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Exploring Underrepresented Doctoral Students' Conceptualizations of the Student-Advisor Relationship in Chemistry

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by
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Accepted by:
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Abstract

While it is typical for doctoral students in the sciences to have a faculty advisor, not all students can name a mentor for their doctoral journey. Noted as the most important factor in determining a student's success and satisfaction in graduate school, the student-advisor relationship is an important area for expanded study and analysis to fill in the gaps in understanding of our doctoral education system. This study details the various ways in which underrepresented chemistry doctoral students view and perceive their relationships with their faculty advisor.

I used purposeful sampling to select 16 underrepresented doctoral chemistry students at public, land grant institutions in the southeastern United States. I generated data through individual, one-on-one interviews using a structured interview protocol that I carefully developed through a pilot study. I analyzed these data using open-coding through several cycles and phases. Additionally, I worked with an analysis team through several cycles of coding, in line with principles for a thorough phenomenographic study.

This phenomenographic investigation of African-American, Hispanic, and female Ph.D. students in the field of chemistry yields five major types of student-advisor relationships: autocracy, business relationship, absentee relationship, mentorship, and mentorship with advocacy. My participants' perceptions and experiences provided the basis for constructing a model that contributes to the body of knowledge on doctoral education and helps to fill gaps in the literature. My model provides powerful implications for change and guidance in PhD programs for students, advisors, and administration. The outcomes of this multi-institutional study expand our current understanding of student-faculty relationships in an effort to improve graduate education in the sciences, particularly

for underrepresented students.

Dedication

To my family, whose love and support have never faltered. To my Mom, Dad, Abigail, Kyle, Brianna, Grace, and Benjamin. To Cody and Braelyn.

Acknowledgments

At the close of what some call the "perilous passage," I acknowledge the support, guidance, and faith of so many that have helped me navigate my way.

I must first thank Eliza D. Gallagher for being a true mentor and an unfailing advocate. Your endless energy and quick-start approach pushed me beyond my self-doubt and my "slowly-gather-all-possible-resources-first" mentality. I look forward to continuing our work together as colleagues.

I would not have made it to the end without the support of the rest of my committee. Lisa Benson, Cindy Lee, and Matthew Boyer: not once did any of you falter in your belief that this would all come to fruition. I am so grateful to have learned from and worked with all of you.

A special thank you to my analysis team! I have loved working and learning with all of you. This work would not have been possible without your devil's advocacy. Khushikumari Patel, Paran Norton, Staci Johnson, and Maya Rucks, thank you.

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To Mr. Eisley for putting the bug in my ear to become a scientist. To Michael Duffy for believing in me as a hesitant college freshman and sparking my interest in both research and teaching chemistry in higher education. To Anna Fedor for the notion that us small-town kids could apply to REUs and attend graduate school. To my Misericordia crew: you know who you are. We have come a long way from the Cougar's Den. To my friends and family around the globe that have touched my life and inspired me in many ways.

To all of my participants in both this study and in the various other research endeavors I am grateful

to have been a part of: I hope I will continue to do you and your lived experiences justice. Without your honest testimonies and willingness to share your lives with me, I could not have completed this work.

To my parents, Jim and Veronica, for reading to me and making me number lines as a child and for your faith in my journey through the Ivory Tower. To all of my siblings, thank you for always cheering me on and making me laugh from 700 miles away. I love you all.

To my grandparents, Jim & Carole and Floyd, thank you for your encouragement and faith through all of these years! Thank you to my Godparents Joe and Jen, and all of my wonderful aunts, uncles, and cousins. To my dear Nana, I hope I have made you proud and I am so thankful for your brave solo passage from Germany to the United States so that my own journey was even a possibility.

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Chapter 1

Introduction

Our competitiveness as a nation hinges on our ability to produce a skilled and diverse workforce that can respond to major changes in the scientific landscape. Scientists are needed to help fill the estimated 20% increase in new jobs (or 2.6 million) requiring Ph.D.s in the United States over the next decade (Wendler et al., 2012). Additionally, broadening participation in doctoral education in the United States is considered to be a national priority so that we can expand our pool of potential scientists to untapped populations (PCAST, 2012). Diversification of not only our graduate student population, but also our future workforce, is critical (Wendler et al., 2012).

Our nation's population is currently 12.2% Black/African American, 16.4% Hispanic, 63.6% White, and 50.9% female (NSF, NCSES, 2015). Over the last 10 years, our nation has awarded 26,694 Ph.D.s in the physical sciences to citizens and/or permanent residents. Of this population, 3.22% are Black/African-American, 4.53% Hispanic, 73.39% white, and 31.41% female (NSF, NCSES, 2015), as shown in Figure 1.1. The small fractions of these populations indicate the vast pool of potential talent and skill we are not utilizing as a nation, and leads to their designation as *underrepresented*. In an effort to increase our diverse workforce of skilled scientists, we must examine doctoral education of underrepresented students.

	African-American	Hispanic	Female
■ Nationwide % population	12.2	16.4	50.9
■ Nationwide % PhD awarded	3.22	4.53	31.41
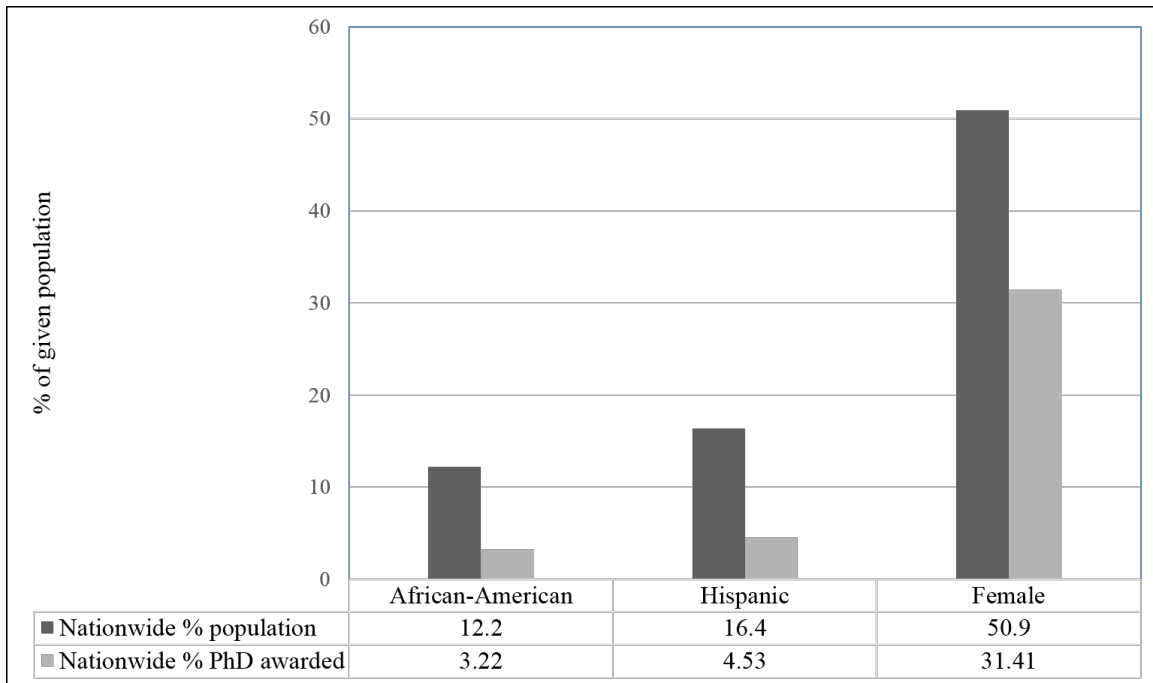
Figure 1.1: Ph.D. Student Demographics Nationwide

