; rather, he works to continually improve the courses he teaches: “my classes – I developed them, taught them, I refined them” [Pierre, Interview 3]. Pierre has utilized some components of his research in the courses he teaches, and in at least one instance used the development of a course’s curriculum to create a research publication. For these reasons, I have described Pierre’s teaching and research roles as moderately complementary.

As described above, Pierre developed a course closely tied to his research interests. This allowed him not only to bring his research into the classroom but also to inform his thinking about his research and inspire the publication of a review article published in a peer-reviewed journal in his main field of study:

I really like the concept and it’s an area where I’m taking my research in some ways… I wrote a review paper called [the title of the course]. It was largely based
on I want to take my research in that direction, but it was largely based on a lot of
the reading and materials. I was like, “Okay I’m going to develop this course, it’s
a lot of work, I’m reading hundreds and thousands of articles in putting this
together. How is all this connected together, that kind of stuff, so I might as well
write a review about it.” [Pierre, Interview 2]

Additionally, when I observed Pierre teaching, he would encourage scientific
thinking in his classroom and occasionally present material directly related to his own
research and explain to students, “This is a huge future area of research for me” [Pierre,
Observation 2]. In these ways, it is evident that Pierre’s research is regularly represented
in his teaching.

It was less common for me to find instances in which Pierre considered himself a
teacher in the research setting. He did talk about training his research students: “Training
students is both an important part of the job as a research professor and educator” [Pierre,
Interview 3], but he appears to consider his role in his research students’ lives more that
of a trainer and mentor rather than a teacher. Pierre was more likely to talk about
“working with and training… PhD students” [Pierre, Interview 3] rather than teaching
them.

Throughout our second interview, Pierre made references to the time and energy
cost associated with balancing teaching, research, and service. This draw upon limited
time and energy resources is the only way in which Pierre expressed feeling a tension
between his roles as a teacher and a researcher:

• During the academic year I’m trying to balance the teaching that I’m doing with
continued research productivity.
It’s exhausting on top of everything else, on top of keeping the publications going, the research going, developing your new courses.

Any one thing [is] not a big deal, but all that stuff during the school year adds up on top of the teaching and everything else… I’ve got my class schedule, I’ve got my teaching, I do these other major things, like the department stuff. This stuff just has to get done.

The sum total of that makes it hard to fit everything into a day without letting it bleed into the evening or the class prep for the next day bleed into the evening and so on. That’s probably not a very unique answer on what it’s like during the semester, but that’s the truth.

Giving a lecture – that is a process that takes energy, and sometimes after a lecture I’m just beat. So then there’s only so many things – I can’t like work on a paper immediately after teaching.

Pierre’s roles as a researcher and a teacher are moderately complementary to each other. Even though he has found some ways for these two components of his job to be complementary, he still largely sees them as separate activities. Additionally, he maintains a focus on research as the central component of his career.

Supporting and impeding activities and experiences

What types of activities and experiences (particularly professional development) does Pierre engage in to support his role as a teacher? Conversely, what types of activities and experiences impede his role as a teacher? In what ways do these activities support or
impede his role as a teacher? Over the course of our interviews, Pierre did not mention engaging in any formal professional development activities. During our follow-up interview, I asked him if he had engaged in any professional development. He said that even though he was aware that there were some teaching seminars available on campus, he chose not to attend them because of the time cost involved and because he believes that learning by doing is the best way to learn. He indicated that anytime he wishes to implement something new in his classroom he can spend a few minutes searching for resources on the Internet rather than spending hours in a seminar on campus to get the same information.

With respect to informal professional development, I found Pierre to be someone who routinely evaluates his own performance, reflects upon his practices, and modifies those practices when he feels is necessary. He made many references to learning on the job during our interviews. Usually, he was speaking about learning how to be a better researcher or mentor to his research students: “We’ll see how well it works out, and I’m constantly learning and adjusting. Like I said each student is different” [Pierre, Interview 3]. However, as mentioned previously, he made a similar reference to the way he teaches his courses: “My classes, I developed them, taught them, I refined them” [Pierre, Interview 3].

Pierre did not identify any aspects of his job that he felt impeded his role as a teacher, though he does find time and energy management to be challenging as described in the previous section.
Personal, cultural, and professional history

What connections might be made between Pierre’s personal, cultural, and professional histories and the way he is currently experiencing the relationship between teaching and research? During the course of our interviews, Pierre did not discuss his personal history. Pierre’s academic and professional history revolved almost exclusively around developing a foundation for his research career. As described previously, Pierre did not even engage in a teaching assistantship as a graduate student. Though this path was in part due to advice from his graduate school advisors, it is also consistent with evidence presented in the research theme above.

Pierre is intrinsically motivated to build a successful research program, and it is for this reason that his past academic and professional experiences as well as his current professional roles are more heavily weighted towards research. Pierre described an academic culture that is consistent with prioritizing one’s research program, but he did not express that this culture is motivating him in the way he chooses to allocate his time and resources between teaching and research. Instead, Pierre explicitly chose a career track that included a position at a competitive institution because the expectations and resources are well matched to his personal career goals.