To do so, one may naturally wish to examine rates of recruitment, enrollment, retention, and completion. However, this becomes quite complicated because there is no singular method or manner by which these numbers are tracked. Different universities, colleges within universities, and individual departments all compile numbers of students entering and exiting their programs differently. Due to the varying lengths and requirements of Ph.D. programs, it is even harder to examine data such as time-to-degree completion of individual students. Attrition rates, or rates at which students leave a degree program, are also difficult to calculate, as some students may leave at varying points with intentions to return, may start a new degree program elsewhere, or may switch advisors. How individual departments report retention or attrition also varies, in that some programs do not consider a doctoral student *enrolled* in the program until they have completed their candidacy exam and have achieved the title of "Ph.D. Candidate." Many students who fail this candidacy exam, or choose to stop out of a program at or before this point, may never have been counted as an enrolled Ph.D. student, leading to inflated rates for successful completion of a Ph.D. From what data are collected, it is generally accepted and reported that 50% of those that begin a Ph.D. program do not finish that program (Lovitts, 2001; Golde, 2005; Gardner, 2009; Di Pierro, 2007).

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In order to take a closer look into the population under examination in this study, we can examine some local rates for doctoral student enrollment and completion. I have compiled current publicly-available data reported from the four institutions represented in this work, which are Southeastern, public, land-grant institutions. To protect the anonymity of my participants, I have not parsed the data into individual institutions, but report them as aggregate data. As seen in Figure 1.2, 23,183 graduate students were enrolled as of the Fall 2017 semester across the four institutions in this study. Of these students enrolled in 2017, 54% were female, 6.9% were Black, and 3.2% Hispanic. Not all of the institutions report separate numbers for the enrollment of doctoral students and master's students, so I am unable to provide program-level enrollment data.
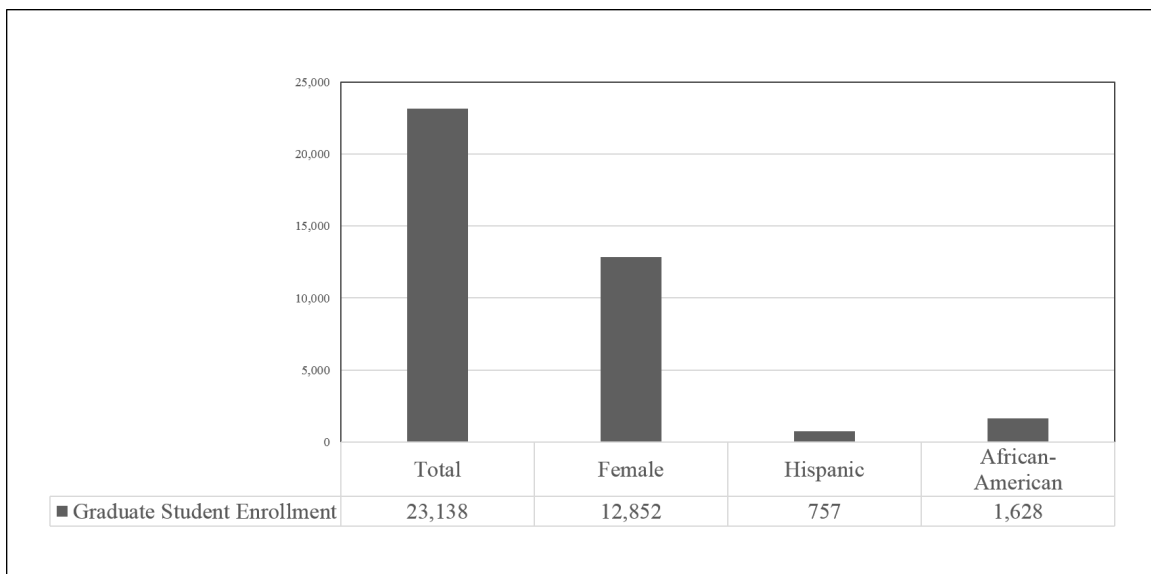
Figure 1.2: 2017 Graduate Student Enrollment for the Four Southeastern Public, Land-Grant Institutions

The next piece of relevant publicly-available data to examine is the doctoral degree conferral numbers. In the last academic year, the institutions in this study conferred a total of 1,842 Ph.D.s, as calculated by combining publicly-available data from each individual institution's website. Not all institutions have reported the breakdown of Ph.D.s by gender and race/ethnicity; however, extrapolating from the institutions that do provide such a breakdown, we can estimate that less than 40% of Ph.D.s were earned by females, less than 4% by Blacks/African-Americans, and less than 4% by Hispanics. By taking these percentages of the sum of degrees conferred by each institution,

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Figure 1.3 shows the extrapolated number of degrees conferred upon female, African-Americans, and Hispanic students. When considering that the numbers were extrapolated from the highest reported percentage ranges within each category, it is in the most positive light that we estimate 74 Hispanic students and 74 African-Amrican students earned their Ph.D.s in 2017. Taking into account that these estimated 74 students are spread across all doctoral programs from these four institutions, it means that perhaps anywhere from zero to two Hispanic students in 2017 graduated with a Ph.D. from a single program.

	Total	Female*	Hispanic*	African-American*
■ Doctoral Degrees Conferred	1,843	719	74	74
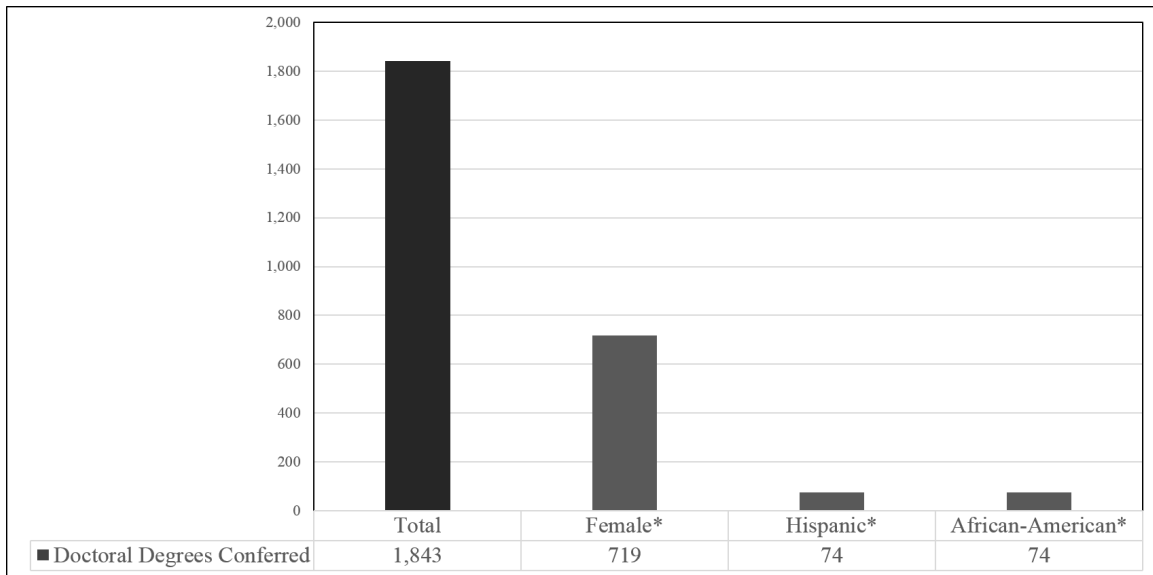
Figure 1.3: 2017 Total Doctoral Degrees Conferred for the Four Southeastern Public, Land-Grant Institutions. * Indicates that numbers were extrapolated.

These numbers are troublesome, particularly when considered in the historical context of race relations in the Southeastern United States, and in the setting of this study at public-land grant institutions. Land-grant institutions, established by the Morrill Acts of 1862 and 1890, were intended to offer a broader, liberal, and more affordable education to the working class (NASULGC, 2008). Moving away from the model of Yale and Harvard, the Morrill Act set aside land in each state to make education more accessible to all; in 1890, it was established that any of the land grant institutions using race or color as an admission criterion would not receive federal funds. All four institutions where participants were recruited in this work did use race for admission purposes and it was not until the 1950s and 1960s that Black students could enroll. Each one of the states where

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the institutions are located, however, established land grant institutions for Black students, so the four institutions still received federal funds, as per the 1890 act. Additionally, 17 historically Black land grant institutions were established in the segregated Southern states. Over time there have been several more acts and programs that have set aside funds for socially disadvantaged populations (NASULGC, 2008). For example, land-grant status was granted in 1994 to Native American colleges, that are on or near reservations. Funding has also been provided for long-term extension programs between previously-established land grant institutions and Native American land grant institutions in the same state (NASULGC, 2008).

Aside from enrollment data and degree conferral data, what do we actually know of the doctoral student experience? Existing literature on the doctoral student experience has yielded valuable information that serves as the foundation from which to build. For example, Nettles and Millett surveyed Black, Hispanic, and White students from four institutions and found that Black and Hispanic doctoral students reported feelings of racial discrimination within their Ph.D. experience (Nettles & Millett, 2006). Lovitts found, in her study of over 800 students at two universities, that 71% of African-American students experienced equal discrimination from their own advisor, other departmental faculty, outside faculty, and students (Lovitts, 2001). According to Lovitts, underrepresented minorities have both lower enrollment rates and higher attrition rates in Ph.D. programs than White and Asian counterparts.

Although there are many facets to the quality of a Ph.D. experience, scholars agree that the single most important factor is the relationship of the faculty advisor and the graduate student (Lovitts, 2001; Gardner, 2006; Nettles & Millett, 2006; Golde, 2000; Council of Graduate Schools, 2008). There is a substantive amount of literature outlining factors for graduate student success, including socialization with peers, interactions with other faculty as independent researchers, and interactions/relationships with the faculty advisor (Nettles & Millett, 2006; Lovitts, 2001; Gardner, 2006, 2008). In fact, the quality of the relationship between the advisor and the student directly affects the rest of these factors, as well as student satisfaction and degree completion (Lovitts & Nelson, 2014). Faculty advisors play an extremely important role in the success and integration of students within the institution, the department, and the individual research group.

In their iconic study on doctoral education which is summarized in their book, *Three Magic Letters:*

Getting to Ph.D., Nettles and Millet define a 'mentor' as "someone on the faculty to whom students turned for advice, to review a paper, or for general support and encouragement" (Nettles & Millett, 2006). Over 9,000 students were surveyed and every single participant reported having an advisor; however, 25% of these students said that they did not have a mentor, and there was significant discrepancy in these rates along racial lines. In the sciences and mathematics, for example, 43% of African-American doctoral students reported that they did not have a mentor, as compared to 24% of White students; African-American students in the sciences were also 2.6 times less likely to find a mentor than their White peers. Given that the relationship between the student and the faculty advisor is of utmost importance, it is startling to learn that many doctoral students implicitly do not consider their faculty advisors to be mentors. In particular, the lack of advisors as mentors for underrepresented doctoral students is a further deterrent to diversification and the broadening of our workforce.