Cross-Case Analysis

It is evident from the descriptions presented above that each of the participants in this study is a unique individual with his own history, goals, and experiences; analysis of each case gave rise to a unique set of themes for each participant (Table 4.1). However,
these participants share some commonalities as well. Not only are they all tenure-track science professors at the same university, but there were also themes that were evident throughout their careers that connected them in deeper ways. I will discuss each of these themes in greater detail with evidence from the cases’ data in this section.
<table>
<thead>
<tr>
<th>Participant</th>
<th>Theme</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Henry</td>
<td>students</td>
<td>Helping students achieve their goals is the main objective of Henry's career activities in all three major areas of his work: teaching, research, and service.</td>
</tr>
<tr>
<td></td>
<td>happiness</td>
<td>Henry chooses his work activities in such a way that will make him happy rather than making efforts to conform to cultural expectations.</td>
</tr>
<tr>
<td></td>
<td>collegiality &amp; collaboration</td>
<td>Henry not only works collaboratively with other scientific researchers but also seeks out teaching and service collaborations.</td>
</tr>
<tr>
<td></td>
<td>inquiry stance</td>
<td>In all areas of his career, Henry consistently makes efforts to question and improve the status quo.</td>
</tr>
<tr>
<td>Ben</td>
<td>research</td>
<td>Ben's primary professional priority is his research program. All of his other job responsibilities are secondary to this research.</td>
</tr>
<tr>
<td></td>
<td>scientist</td>
<td>Ben's personal and professional identities are closely aligned with his understanding of the way a scientist thinks and behaves. Namely, he focuses on understanding the world through what he calls the scientific method.</td>
</tr>
<tr>
<td></td>
<td>early career</td>
<td>Since Ben is only in his seventh year of his first faculty job, he has maintained a focus on learning how to lead his research group and prepare for tenure.</td>
</tr>
<tr>
<td></td>
<td>academic culture</td>
<td>Ben's personal goals for his work are in alignment with cultural norms and expectations in his institution and discipline at large.</td>
</tr>
<tr>
<td>William</td>
<td>researcher</td>
<td>William identifies himself as an astronomy researcher, both personally and professionally.</td>
</tr>
<tr>
<td></td>
<td>community</td>
<td>Interaction with local colleagues (including his own research students) as well as the astronomical community at large is an important part of William's work.</td>
</tr>
<tr>
<td></td>
<td>family</td>
<td>William's role as a husband and father are important to him, and he makes career decisions based on his commitment to his family.</td>
</tr>
<tr>
<td></td>
<td>tenure</td>
<td>Having just received tenure during the course of this study, William has maintained an acute awareness of the tenure process throughout his time as a professor.</td>
</tr>
<tr>
<td>Pierre</td>
<td>research</td>
<td>The main focus of Pierre's career, from the time he was in undergraduate, has been building a successful scientific research program.</td>
</tr>
<tr>
<td></td>
<td>students as scientists</td>
<td>Pierre feels that training students to be scientists both in the research setting and the classroom is a vital responsibility of his job.</td>
</tr>
<tr>
<td></td>
<td>cultural awareness</td>
<td>Pierre maintains an awareness of the culture he is working in and makes explicit efforts to be successful in that culture.</td>
</tr>
<tr>
<td></td>
<td>emotional connection</td>
<td>Pierre's passion for his job results in both joy for the positive aspects of his work and anxiety over the stressful components of his career.</td>
</tr>
</tbody>
</table>

Table 4.1. Summary of themes by participant.
Themes

I have identified four themes that are apparent across all four cases: intrinsic motivation, students, time management, and lack of training. All of the participants expressed that their professional goals were largely intrinsically motivated; that is, the participants in this study are shaping their careers in such a way that satisfies their own personal goals. Often those goals are in alignment with the institutional culture they experience, and sometimes institutional culture reinforces those goals, but it was clear that none of the participants were solely or even primarily motivated by external career pressure. All four of the participants in this study also indicated that they are highly motivated to support, teach, and train undergraduate and graduate students. The third cross-case theme, time-management, was evident throughout every conversation I had with every participant in this study. The professors in this study are all acutely aware of limited time resources in an unlimited work environment. Finally, while all of the participants in this study are highly trained scientific researchers, they all indicated that they received very little preparation to perform in any other area of their current job, particularly teaching or managing a research group.

Intrinsic motivation

When I first engaged in the study, I was curious to see whether and to what extent the research-intensive culture of the RU/VH university would influence the way professors chose to allocate their resources across the various aspects of their jobs. I was surprised to find that the professors in this study consistently reported that the cultural
backdrops of their departments and colleges and the university did not actually impose much influence on the way they engaged in their jobs.

Henry’s happiness theme provides evidence that even in cases where his goals do not align with cultural norms, he pursues his own interests rather than conforming to those norms. For example, he explained that at his previous institution many colleagues encouraged him to focus solely on his research to the exclusion of teaching and service activities. However, he chose not to follow their advice: “I don’t want to do one thing. I want to do three things. I wanna teach, I wanna do service, I wanna do research” [Henry, Interview 1]. Apart from the way Henry allocates this time, he feels that in many ways his goals for his teaching and research are in alignment with his institution’s goals: both Henry and the institution want classroom students to learn and want research students to become independent scientists. The difference between Henry’s goals and the institutional culture only lies and Henry’s emphasis on student happiness; Henry indicated that the institution tends to emphasize productivity and efficiency.

When I talked to Ben about how his goals for teaching and research aligned with his institution’s goals, he indicated that there was very close alignment between the sets of goals. As Ben feels that the institution favors research productivity over teaching efficacy or service work, evidence of the alignment of Ben’s goals with this culture can be seen throughout the themes described in Ben’s case. Particularly, Ben’s personal desire to focus on prioritizing his research above all else is explicitly in alignment with his department’s culture:

I think our department does a really good job of supporting assistant professors… They try to limit the amount of service work. You’re still teaching, but they set
you up with the course that you teach a few times to sort of help. [Ben, Interview 2]

During our follow-up interview, I explicitly addressed this intrinsic motivation theme with Ben, and he confirmed that the way he has managed his career has been driven by his personal goals and that those goals happen to be in alignment with academic culture rather than imposed by academic culture. He reiterated: “research number one, teaching number two and everything else number three” [Ben, Interview 4].

William’s prioritization of research over the other components of his job is very similar to the way Ben prioritizes his work. This is evidenced in the researcher and tenure themes presented in William’s case above. As William talked about the way he has structured his time as a pre-tenure professor, he indicated that he made research a priority and that his department supported this effort: “The pre-tenure faculty are busy earning tenure, so my department head was just very conscientious of not giving me too many new teaching assignments and not overloading me with committees” [William, Interview 2]. When I explicitly asked him if his goals were in alignment with the university’s goals, he explained:

I think they’re well aligned. I think they were pretty clear. Especially just coming from tenure, I have a good sense of what they appreciate. The university wants to see me having an active research group, publishing papers, graduating students, and getting citations. The university wants to see me bringing in grant money and supporting people. [William, Interview 3]

During our follow-up interview, I also asked William to confirm that academic culture did not heavily influence his career choices. He indicated that he largely agreed,
though in some cases he did modify his behavior in order to attain tenure. He provided one example: before he received tenure, he spent more time traveling to give research talks then he would have liked because this activity would bolster his tenure application. He said that other than this instance, his intrinsic motivations and goals are in alignment with the culture of his institution.

Out of all the participants, Pierre’s career goals are perhaps most closely aligned with those of the institution. As Pierre is currently working towards achieving tenure, he is acutely aware that he must prioritize his research productivity for this purpose. He also explained to me that he chose to work at a research intensive institution with “eyes wide open” [Pierre, Interview 3] because the institutional culture is in alignment with his personal career goals. He explained:

There is a match between – it’s not perfect, it’s not linear – but there is a match between the university and department and how they set you up to succeed in your career and in your research career. The resources available, the quality of the grad program, the funding opportunities, the clearing of the bullshit that keeps you from being successful. There is a near linear relationship, imperfect but a strong positive relationship between that and the expectations of the university… Ultimately for me part of it was that my particular research program…is very expensive… Either I go all in and do it the way I think it needs to be done or not at all and do something pretty different. [Pierre, Interview 3]

Thus it is evidence that not only are Pierre’s goals in alignment with his institution’s goals, but he chose his institution based on that alignment.
Students

All four of the professors who participated in this study indicated that helping students (at all levels) is one of their primary professional responsibilities. Henry was perhaps the most student-centered professor who participated in the study, as is evident in the description of this student theme in his case described above. Henry’s characterization of the similarities between his teaching and research goals provides an apt representation of this theme: “I want to help these students get to where they want to go… Similar aims, helping people basically” [Henry Interview 3].