1.1 Purpose

Currently, there are no studies closely examining students' perceptions of this critical relationship. There are studies that compile statistical survey data and interviews about the experiences of both students and faculty (Lovitts, 2001; Nettles & Millett, 2006; Gardner, 2009; Byers et al., 2014; Felder, 2010), but none which takes an analytical examination of the breadth of student perceptions. My study contributes to the body of knowledge in science doctoral education through a careful examination of the student perception. This was achieved through the employment of phenomenography, a methodology designed to first explore and expose the critically different ways that people experience and perceive a phenomenon, and then use those results to promote and support change. The overarching research question that guided this entire study is, *What are the different ways underrepresented doctoral students in chemistry perceive their relationship with their faculty advisor?*

1.2 Definition of Terms

The following terms are used throughout the study and are ordered as they appear in the subsequent chapters.

Attrition refers to students who leave a program or a university. Attrition rates are calculated at varying levels of consistency and with different criteria across programs, departments, and institutions so that it is difficult to determine the actual number of graduate students or doctoral students that have left without completing degrees. Furthermore, there are many scenarios through which a student leaves a department or degree program and joins another either immediately or at some subsequent time, leaves a university entirely and begins study at another institution, or picks up study at some later point. These scenarios add to the difficulty in knowing just how many doctoral students fit into attrition data. Overall, it is generally recognized that across all programs, fields, and types of doctoral students, 50% of those that begin a PhD program do not finish that program (Lovitts, 2001; Golde, 2005).

A *graduate student* is a student who is in a graduate program seeking a Master's or Ph.D. In this study, all of the participants were Ph.D. students (one had just defended her Ph.D.) at the time of the interview. For this work, the term *graduate student* is used interchangeably with doctoral or Ph.D. student.

STEM is inclusive of fields that are science, technology, engineering, and mathematics. The National Science Foundation has a broad definition of science and engineering that includes biological sciences, engineering, physical sciences, mathematics, social sciences, computer sciences, and psychology (NSF, NCSES, 2015). I refer to science as inclusive of biological sciences (biology, microbiology, toxicology, entomology, etc.) and physical sciences (physics, astronomy, and chemistry).

A *doctoral* or *Ph.D. candidate* is a doctoral student or Ph.D. student who has successfully met departmental- and college-level criteria that allow them to progress toward conducting their independent research. This is typically achieved through one or more types of examinations, presentations, or proposals in which they present and defend the work they propose to do in completion of the Ph.D. requirements.

A *faculty advisor*, as defined by Nettles and Millett, is the person (or persons) "assigned by [a student's] department to act in an official capacity in such ways as discussing and approving [their] coursework, or signing registration forms" (Nettles & Millett, 2006)

A *mentor* according to Nettles and Millet is "someone on the faculty to whom students turned for advice, to review a paper, or for general support and encouragement" (Nettles & Millett, 2006).

I use the terminology of *Black/African-American* in the introduction to align with terminology used by the NSF and by the United States Census (Salinas & Lozano, 2017) for reporting data. Moving forward in this work, I use the terms *Black* and person(s) of color. *Person of color* generally refers to an individual who is neither White nor of European descent. Here I provide an extended commentary on the definition from the *Encyclopedia of Race, Ethnicity, and Society*:

> "People of color explicitly suggests a social relationship among racial and ethnic minority groups . . . [It is] is a term most often used outside of traditional academic circles, often infused by activist frameworks, but it is slowly replacing terms such as racial and ethnic minorities . . . In the United States in particular, there is a trajectory to the term from more derogatory terms such as negroes, to colored, to people of color . . . People of color is, however it is viewed, a political term, but it is also a term that allows for a more complex set of identity for the individual - a relational one that is in constant flux" (Vidal-Ortiz, 2008).

I used the term *Hispanic* here to refer broadly to persons who are from Spanish-speaking countries, primarily from Latin America (Marin, 2008). The use of the term *Hispanic* is often problematic because the term was originally used to refer to people from the Iberian Peninsula (Spain and Portugal), and over time came to generally mean any Spanish-speaking person. The term *Latino*, referring to those from Latin America, includes those from countries that primarily spoke other languages, such as Brazil and French Guiana (Salinas & Lozano, 2017). There is growing recognition in the United States of the use of the term "Latinx" to refer to persons from Latin America and to move away from the gender binary. My primary reason for using the term *Hispanic* in this work was to align with terminology used by the NSF and by the United States Census (Salinas & Lozano, 2017).

The National Science Foundation defines *underrepresented* in STEM to be women, persons with disabilities, and the three racial/ethnic groups of Black, Hispanic, and American Indian. This study, taking place in the southeastern United States, includes participants who identify as women, Black, and Hispanic. At the four institutions where I conducted the study, I did not seek disabled (or differently abled) persons; in my recruitment phase I did not find any American Indian doctoral students.

When I refer to *administration* and *administrators* throughout this work, I am including department chairs, deans, provosts, vice presidents, and presidents of a university. This includes more specific persons such as the Vice President of Academic Affairs, Assistant Dean for Professional Development and Inclusive Excellence, and Chief Inclusion and Equity Officer. I refer to administration to broadly include those who would ideally be supporting faculty and students and enforcing policies within departments, between departments, among the colleges at the university, and within the graduate school and the institution as a whole.

Doctoral student *socialization* refers broadly to the process of acquiring attitudes, beliefs, values, and skills that are essential to effective participation in a field or profession. Traditions and norms of a group (such as an institution, department, or research group) are passed through the socialization of its members.

Critical Incident Technique was used in the interview process with participants as a way to elicit rich detail. First used in the 1980s in service research to determine customer satisfaction with service providers and determine specific critical incidents that led to customers to either stay with their current provider, or switch to a new service provider (?, ?). A critical incident in a person's life is one which has negative or positive emotional indicators associated and is easier to recall because it is attached to a specific event or series of events (Edvardsson & Roos, 2001). For example, participants could easily recall the 'happiest conversation' and the 'worst conversation' that they have ever had with their faculty advisor in graduate school.

Free-listing was used in the interview process with participants as a way to elicit rich detail in a manner other than through speech. Giving participants pen and paper and asking for words or small phrases to describe their relationship with their faculty advisor helped to elicit various aspects

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of their experiences and feelings about the relationship that they may have never vocalized in the interview. For example, participants often wrote words that were in opposition of one another (such as difficult and rewarding). The conversations that stemmed from this activity were integral in understanding participants' experiences.

1.3   Brief Overview of Study

I used purposeful sampling to select 16 underrepresented doctoral chemistry students at public, land grant institutions in the southeastern United States. I generated data through individual, one-on-one interviews using a structured interview protocol that I carefully developed through a pilot study. I analyzed the data using open-coding through several cycles and phases. Additionally, I worked with an analysis team through several cycles of coding, as is recommended for a thorough phenomenographic study (Bowden & Green, 2005; L. Mann, Dall'Alba, & Radcliffe, 2007; Green & Bowden, 2005).

In an effort to determine and document the qualitatively different ways that underrepresented doctoral chemistry students perceive their relationship with their faculty advisor, I shaped this study using the methodological guidelines and suggestions of phenomenography as described largely by John Bowden (Bowden & Walsh, 2000; Green & Bowden, 2005) and Llewelyn Mann (L. M. Mann, 2005). Briefly, this involved many successive cycles of coding through all of the transcripts as a whole to find themes and categories of description among the participants' experiences and testimonies. The outcome of several passes and cycles through the data was a model of varying ways that underrepresented students experience their relationship with their faculty advisor.

1.4   Delimitations and Limitations of Study

As in any interpretive qualitative study, there are both limitations and delimitations (boundaries) to the study. Delimitations are necessary for the clarity and feasibility of a study. Both delimitations and limitations restrict the questions that a study can answer. The difference is that delimitations

are set by the researcher (as bounds of the study) and limitations are largely out of the researcher's control.

1.4.1   Delimitations

There are several delimitations in this study that were set for reasons of clarity and utility. The main boundary that was set was to focus on underrepresented doctoral students in the physical sciences. This was done in response to the national need for broadening participation in STEM fields and in positions requiring skilled Ph.D.s. The study was bounded to participants in Ph.D. programs at public, land-grant institutions in the Southeastern United States of higher or highest research capacity (R2 and R1, respectively) (Carnegie Foundation for the Advancement of Teaching, 2017). Given the purpose of land-grant institutions to make education more accessible to the working class (NASULGC, 2008), it is important to study students' experiences in the Southeastern United States, which has a long history of oppression and racism, reaching back to times of slavery through segregation to present day. I also purposefully recruited Ph.D. students who had either attained candidacy status, or who had at least hit some type of benchmark in their program and were pre-candidacy so that they had the time to be in their program, experience some type of major milestone in the Ph.D. journey, and be able to reflect upon their relationship with their advisor. Lastly, in seeking underrepresented students, I sought within the demographic constraints of both the Southeastern United States and of those in science doctoral programs. This led me to primarily seek Black males and females, Hispanic males and females, and White females.

1.4.2   Limitations

There are inherent limitations to both qualitative research in general, and to the ascribed methodology of phenomenography in this study. While I initially set out to study both physics and chemistry graduate students (physical science), the actual number of physics doctoral students in the target population currently studying in the Southeastern United States put a serious constraint in the recruitment phase. Only one physics doctoral student was successfully interviewed, so this participant's data were not analyzed in entirety with the rest of the participants.

As the focus of the study is on underrepresented students, this likely inhibited some students from responding to recruitment emails or committing to be a part of the study. There were some email exchanges with potential participants who did not feel 'underrepresented' and who seemed very uncomfortable and wary with the fact that I contacted them, as they felt it implied that someone who knew them 'sent them' to me.

1.5   Political Climate

While this section is not a personal statement of political affiliation or an opinion piece, I do intend to set some of the political climate at the time the data were collected. This is in an effort to shed some light on the messages, images, influences, and societal tensions at the time that participants agreed to share their experiences and perceptions with me.

Although potentially not as salient or important outside of this time period (February through May 2017) topics and themes relating to political issues emerged as important to the participants' perceptions and experiences in graduate school. Some of these experiences emerged heavily due to the political climate and the circumstances surrounding the nomination, election, and inauguration of our 45th President. This election has been compared by some to be reminiscent of the 1964 election year: "a presidential campaign with deep, and painful, racial undertones" (Milligan, 2016).

The pilot studies, conducted in order to narrow the focus and to structure the interview protocol, took place before the mounting tensions of the primaries. The recruitment process and the interviews were conducted after the inauguration, when tensions were high. Many people felt threatened, scared, and unsettled. There were no questions directly probing for reactions to the election in the final protocol that was used in the full study because these were things that emerged as I was in the midst of interviews. It became very clear that participants of my study were experiencing real fear, and racial tension, although I did not probe for these as a reaction directly.

1.6   Positionality Statement

As a former doctoral chemistry student who achieved the candidacy status and then left the program with a Master's degree, I have an agenda with this work that I feel should be elucidated. I have personal experiences and perceptions as a scientist, woman, student, mentee, advisee, researcher, former chemistry Ph.D. student, and current Ph.D. candidate. I not only left a Ph.D. program to start a different doctoral journey, but also found myself in the midst of a mismatch in the middle of this journey, and switched advisors in an effort to move forward successfully. This project is a work of passion, a personal desire to learn more of others' experiences in an analytical way outside of my own, and a tangible way to construct something meaningful to reach those who need it most. I approached all of the analysis and the communication of my findings with my personal agenda, which continues to fuel how I am disseminating and communicating my work. I took careful steps along the way at every stage of the making and handling of the data to mitigate bias through bracketing and memoing. All of my choices were driven by my need to make graduate education better for students and faculty alike.

Those who, in my mind, need to see and understand the perceptions of doctoral students, are current and potential graduate students. Current and future faculty members, exposed to the perceptions that my participants have of what they think the relationship is supposed to be, juxtaposed with their actual experiences, can also benefit faculty as they build their own advising and mentoring. In general, little exists at most institutions to train faculty members how to be effective and appropriate advisors and mentors. Administrators also need the exposure to the perceptions of students so that they can support faculty and students alike in the roles and relationships that develop in the complex hierarchy of academia.

Chapter 2

Conceptual Framework

In this chapter, I summarize the main theoretical frameworks that I used as foundations for my dissertation, along with what I gathered and learned from my pilot studies. After the first pilot study, I utilized Socialization Theory and the Quality Engagement Theory of Graduate Education as theoretical foundations to this work to guide my second pilot, which directly shaped my interview protocol. This is summarized in Figure 2.1. As can be seen in Table 3.3, my interview questions are directly tied to theoretical frameworks and particular methods aimed at obtaining rich testimony. A theoretical framework is a pre-existing, documented, guiding structure and foundation based upon theories that other scholars have used in their research.