Ben was less explicit about this priority in his career, but it was evident in many of his actions. For example, in his research lab, Ben emphasizes helping his research students become independent scientists instead of enabling them to “keep asking well what should I do, what should I do, what should I do” [Ben, Interview 1]. In the classroom, Ben is a reflective practitioner and is always seeking ways to improve his teaching. Finally, Ben explained that he chose to work with undergraduate students as part of his service responsibilities even though most new professors prefer to work with graduate students for recruitment purposes. He did this because his experience as an undergraduate student at a largely undergraduate institution instilled in him a passion for assisting undergraduates to find research opportunities and for providing them with career advice.

William’s emphasis on student support can most clearly be seen in the community theme described in his case. From the time he was in graduate school, William saw value in fostering a sense of community with his colleagues, and as a professor he views his
students – at least his research students – as his colleagues. When I asked William about how he scheduled his days, he made it clear that his research students’ needs come first; if one of his students knocks on his door, he makes that meeting a priority.

Students are important. Even if the particular thing they’re working on isn’t important, they are important and so if the student were knocking on my door, I always try to answer it and deal with it. So if I’m looking at my inbox to try to figure out what thing to deal with next and the door [knocks] and it’s a student, the student comes in. [William, Interview 2]

William’s respect for students also extends to his classroom, where he emphasizes the importance of providing students with the tools to either make career decisions or learn important professional skills (depending on the course).

Pierre’s commitment to his students is similar to William’s. With respect to research, Pierre prioritizes training his students to be independent researchers, and in the classroom he teaches his students to think like scientists. Evidence of the way Pierre prioritizes student success in his career can be seen in the students as scientists theme described above. In our third interview, Pierre summarized this theme: “Training students is both an important part of the job as a research professor and educator.” Pierre also seeks to assist students by engaging in service work that will help both undergraduates and graduates have a better experience at the university.

Throughout my observations of all four of these professors, it struck me that they could all be described as a student-centered teachers. All four of them consistently made efforts to engage with their students during class by asking probing questions, making eye contact, following up on student questions, checking for understanding, etc. All four
of these professors indicated that they received positive feedback from their classroom students, and this feedback was an important metric for all of them to reflect upon their practices. Similarly, during research observations, I felt that all four of these professors were supportive of their research students. It was typical for the professors to ask questions about the students’ research, but the tone was always supportive and conversational; I never felt uncomfortable or got the impression that the professors were being antagonistic towards their students. The students themselves also appeared to be relaxed and engaged in scientific discussions with their advisors rather than nervous or defensive. Thus, all four participants not only claimed that they desired to support students during our interviews, but I also felt that the interactions I observed during classes and research group meetings supported the participants’ claims.

Lack of training

Even though all of the professors who participated in this study are well-trained scientists with positions in competitive science departments, they all agreed that they came to their jobs with little to no training for anything other than scientific research.

Even though Henry had tutoring experiences from the time he was in high school and engaged in service and research activities from the time he was in undergraduate, he explained to me that none of those experiences prepared him to be a professor. On multiple occasions, he expressed dissatisfaction with the lack of training professors receive to do anything other than research:
I mean we talked about the fact that preparation for teaching for example is pretty lamentable. And preparation for being a group leader is not existent, so definitely there's a difference between, as a researcher, as a graduate student, where you can just worry about the problem and as a professor where you have to worry about how am I going to fund the problem (laughs), how am I going to pay for my students, where are we going next. I can't really be thinking about this problem because I gotta be thinking about what are we gonna be doing in six months so that we can keep going and things like that, so yeah there's a big difference in that way. [Henry, Interview 3]

Ben expressed a very similar sentiment. He said that sometimes he feels like other professors have all the answers, but he is still trying to figure things out. He explained:

Well as I said you know physical science you are taught your graduate work and your postdoctoral work primarily teaching you to be a bench level scientist, so coming in and becoming a professor you have all these things that there’s no formal teaching about. So I talk about me being a manager of scientists, dealing with these social interactions, so not just thinking about the science but thinking about the people doing the science. But then there are things like coming up with a budget, no one ever taught me how to come up with the research budget before I came here, and again you know coming in you know I never taught a full course before… You’re not taught how to teach. You’re just you’re taught how to do research on a bench and then you’re given all these other responsibilities and hopefully you learn. [Ben, Interview 2]
Of all the participants, William is the only one who expressed having any training in anything other than engaging in research. During his time as a postdoc he said:

[My postdoctoral advisor] taught me a lot about how to be – a lot about the details of doing astronomy: how to be shrewd about getting proposals accepted, how the money works, how money flows, what overhead is, and the things like that that I had no exposure to [as a graduate student]. [William, Interview 1]

In a later interview as we discussed professional identity, I asked William if he quit his job tomorrow, would he still identify himself as a teacher? He responded: “No. No because my training’s not in teaching. I have almost no training in teaching. So I haven’t spent years of my life learning to be good at it. It’s definitely a profession and not an identity for me” [William, Interview 3].

Throughout my interviews with Pierre, the only career preparation he discussed was his training in his research fields. He indicated that when he was a graduate student he was concerned that his lack of teaching experience would impede his job search:

I actually never TAed in grad school… I was a little worried about that at the time. I said, “Is this something that’s going to hurt me when I apply for jobs?” And my advisor and advisors…were like, “No, not having any TA experience doesn’t matter. People are gonna hire you based on your research you’re producing, good papers, etc. Just keep focusing on that.” [Pierre, Interview 1]

Pierre did not explicitly address a lack of preparation for leading a research group, but he often made references to the fact that he has been trying multiple methods for mentoring his students and is still learning what works and doesn’t work.
All of the participants in this study consistently commented on the time cost associated with various activities. They are all acutely aware of their limited time resources in an environment where their workload is truly endless.

During my interviews with Henry, we discussed the fact that being a professor is not a 9-to-5 job, and I asked him to explain why this might be. He described that being a professor is more an identity than a job:

I have friends for example who have jobs where it's like five o'clock, that's done, now I can go be myself. And that is definitely not my life in any way, shape, or form. And partly because I am doing physics at 2 AM and I take it home and I think about it all the time and think about how to teach better, think about how to solve some problem in the lab, how to write some paper. That consumes me. So partly it's that, but it's - I love it. [Henry, Interview 3]

When we discussed what he would have to do in order to take on more responsibilities, he remarked:

I do a lot of things. In order to do more things, I have to give up something. It could be sleep I suppose, but I'm already giving up a lot of sleep, so I'd have to figure out what to jettison, or change anyway, shrink. [Henry, Interview 3]

Henry never seemed dissatisfied with the amount of time he spends working; he is simply aware that he has many responsibilities and a limited amount of time.

Ben expressed similar feelings about his limited time resources when I asked him about collaborating with other educators on campus:
The issue is I have a variety of different responsibilities, and maybe it's an excuse, but I only have so much time in the day. If I really wanted to I think I would have to focus a lot more attention on what’s going on. I mean certainly we do have resources [here], like the [discipline specific teaching and learning center]. There’s other centers. I guess I could reach out to other departments. I know there’s reading through say Science magazine or Chemistry and Engineering News… I’m sure there’s more information within the education-based journals, but I just haven’t found the time to further search them. [Ben, Interview 3]

He further explained:

There’s only so many hours within the day. I know that I do consider the research to be a little bit more important to get the grants written, getting more and more funding, supervising the lab and so on. And so sometimes I have to think about how I want to divide my time and what will push the science forward. And so sometimes again there are these time constraints. [Ben, Interview 3]

William also expressed the need to manage his time carefully. As he talked about managing his research group, he explained that he didn’t want his group to become so large that he would not have time to provide individual attention to all of his students:

“It’s hard, the group just keeps growing and I need some people to graduate to free up some time so that I can give people more individual attention” [William, Interview 2].

William indicated that it is harder for him to manage his time when he is teaching classes:

“Summertime is better. I tend to have more time on the whole because no teaching. Like
this last fall was dead because I had to do new class prep, and that just eats up all the time” [William, Interview 2].

Pierre’s comments on time management were typically connected to his desire to balance his workload as described previously. He explained that there was a time as a graduate student when he was working almost constantly, but that he has recently been learning to manage his workload: “I’m learning how to manage what I say yes and no to and the consequences of starting a new project, how that’s gonna pile on together 16 months from now or something” [Pierre, Interview 2]. Later, he offered a detailed description of the challenges associated with managing time as a professor:

All that stuff during the school year that adds up on top of the teaching and everything else… I’ve got my class schedule, I’ve got my teaching, I do these other major things, like the department stuff, this stuff that you know just has to get done… meetings, that sort of stuff. I work on my emails. I literally mean that. I get my emails that come in every day and I’ve gotta manage that process right? Like small amounts of work associated with these emails is my work. Email is kind of like my to-do list, and in fact I send myself emails… And then I try to carve out time half an hour here 15 minutes here an hour here to work on the science productivity… Making comments on a paper that my postdoc has drafted, advancing my own papers and analyses… I kind of make sure that I’m prioritizing that and I’m moving forward… The sum total of that makes it hard to fit everything into a day without letting it bleed into the evening or the class prep for the next day bleed into the evening and so on. So that’s probably not a very
unique answer on what it’s like during the semester but that’s, that’s the truth.

[Pierre, Interview 2]

Conclusion

After engaging in 56.5 hours of data collection with these four tenure-track science professors over a period of 38 weeks, I was able to gain a better understanding of the way they experience their careers on a daily basis. Each of the professors who participated in this study exhibited a unique set of themes associated with his work (Table 4.1). As these themes gave me unique insight into the way each individual participant experienced his career, I recognize themes that were common across all four cases in this study (Table 4.2). All of these themes will be utilized to re-examine the research questions for this project, discuss implications of this work for improving postsecondary science education, and propose future lines of research.

<table>
<thead>
<tr>
<th>Theme</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>intrinsic motivation</td>
<td>Career decisions made by the participants are consistently motivated by intrinsic goals and desires rather than external factors such as institutional culture or peer expectations.</td>
</tr>
<tr>
<td>students</td>
<td>All of the participants in the study expressed a desire to support the students at their institution.</td>
</tr>
<tr>
<td>lack of training</td>
<td>Whereas all of the participants in the study are highly trained research scientists, they all indicated that there is little to no preparation for any of the other responsibilities of professors, e.g., teaching, managing research groups, etc.</td>
</tr>
<tr>
<td>time management</td>
<td>The participants consistently commented on their limited time resources and unlimited workload. Prioritizing their professional responsibilities and managing their time are common challenges for professors in this study.</td>
</tr>
</tbody>
</table>

Table 4.2. Summary of cross-case themes.
Chapter 5

Discussion

Concerns about the American STEM workforce (Bradforth et al., 2015; National Science Board, 2015) and an increased demand for STEM-qualified workers (Langdon et al., 2011) have generated renewed interest in postsecondary science education. This interest has resulted in multiple stakeholders calling for postsecondary science education reform (American Association for the Advancement of Science, 2015; Association of American Universities, n.d., 2011; National Research Council, 2013; National Science Board, 2010a; President’s Council of Advisors on Science and Technology, 2012).

Some researchers have engaged in investigations that seek to improve the quality of postsecondary science education by improving professors’ teaching practices. These researchers make a variety of arguments to justify such work. One popular position has been to attempt to draw a direct connection between teaching practices and student attrition (Graham et al., 2013; President’s Council of Advisors on Science and Technology, 2012; Seymour & Hewitt, 1997; Ulriksen et al., 2015). However, there has not been extensive work investigating the link between teaching quality and attrition, making the validity of this claim questionable. Recently, it has become more popular for practitioners of postsecondary science education to demand reform in their field for the simple sake of professional excellence. That is, these professors posit that since various
research-based teaching methods have been shown to be more effective than lecture, the field must respond by utilizing these methods (Bradforth et al., 2015; Eddy & Hogan, 2014; Hrabowski, 2010; Wieman, 2012).

No matter what justification individual groups of stakeholders choose to put forth in the argument for improving undergraduate science education, it is clear that there is a consensus that postsecondary science education is an area that merits further study by educational researchers (see Table 1.1 for a survey of stakeholders’ reports and recommendations). My research does not seek to solve questions regarding why it is important to improve undergraduate science education. Instead, I have chosen to begin to try to understand the current landscape of this field by immersing myself in the lives of science professors – an understudied stakeholder in postsecondary science education.