In an effort to bring together relevant literature and common theoretical frameworks used in the study of doctoral education, this chapter serves as a conceptual framework. Although 'conceptual framework' is often used interchangeably with 'theoretical framework' by some researchers, I use them as distinct from one another. A conceptual framework, as I use it in this work, encompasses the knowledge brought in from other scholars and studies through the literature as outlined and supported by already-established theoretical frameworks, as well as from my own research helping to frame my understanding and direction. The theoretical frameworks that I chose and used to build my pilot study did not fully answer my question and left gaps in understanding. Therefore, I tend to think of them and utilize them more as a 'foundation' and less as a 'framework.' My conceptual

framework is more inclusive than simply the foundation, because it also helps to situate this work where there is the knowledge gap, and further takes into account the knowledge and direction gained from employing the pilot studies. In Chapter 3, I outline and explain my overall paradigm, assumptions and philosophies, and specific methods to collect and analyze the data.
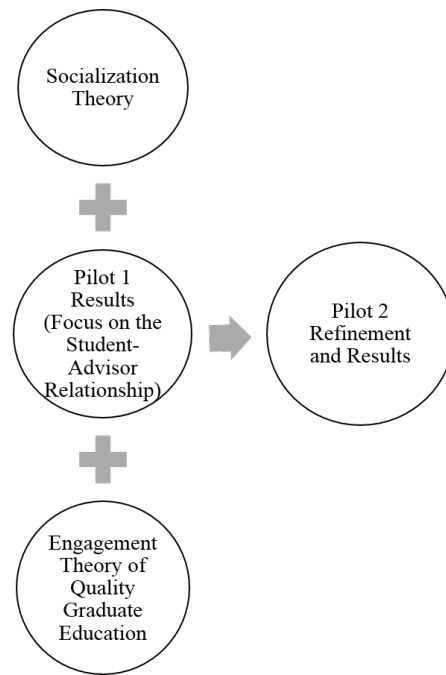
Figure 2.1: Conceptual Framework

2.1 Socialization Theory

In a broad sense, socialization theory provides a lens for discovering and describing how students integrate into a new group to become a part of a culture. Socialization also helps to examine how norms are shared in a group and describes the satisfaction of individuals who begin to 'fit in' with peers in the newly adopted group (Gardner, 2010; Gardner & Mendoza, 2010; Gardner, 2006). In joining any kind of organization or group, new members (such as graduate students entering their new degree program, department, and cohort) learn to adopt values, skills, and attitudes. These pieces, and the activities that members of a group take a part in, make up the culture and climate

of an environment and group. Taking an active part in these activities in conjunction with others is seen as integration, and successful socialization. This includes socialization with peers, with a faculty advisor, and with other faculty members and researchers as the student grows as a researcher and scientist (Gardner & Mendoza, 2010; Austin, 2002).

Students who are successful in socializing are more likely to build social and cultural capital (Huber, 2014; Longden, 2004). The forms of capital that are generally valued in higher education, and therefore graduate education, are those that have been normalized in the history of our country, those of white, middle-class males (Gardner, 2008; Bancroft, 2014). Students who do not identify with the majority category are less likely to possess the same valued, normative capital (Gardner 2008). Furthermore, integration into a new group and field that does not hold the same capital as valuable, will be that much more difficult. The original work of Vincent Tinto, widely cited by scholars in higher education, claims that students who fail to leave behind their individual culture and fully assimilate into their new culture will fail at integration (Tinto, 1975, 1993). Tinto's original theory of student departure has been reworked over decades of research and cultural criticisms, but there remains truth in the original theory for underrepresented students. These students do not quite 'fit the mold' of a graduate student and sometimes the consequence may be a failure to truly thrive (Austin, 2002; Weidman & Stein, 2003). A major consequence can also be their full departure from the Ph.D.

2.2 Engagement Theory of Quality Graduate Education

Haworth & Conrad's Engagement Theory of Quality Graduate Education provides a foundation to describe high quality programs as those in which students, faculty, and administrators are all invested in "mutually supportive teaching and learning" (Haworth & Conrad, 1997), as illustrated in Figure 2.2. This theory gauges engagement via student participation in learning, personal investment in research, and student satisfaction; it states that teaching and learning must be interactive and well-funded, and must lead to enhanced collaboration. The researchers who constructed this theory began their work with the notion that student growth and development are paramount despite differences in institution, program, department, and level. They interviewed 781 people, including

faculty, students, administrators, alumni, and employers to identify the attributes that they claim typify an ideal program in higher education (Haworth & Conrad, 1997).
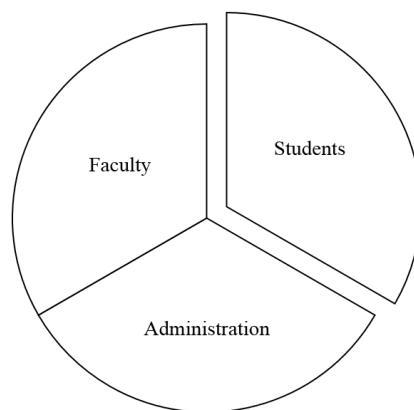
Figure 2.2: Quality Engagement: Three Pieces of the Puzzle

There are five major features of a properly engaged program: 1) diverse and engaged participants, 2) participatory cultures, 3) interactive teaching and learning, 4)connected program requirements, and 5) adequate resources (Newswander & Borrego, 2009), as seen in Figure 2.3 and delineated in Table 2.1. This theory can be used to determine facets of a program (or a department or research group) that are strong and/or that need strengthening. In this work, these pieces are also important for the discussion of implications in Chapter 7.