The set of four phenomenological case studies described herein were designed to address the following research questions:

- What is the relationship between the teaching and research roles for individuals in a sample of tenure-track science professors at an RU/VH institution?
- What types of activities and experiences (particularly professional development) do participants engage in to support their roles as teachers? What types of activities and experiences impede their roles as teachers? In what ways do these activities support or impede participants’ roles as teachers?
- What connections can be made between the participants' personal, cultural, and professional histories and the way they are currently experiencing the relationship between teaching and research?
As described in this report, my investigation revealed that each of the professors who participated in this study had his own unique and interesting experiences related to teaching and research (see Table 4.1 for a summary of themes for each participant). The main focus of Henry’s career has been to help students and pursue matters which make his personally happy. He engages in his work with a great emphasis on collaborating with his colleagues while always questioning and improving the status quo. Ben maintains a strong focus on the research component of his job and clearly identifies himself as a scientist both personally and professionally. Throughout our time together he emphasized that his career was in its early stages and often referenced the tenure process as he was applying for tenure during the course of my study. Similarly to Ben, William also focuses on the research component of his job and was engaged in the tenure application process during a portion of my study. William’s emphasis on the importance of his scientific community and the role his family plays in his professional decision-making were unique components of his experiences. Finally, Pierre (similarly to Ben and William) primarily focuses on the research component of his job but also emphasizes the importance of training students – both in the lab and the classroom – to be independent scientists. Pierre also exhibited an interesting cultural awareness of his professional settings and relationships as well as a unique emotional connection to his work.

Additionally, I was able to uncover common themes among the participants (see Table 4.2 for a summary of cross-case themes). All of the participants indicated that they were pursuing career goals according to their own intrinsic motivation and were rarely significantly influenced by institutional mandates or norms. All four of the participants also expressed a desire to support their students – both in the laboratory and in the
classroom. In fact, in follow-up interviews, all of the participants indicated that they engaged in this study because they wanted to help me as a graduate student. All of the participants described a lack of training or preparation for their work as professors (with the exception of scientific research), particularly with respect to teaching and research group management. Finally, all of the participants in my study consistently expressed an awareness of the time cost associated with various work activities and the need to manage their time carefully.

By using case study and phenomenology to gain a deep understanding of several professors’ lived experiences, this work fills a gap in literature on postsecondary STEM education. As reported in Chapter 2, there is no study comparable to the one herein as it not only examines the relationship between teaching and research for professors but also collects holistic data about their professional lives in order to attain socioculturally situated understandings of the phenomenon (the relationship between teaching and research). Such understandings have allowed me to answer my research questions from my participants’ perspectives. This emic stance has also allowed me to shed some of my initial expectations and assumptions that I held at the start of the study and reframe my approach to future work in this field.

In the following sections I will re-examine my initial expectations and assumptions, describe the limitations of this study, discuss the reframing of my research questions based on these research findings, and explore possibilities for implications and future work informed by the results of this study.
Initial Expectations and Assumptions

At the conclusion of this study I revisited my initial expectations and assumptions as reported in Chapter 1. Before I began data collection, I had anticipated that

- participants would experience the relationship between teaching and research as a tension,
- few of the professional activities spontaneously described by my participants would be intended to support their roles as teachers,
- and participants would not readily draw and express connections between their personal and professional histories and current career experiences.

My first expectation was not met by any of my participants. In fact, all four of the professors in this study described efforts to use their research to inform their teaching or use their teaching roles to strengthen their research activities. These efforts were exhibited in different ways for each participant, but across the cases, synergistic connections between research and teaching at both the undergraduate and graduate levels were seen. The only way in which the participants in this study experienced a tension between teaching and research was with respect to time management.

My second and third expectations were consistently met by all of the participants in the study. Formal and informal professional development activities were rarely described through natural conversation, and when I asked participants about the topic, they typically said they did not or did not often participate in professional development of any kind. An exception might be made for “on the job” learning, which was referenced frequently by my participants, particularly by the early career professors. Finally, there
were almost no instances in which professors offered a connection between past and present events. I consistently had to prompt such reflection by asking focusing questions.

Limitations

This study experienced several limitations. First, I was the only researcher performing data collection and analysis. I consider this a limitation because having another researcher on the project might have resulted in different and perhaps even better analyses of the data. Second, within the time available for the study, I was not able to add interviews or focus groups with participants’ research group members or classroom students. This additional data might have provided greater depth to the study. Third, I chose not to video record my interviews or observations with participants in order to minimize distractions from their normal routines. This lack of visual data limited my subsequent impressions of things such as facial expressions and body language to things I wrote in my field notes or remembered. Finally, the lack of individuals from underrepresented groups and multiple institutions as participants in this study limited the scope of my findings. This study only presents stories from White, male, middle-aged STEM professors at a single institution. All future work will include focused efforts to recruit individuals from underrepresented groups. According to the National Science Foundation, underrepresented groups in STEM are women, persons with disabilities, blacks, Hispanics, and American Indians (2013).
Reframing Research Questions

Thoughtfully designed and executed qualitative research proceeds via an iterative process whereby the goals of the research, the conceptual framework, validity issues, methods, techniques, and research questions all constantly inform each other (Maxwell, 2013b). For example, this work did not initially seek to collect data regarding professors’ personal and professional histories; I also initially used the phrase “the tension between teaching and research” rather than “the relationship between teaching and research.” However, early stages of literature research and communication with colleagues transformed my thinking, and my research questions evolved into the form presented herein. Additionally, once I collected and analyzed all of the data associated with this project, I decided to revisit my research questions to determine whether they were still appropriate given my deeper understanding of the way my participants experience their careers. This consideration has led me to reframe my research questions, and these new research questions will now be useful in the planning and execution of future work.

I did not feel that the participants in this study reported a relationship between teaching and research as a construct that would appear to be useful for further study. That is, they engage in teaching and research, but “the relationship” between those two activities remains too ill-defined for me to find it useful for my work. Though I have been careful not to generalize this study’s findings to larger populations of STEM professors, I do acknowledge the intellectual generalizability of this study’s findings. In other words, I have used the experiences I gained engaging in this study to inform my thinking about the future of my research program. Specifically, I am concerned that I saw almost no
evidence that considering the construct “the relationship between teaching and research” facilitated a better understanding of my participants’ careers. Thus, I have decided to eliminate this vocabulary from my future research. Instead, given the way my participants described the need to prioritize their daily professional lives, I’m interested in further investigating this prioritization. In practice, shifting from the study of the relationship between teaching and research to the study of the prioritization of professional responsibilities is a subtle and semantic distinction and will not result in vastly different work. However, it is far more consistent with the way my participants understand and experience their jobs.

Furthermore, the research questions for this study only addressed teaching and research roles for professors. The data collected indicated that service activities might play a more significant role than I originally anticipated, so future work will seek to include questions about professors’ service.

To this end, future work that builds upon the results of this study will utilize some form of the following reframed research questions:

- How do science professors prioritize the various responsibilities of their jobs (particularly teaching, research, and service), and what are the practical implications of such prioritization?
- What factors influence professors as they make decisions regarding their professional priorities? In what ways do these factors influence those decisions?
- What types of pedagogical trainings and interventions might professors be willing to engage in? What types of pedagogical trainings and interventions might
professors find useful? In what ways do professors find pedagogical trainings and interventions useful?

These questions will be utilized to develop the implications and future work described in the next section.

**Implications and Future Work**

The purpose of this study was not only to increase knowledge about the way professors experience their careers, but also to attempt to gain some insight into the ways professors might be supported as teachers. Ultimately, it is desirable to support professors’ teaching activities in order to improve undergraduate STEM students’ experiences in our universities. As my work has unfolded, I have begun to understand that future research on professors’ careers is synergistic with professional development for professors. Thus, in the following sections I describe how each of the four cross-case themes reported in Chapter 4 can be utilized to not only support professors in their careers but also to further enrich academic knowledge about professors’ professional lives. I also describe how I might utilize a follow-up study to further develop the data collected in the research project described herein. Personally, I anticipate that the next steps in my research program will utilize research studies that simultaneously provide the academy with more scholarly knowledge on professors’ careers and help develop innovative pedagogical support for professors.
Intrinsic motivation

If intrinsic motivation is more influential than institutional culture in driving professors’ behaviors, then pedagogical interventions and support programs might not be effective unless they are already in alignment with professors’ goals and beliefs. There is a relatively novel movement in psychology research to “promote work design research as a distinct area of psychological inquiry” (Parker, 2014). Such work examines a variety of factors involved in workplace satisfaction and efficacy including “motivational approaches…work design for learning and development, work design for health and well-being, and work design for the dual outcomes of control and flexibility” (Parker, 2014).

Researchers in work design define work motivation as “a set of energetic forces that originate both within as well as beyond an individual’s being, to initiate work-related behavior and to determine its form, direction, intensity, and duration” (Latham & Pinder, 2005).

Work motivation is itself a complicated construct in the psychology literature; Latham and Pinder’s review examines the following features: needs, personal traits, values, national culture, job design characteristics, person-context fit, cognition (especially goals), and affect (2005). This means that for stakeholders who seek to support science professors as teachers, we must consider all of these variables when designing and implementing pedagogical training and intervention. It was clear from my study described herein that participants prioritized the components of their jobs according to their intrinsic motivations, a conjecture supported by some psychology researchers (Blackburn & Lawrence, 1995; Lattuca, Bergom, & Knight, 2014; Sonnert, 1996). My
study results suggest that professors at RU/VH institutions might intrinsically prioritize research over teaching. If this finding is generalizable (see below), then professional developers might approach their work in the following ways: target supporting professors who express a desire to participate in professional development rather than working to convince individuals who are not already interested, or design more creative pedagogical support for professors who have no desire to engage in formal professional development.

A more poignant implication however is that professional developers might be able to design more successful pedagogical support programs if they first determine which intrinsic motivational factors are most important for their faculty.

This implication (the potential for increased success of professional development designed with professors’ intrinsic goals in mind) is connected to my revised research questions:

- How do science professors prioritize the various responsibilities of their jobs (particularly teaching, research, and service), and what are the practical implications of such prioritization?
- What factors influence professors as they make decisions regarding their professional priorities? In what ways do these factors influence those decisions?
- What types of pedagogical trainings and interventions might professors be willing to engage in? What types of pedagogical trainings and interventions might professors find useful? In what ways do professors find pedagogical trainings and interventions useful?
As described above, some literature (Blackburn & Lawrence, 1995; Lattuca et al., 2014; Sonnert, 1996) supports the findings reported in this study that professors might be more inclined to prioritize their various job responsibilities according to intrinsic motivational factors (e.g., professional interests, goals) rather than extrinsic motivational factors (e.g., promotional and tenure guidelines, top-down reform efforts, etc.) though those two types of motivators might be aligned at times. Future work should investigate the generalizability of this claim by collecting survey data that might provide statistically significant results.

Personally, I am interested in investigating academic cultures in which top-down edicts and institutional regulations are strong governing factors (i.e., cultures in which professors experience little autonomy) to see how professors in these environments balance intrinsic and extrinsic motivational factors. With an understanding of individual professors’ motivations, I might be able to connect them to more appropriate professional development resources and study how this type of pairing influences the way professors experience the professional development. This type of study could potentially allow me to simultaneously engage in innovative research and provide professors with effective professional development.

**Students**

If professors are heavily motivated by helping students, then efforts to implement educational interventions should be student-centered, and professors should also understand how those interventions will help students. In other words, the
implementation of research-based teaching methods might be more successful if professors are shown data that indicates these methods are proven to support student learning, achievement, retention, etc. As Weimer explains, because most professors tend not to read educational literature, they are not aware of and therefore do not explicitly utilize the descriptors “student-centered” or “learner-centered” (2012); this was confirmed in my own study where my participants extensively described the role of students in their work, but never used the aforementioned vocabulary.

Research on K-12 professional development programs has already shown that successful professional development programming should be student-centered (Darling-Hammond et al., 2009; Easton, 2008). This type of data has not been studied extensively at the postsecondary level, but researchers are making progress on defining, leveraging, and disseminating information about student-centered teaching in colleges and universities (Addy, Simmons, Gardner, & Albert, 2015; Henderson, Beach, & Finkelstein, 2011; G. B. Wright, 2011). Weimer summarized other scholars’ characterizations of postsecondary student-centered pedagogy operationally (2012). This pedagogy involves such activities as allowing students to make decisions about policies and procedures and making students responsible for their own pre-class preparation. In a review of student-centered learning in postsecondary setting, Wright concluded that “many college teachers believe that a student-centered classroom provides a more effective learning environment and are making efforts toward this end” (2011).

Indeed, my data does not provide me with sufficient information to speculate upon my participants’ definitions of student-centered teaching as compared to scholarly work on student-centered pedagogy. Thus, in my own future work I am interested in
further investigating my participants’ beliefs on student-centered pedagogy, particularly with respect to professional development designed to support student-centered pedagogy. This type of study would be directly related to my reframed research questions: What types of pedagogical trainings and interventions might professors be willing to engage in? What types of pedagogical trainings and interventions might professors find useful? In what ways do professors find pedagogical trainings and interventions useful?

The data presented herein does support the notion that my participants would be pleased to engage in teaching activities designed to improve student learning as long as such activities were designed in such a way that they did not interfere with the participants’ research activities. The generalizability of this finding should be tested with large-scale studies which could provide statistically significant result.