Although my study focuses particularly on the student perceptions and student conceptualizations of the relationship with faculty advisors, understanding how the students, faculty, and administration are all intimately connected in graduate schools and graduate programs is essential to situate findings in the broader landscape. Focusing qualitatively on doctoral students, at this time, will help set the stage for future studies focusing on faculty, administration, and ultimately, on the entire system. Engagement theory is becoming increasingly important as scholars and federal agency reports show that in order to improve our graduate education infrastructure, we need to make changes and work towards higher levels of engagement, accountability, and quality career preparation (Nettles & Millett, 2006; Lovitts & Nelson, 2014; Haworth & Conrad, 1997; Council of Graduate Schools

17
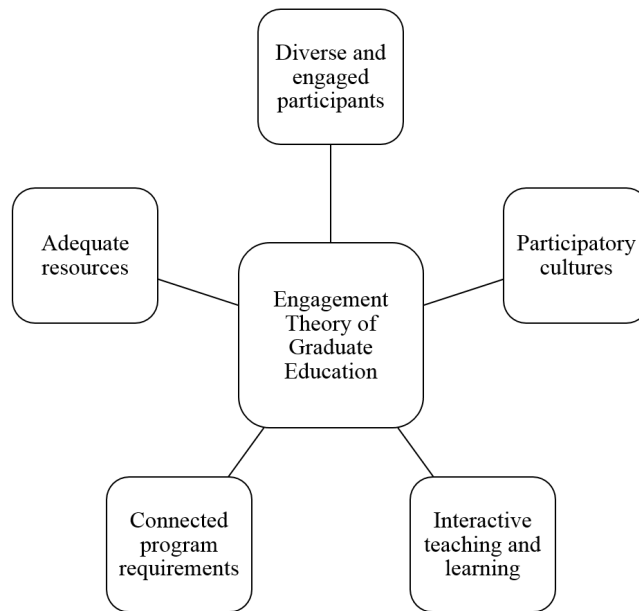
Figure 2.3: The Engagement Theory of Quality Graduate Education

Table 2.1: Five Attributes of an Engaged Program, as adapted from Haworth & Conrad's Engagement Theory

Program Attributes	Brief Description
Diverse and Engaged Participants	Faculty and administrators seek to attract faculty and students with diverse perspectives in teaching and learning.
Participatory Cultures	Develop and sustain a shared program direction, a community of learners, and a risk-taking environment.
Interactive Teaching and Learning	Critical dialogues about professional practice, cooperative peer learning, mentoring, out of class activities, and integrative learning.
Connected Program Requirements	Aimed at a planned breadth and depth to challenge students to develop mature understanding of their profession and field.
Adequate Resources	Investment in the program in both monetary and non-monetary ways for basic infrastructure needs and sustainability.

and Educational Testing Service, 2010; Sowell, 2008; Golde, 2015; Allum, Kent, & McCarthy, 2014).

2.3 Prior Work and Pilot Studies

I employed two pilot studies to inform and shape this project, interviewing four chemistry Ph.D. students in the first pilot, and four STEM Ph.D. students in the second. The first pilot allowed me to shape and narrow the focus of the doctoral student experiences to examine the student-faculty advisor relationship. I then undertook extensive shaping of the interview protocol, guided by the theoretical frameworks summarized above. As seen in Figure 2.1, the frameworks and knowledge gathered from the pilots shaped the full study. I used the second pilot to focus on refining and testing the interview protocol. In keeping with recommended practice (Bowden & Green, 2005) as described in Chapter 3, I carried out a second pilot stage to refine and test the interview protocol. In order to show the progression of the current study, I will first summarize results from Pilot 1, and then summarize results from Pilot 2.

2.3.1 Pilot 1

In the first pilot study, I interviewed four chemistry Ph.D. students using a semi-structured, open-ended protocol about their experiences in a doctoral program. I focused on departmental culture, socialization, and the overall graduate student experience. The results from this study provided common themes about the doctoral student experience in chemistry. Specifically, the major themes that emerged from the first pilot study were departmental ambiguity in requirements; the difficulty of navigating aspects of graduate school such as coursework, research, teaching, and being in a new place; everyday challenges in graduate research (such as failed experiments); factors determining success for graduation; goals of the Ph.D.; and the student-advisor relationship. Within the domains of each theme, the participants all discussed their advisor in some way, reinforcing how almost all facets of the Ph.D. experience are connected with the faculty advisor (Nettles & Millett, 2006; Lovitts, 2001; Zhao, Golde, & McCormick, 2007; Lovitts, 1996).

> "I knew it would be a hard road. I just didn't know what hard entailed here. I figured
> the research would be hard. The hours. Just trying to do, make your boss happy with
> data. I kind of knew that. I didn't anticipate for all the, I guess, the little things, like

day-to-day . . . I just anticipated the larger macros scale of things but on the micro scale. I didn't know what to expect there so I kind of learned there, all the little hardships."
–Grant

The questions I asked in the first pilot study were broad and addressed the overall experience and culture of both the institution and the department, as shown by some selected questions from the protocol for Pilot 1 in Table 2.2.

Table 2.2: Selected Questions from Pilot 1 Interview Protocol

Sample Questions from Pilot 1
Can you tell me a little bit about your favorite part of graduate school?
How do your advisor's requirements for graduation line up with departmental requirements?
How would you describe the culture and climate of your department?
Now that you are several years in, can you reflect on anything that has been a surprise to you as a graduate student? Or anything you wish you had better understood before coming to graduate school?
How has your upbringing and past experiences led you to where you are today?
Can you tell me about your research group and your labmates?

The pilot study revealed that students typically have conceptualizations not only about how the department influences their experiences, but also about how their faculty advisor carries out practices. In this pilot, as well as anecdotally in the community, students shared instances of departmental requirements that were either upheld, expedited, or ignored by their faculty advisor. This either increased a sense of engagement with students in instances where requirements were enforced by advisors, or fostered a lack of morale and respect when requirements were ignored for some students and not for others. This example reiterates how almost all aspects of the Ph.D. experience, as elicited in this study through student perception and as noted in the literature, can be influenced

by the relationship with the faculty advisor. This early pilot helped me to narrow the focus to students' conceptualizations of this important relationship, and then to select phenomenography as the appropriate methodology for the full study.

2.3.2 Pilot 2

In the second pilot study, I interviewed four Ph.D. students in four different STEM disciplines in order to test and shape the interview protocol that I used in the full study. I also utilized several interview techniques, such as critical incident technique (Edvardsson & Roos, 2001), and free listing (Bernard, 2006).

Critical Incident Technique. I used the critical incident technique to elicit rich information about subjects' relationship with their advisor. I asked each participant to tell me about their most recent milestone in graduate school. This allowed the participants to focus on a significant event (such as a proposal defense or cumulative exam) and answer related questions. The focus proved useful for stimulating conversation on the relationship from their perspective. In addition, I asked participants to tell me about both the best/happiest conversation they have ever had with their advisor, and the worst conversation. Evoking emotional indicators allowed participants to retrieve these critical incidents and reflect upon them in the interview.