**Lack of training**

If a lack of pedagogical training is a pervasive phenomenon for science professors, then efforts to introduce research-based teaching methods at an earlier stage (e.g., during graduate school) might garner more interest in professional development activities at later career stages. I agree with Oleson and Hora’s (2014) assertion that even though there is a popular sentiment that faculty teach the way they were taught, this mantra is overly simplistic and neglects to acknowledge the wide range of personal and professional experiences individuals bring to their work. Furthermore, “the claim has little basis in empirical evidence” (Oleson & Hora, 2014). Stakeholders in postsecondary education reform agree that pedagogical training for graduate students and professors
could have a positive effect on professors’ teaching practices (Austin, 2013; Hekelman, Harris, & Irby, 1995; Hubball & Burt, 2006; Thoron, Myers, Harder, Stedman, & Roberts, 2012; M. Wright, 2005).

The findings reported in my study as well as a body of literature agrees that professors are typically well-trained as researchers during graduate school but receive little training in teaching or research group management (Austin, 2013; Ciaccia, 2011; Feldman, Divoll, & Rogan-Klyve, 2013; Qualters, 2009). Thus, education researchers are interested in developing training programs for graduate students which are more closely aligned with what professors will actually be expected to do in their jobs (Austin, 2013; Ciaccia, 2011; Feldman et al., 2013; Seung, Bryan, & Haugan, 2012; Thompson, Christensen, & Wittmann, 2011; Zhu, Groscurth, Bergom, & Hershock, 2010).

Similarly, researchers are interested in investigating support for early-career professors (McGill & Settle, 2012; Schechner & Poslusny, 2010; Tenuto & Gardiner, 2013; Thoron et al., 2012). The findings reported herein provide further support for both of these types of efforts (professional development for both graduate students and early career faculty). Studies which examine programs that do provide professional development for graduate students and early career faculty could provide interesting contrasts to the majority of reports currently found in the literature.

Personally, I am interested in conducting a longitudinal study which follows two groups of individuals: graduate students who intend to become professors and receive pedagogical training throughout graduate school, and early career professors who receive pedagogical training throughout their pre-tenure years. This study would track these individuals as well as a control group of matched cohorts who do not receive such
training in order to study the effect of the training on factors such as retention in academia (including achievement of tenure), job satisfaction, teaching excellence, etc. This study would primarily be related to my reframed research questions: What types of pedagogical trainings and interventions might professors find useful? In what ways do professors find pedagogical trainings and interventions useful?

**Time management**

If professors are not seeking professional development or pedagogical support because they prioritize research activities over teaching, then professional development offerings which are primarily job-embedded and require little to no additional time commitment might be more successful. It is also possible that providing free time through teaching or service relief could allow some professors to engage in professional development they would otherwise not have time for. However, this latter conjecture is uncertain considering what this study uncovered about the way participants prioritize their time (research, then teaching, then service). It is possible that buyouts and other time relief efforts would simply lead to more time spent on research.

In a recent review of faculty time allocation literature, Anderson and Slade (2015, p. 4) explain that although extensive research has been done on professors’ work-life balance, “faculty time allocation and ensuing pressures are poorly understood” and “tradeoffs between different types of faculty work activities have received little scholarly attention.” Other scholars (Colbeck, 1998; Healey, 2005; Jenkins & Healey, 2005; Marsh & Hattie, 2002) seem hopeful that efforts to integrate research and teaching
activities would lead to the simultaneous accomplishment of professors’ research and teaching goals; however, all of these researchers agree that more work must be done before generalized recommendations can be made.

I am personally motivated to engage in research that investigates whether the prioritization of work activities seen in my study is generalizable to the larger population of STEM professors, addressing my reframed research questions: How do science professors prioritize the various responsibilities of their jobs (particularly teaching, research, and service), and what are the practical implications of such prioritization? What factors influence professors as they make decisions regarding their professional priorities? In what ways do these factors influence those decisions? I am interested in engaging in large scale studies which further probe the question of how professors manage their time and prioritize their multiple professional activities. Since the study executed herein took place at an RU/VH institution, it only represented professors who are expected to produce high volumes of research work. Thus, in this proposed future study, I will also investigate professors at other types of institutions in order to understand how the type of school might effect this prioritization.

**Follow-up**

Because early career professors are experiencing a unique period of growth and change, I am interested in engaging in a follow-up study one year from now with the three early career professors (Ben, William, and Pierre) who participated in the study described herein (note that Henry is not an early career professor). The period of one year
has been chosen based on the participants’ assertions their jobs change weekly, monthly, and yearly, and weekly or monthly follow-ups would be impractical within the time and financial constraints of the project. All three of these participants have expressed interest in participating in this follow-up study.

This follow-up study will be very similar to the one described in this dissertation, but I hope to engage in some data collection that reaches a greater depth of understanding about these individuals’ careers and the nature of change over time. I will revisit the professors, observe their professional activities, and engage in phenomenological interviews. I will utilize the reframed research questions described previously, and I will compare the way they are experiencing their careers during the follow-up study to the way they experienced their careers during this original study. Based on comments the participants have made about ways in which their jobs have already evolved in recent years, I imagine that changes in the participants’ careers will include greater confidence, more systematic routine to some parts of their jobs, and less stress regarding promotion and tenure (particularly in Pierre’s case, as he had not yet applied for tenure at the time of this study).

Conclusion

This study began as an exploration of the lived experiences of STEM professors at research-intensive universities. It was my hope that by honoring the traditions of qualitative research I would gain a deep understanding of my participants’ professional lives in order to contribute to the body of scholarly knowledge on these understudied
stakeholders in postsecondary science education. Furthermore, I viewed this study as a springboard for my entire career; I hoped that the insights gained here would shape my thinking to inform subsequent studies. My ultimate career goal is to find innovative ways to support science professors while simultaneously contributing to the body of scholarly knowledge on science professors’ careers, as I believe this strategy is an untapped resource in current efforts to improve undergraduate STEM education. My unique opinions on this topic defy some popular efforts as I do not endorse top-down reform or even unsolicited peer-driven professional development. Instead, my approach to supporting science professors begins with hearing their stories. I ask, “What do you want to accomplish, and what can the academy do to facilitate those goals?”

In my final paragraphs, I present my “gut reaction” to my study’s findings as well as my opinions as a DBER practitioner. The results of this study, though they are limited in their generalizability, have refined my understanding of the way professors might experience science education. In my experience, education experts all too often narrowly view college campuses as homes for our classrooms. There is a disconnection between this view and the greater intricacies of science professors’ roles and responsibilities. As Henry reminded us, our professors do not want to do just one thing. I am eager to further investigate the way larger populations of science professors prioritize their careers. If many of them are intrinsically motivated to prioritize their research programs over their teaching as are several of the participants in this study, then postsecondary education reformers must stop pretending that this is not the case. We must respectfully acknowledge that science professors do not have to view teaching as more important or even place it on par with their research programs in order to be effective practitioners.
We must create new resources that are intelligently designed to operate within a system where teaching is considered important but perhaps not *most* important. Indeed, this will seem like an unthinkable idea to some, but just as Pierre has asserted, it is essential that we know the culture we live in and learn to excel in it.

I am aware that the opinion I present in these final paragraphs might incur criticism. One might ask why I do not propose to change a culture that I believe prioritizes teaching after research. My answer is simply that it is not within my rights to choose for other individuals what aspects of their careers they are passionate about. It is understandable to me, for example, that a science professor who has spent her entire academic career training to be a scientist will prioritize a research grant that will fund her lab for five years over the preparation of the next week’s lectures. Thus, instead of attempting to change the very core values of that professor’s career, I would rather respect those values and create resources for her to be successful in *all* areas of her job without compromise.

Research universities are complicated communities of a wide variety of individuals. With so many competing agendas, it is important to consider the full range of issues involved in each opportunity for growth. For these reason, my research program will continue to deeply study science professors’ lived experiences and design postsecondary pedagogical support programs.
Appendix

Autoethnography

This autoethnography was written in January 2015 before the commencement of the research project described herein. Throughout my study, I was able to maintain a mindfulness of my own experiences as separate from my participants’ experiences as this document gave me the intellectual space to bracket my experiences.

As I embark upon a study of university science professors’ careers, I am keenly aware of the proximity of this project to my own experiences. Though my previous participation in the culture I am studying will provide me with many valuable insights, there are also ways in which it could impair my ability to understand my participants as a social scientist. With this understanding, I am writing this autoethnography in an attempt to bracket my experiences, gain some degree of analytical distance from them, and offer transparency to consumers of my research.

Though my earliest experiences with postsecondary science education were in my freshman and sophomore years of college (1999-2000), I do not have a sense of these introductory courses making a great impact on my current thoughts and opinions. My best recollection of those years is making an effort to pass general chemistry without putting in much effort – flying under the radar, so to speak. I did not have an interest in a science career at that time, so it was not until several years later, when I began to take a
serious interest in pre-medical courses, that I decided to make an earnest effort to “learn” science. In 2003, I took my first organic chemistry class, and this was the first instance that I can remember loving a science class. I attribute this positive attitude to the skill of the professor for the course, Dr. Georgina Hart. Even now, as I conduct research in the field of postsecondary science teaching, when I try to determine what my conceptions of a “good” science professors look like, I turn to my memories of Dr. Hart. I felt then (and still believe) that the essential component to her “good” teaching was her personal passion for the content matter combined with her authentic concern for the success of her students. This is the first caution I issue to myself: I must try not to compare my research participants to Dr. Hart, the person I consider the embodiment of a “good” teacher.

After my experience in Dr. Hart’s organic chemistry courses, I decided to pursue a career in organic synthetic chemistry. I was accepted to an undergraduate research program at Florida International University (FIU) and thus embarked on three years of research under the mentorship of Dr. Stanislaw Wnuk. I have chosen the word “mentorship” here purposefully; Dr. Wnuk was an exacting scientist with high standards for research, but he never failed to see the human side of our work. I learned from my years in Dr. Wnuk’s lab that science is primarily a human endeavor, that scientists are passionate people, and that the culture of science research must be built on a strong foundation of collaboration and collegiality. These beliefs would come to be shaken through future experience, but for now I will remark that another caution I issue to myself upon engaging in my doctoral work is this: I must take care not to compare my research participants or their lab groups to Dr. Wnuk and the familial lab culture I enjoyed as his student.
Upon graduating from FIU and arriving at Penn State, I joined another synthetic organic chemistry lab. My plan was to obtain my Ph.D. and become a professor of chemistry. My first two years here proceeded relatively smoothly, though I noticed that the cultural norms were very different from what I had experienced previously. In short, scientists here seemed to work more independently and competitively, and larger sociocultural relationships pertaining to race and gender were more strained. The principal investigator (PI) in my lab was primarily interested in lab productivity and publication rates. By my third year, I had grown weary of my life isolated in the lab and reached out for more teaching experiences. Up to that point I had been supported by grant money that “freed” me from teaching, and my PI wanted me to focus on lab work. As I felt more and more longing to interact with students, I began to question the way science graduate students were trained. I could not understand how I could be a good professor if I was only going to be trained in my content area and never take a pedagogy course or even have the opportunity to work with students. After almost a year of discontent, I made the decision to change doctoral programs from chemistry to science education.

Those three years in chemistry at Penn State have shaped a great deal of the thinking that has gone into the design of the project proposed herein. Therefore, it is here that I must pause with the greatest sense of reflection and consider the areas which need to be bracketed:

- At times, I felt that I was treated unfairly due to my ethnicity and gender. I must take care not to be overly sensitive to these issues during my research, though I will utilize my awareness of them.
- I believe that science graduate students who wish to teach are not properly trained to do so. I must not impose this belief upon my participants or assume that they have not been adequately prepared to teach.

- I am concerned that some science professors place such an emphasis on research productivity that their students (both undergraduate and graduate) suffer a form of neglect as people who have complex lives, goals, and needs. Again, I must not be too sensitive to this issue while I use this cultural knowledge to my advantage.

Finally, I have now been working in professional development and outreach for nearly five years. This work has allowed me to interact with a wide variety of stakeholders in science education, from K12 teachers and outreach staff to university professors and administrators. I have come to understand a great deal about the range of issues and concerns that all of these individuals bring to the table, but most importantly, I feel that the majority of them possess a sincere desire to create the best educational system possible for our students. However, even though this is my experience and belief, I should not assume that my participants feel this too. I must try to remain open-minded about what their actual goals and intentions are.

Taken holistically, the experiences I have described here do more to enhance than hinder my ability as a researcher in postsecondary science education. I have an “insider’s” understanding of the language and culture I am studying – as a student, researcher, graduate assistant, and professional developer. This will make it easier for me to comprehend many of the things my participants say and do, as it has already helped me consider which issues I should be studying and how I should be studying them. I am cautious however, and will remain vigilant to consider how my feelings and beliefs might
influence me over the course of my work (indeed, my career). Certainly I will not claim or even attempt to eliminate my personal view from my work, but I will make every effort to remain transparent to consumers of my research.
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Professional Service

2013 – 2015  Diversity and Community Enhancement Committee (DCEC), College of
            Education, The Pennsylvania State University

2013 – 2015  Advisory Board, Center for Excellence in Science Education (CESE), Eberley
            College of Science, The Pennsylvania State University; Subcommittee member,
            Peer Learning Corps

2012 – 2013  Student editor, American Journal of Education Forum, University of Chicago
            Press

2011 – 2013  Organizer, Women in STEM Education, College of Education, The
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