Free-listing. Another technique that I tested during this phase was free-listing. As opposed to asking participants to describe their relationship with their advisor out loud, I gave them a sheet of paper and asked them to write down five to ten words that described the relationship. While one participant used consistently negative words, another wrote conflicting words such as supportive and frustrating, and even noted that when sharing the list with me. She was also able to articulate, when asked what may have been different had I asked her to simply describe the relationship, that she would have likely told a more one-sided story, or used similar adjectives that were not as juxtaposed as the written words on the page. Free-listing has the potential to allow participants to write words which will describe diverse facets of the relationship.

Chapter 3

Research Design and Methods

3.1 Institutional Review Board and Approval

The work undertaken in this study was approved under Clemson University Institutional Review Board (IRB) number IRB-2014-323. Recruitment emails, statements of informed consent, and interview protocols were approved through the IRB and administered in a manner consistent with ethical human subjects research. See Appendix A for approved recruitment email and informed consent documents. Phone calls were made to individual campus IRB offices to obtain verbal consent that no further IRB protocol be filed at individual institutions.

3.2 Overall Paradigm

I utilized a transformative paradigm (Mertens & Ginsberg, 2008; Teddlie & Tashakkori, 2009) to explore the ways in which underrepresented students perceive their relationships with faculty advisors. Transformative research typically focuses on underrepresented or marginalized groups with a social justice theoretical framework with the intent to bring about change (Teddlie & Tashakkori, 2009; Creswell & Clark, 2011). Issues that arise in graduate education are often overlooked, or seemingly

nonexistent, as it is a silent problem (Hinchey & Kimmel, 2000). The culture of graduate education creates power structures which can be particularly difficult for underrepresented minorities, who are navigating an institution not created with them in mind (Yosso, 2005; Espino, 2014). With the mindset of a transformative paradigm and with the desire to be an agent of change, I approached all aspects of the project with flexibility to respond to the data which are grounded in the transcripts and an openness to hear the participants' voices. There are more details on steps taken to ensure quality and to remain true to the participants' lived experience in Chapter 6.

Guided by the overall transformative paradigm, I summarize in Table 3.1 the other guiding elements of this research study as outlined by Crotty (Crotty, 2003). The guiding epistemology, which is a way of understanding reality, or how we know what we know, is that of constructivism (Creswell & Clark, 2011). Constructivism is the stance that as individuals, we construct knowledge about the world around us within our social context (Lincoln & Guba, 1985). This is important here because in this work I focus on the participants' experiences and their sense-making of their environment and lives as doctoral students and their relationships as they perceive them. The constructivist stance feeds into the ontological assumption, or what counts as knowledge in the social reality under study. I take an interpretivist stance in this work, where as the researcher I cannot be separated from the research itself and am inherently connected to this social situation of the experience of the student-advisor relationship, and am a part of the socially constructed reality under investigation. I am both committed to and involved in the interpretation and advocacy of the participants in this social situation. The joint construction of understanding, or social constructionism, is the theoretical perspective which informs and justifies the methodology of the study. The chosen methodological framework is discussed in detail in subsequent sections; additionally, the elements of quality considered and utilized in my study are discussed in Chapter 6.

Table 3.1: Elements of a Research Study Adapted from Crotty

		Definition	Selection	Explanation
Epistemology		The relationship of the knower to the known	Constructivism	Individuals construct knowledge about the world in one's social context
Ontology*		The nature of the empirical reality under investigation.	Interpretivist (nondualistic, socially constructed reality)	The knower and known are inseparable; the researcher is connected to the social situation
Theoretical Perspective		Philosophy informing methodology	Social Constructionism	An understanding of the world as jointly constructed with others.
Methodology		Philosophical justification for research design	Phenomenography	Learn the different ways people experience some aspect of the world, and enable change
Methods	**Making* Data**	Particular procedures used to collect and analyze data (make and handle data)	Semi-structured interviews	Open-ended questions and conversational approach
	Handling* Data		Iterative process with team approach	Categories of description subject to scrutiny
	Overall* Quality		Q^3 framework	Quality considerations built into entire protocol, to minimize bias and ensure validity

*Not a part of Crotty's elements of a research study

3.3   Methodology

3.3.1   Justification of Methodology

The methodologies of phenomenography, grounded theory, and phenomenology are often employed to investigate people and their interactions with phenomena. In this study, for example, the phenomenon under investigation is the perception of the student-advisor relationship. All three approaches are inductive in nature, with the findings grounded in the raw data. In all three traditions, it is recommended that the researcher or analyst bracket her views to minimize bias (Starks & Trinidad, 2007; Bowden & Walsh, 2000).

Phenomenology versus phenomenography   Phenomenology is employed to find the essence of how people experience a phenomenon; the unit of description in this research approach is the phenomenon itself (Creswell & Clark, 2011). The unit of description in a phenomenography is

the actual experience of the phenomenon, and the results are used to highlight the different ways humans experience that phenomenon. A phenomenology would be more appropriate to showcase commonalities of a universal experience for a population, as it is designed to explore the essence of the way humans experience a phenomenon (Creswell, 2007). All of these nuances, although slight in their differences, are important to understand when making methodological decisions about the reality under investigation. Phenomenography as a methodology guides the entire process and allows for the description of the qualitatively different ways that students experience and conceptualize their relationship with their faculty advisors on their Ph.D. journey (Marton, 1986; L. Mann, 2009; Åkerlind, 2005; Marton & Pong, 2005).

The outcome space of a phenomenography is typically a graphic or relational model of categories that are used to address the issue under study in an effort to advocate for change. Employed to highlight the range of various ways a group of people will experience a phenomenon (Bowden & Green, 2005), the goal of any phenomenographic study is to determine "the qualitatively different ways in which people understand a particular phenomenon or an aspect of the world around them" (Marton & Pong, 2005). These different ways of understanding are represented through categories which highlight critical variations; and the outcome space of these categories is a collective representation of this finite number of different ways of experiencing the phenomenon of interest (Forster, 2012).

Phenomenography versus grounded theory A grounded theory outcome space, also a model, is typically used in the development of a theory for something previously not documented. Phenomenography is also distinguished from grounded theory because there are very different methodological approaches in addition to the outcome space. In a grounded theory, one participant's interview data is analyzed and coded before theoretical sampling and recruitment of the next interview participant (Strauss & Corbin, 2008). In phenomenographic studies, all of the participants are recruited and analyzed in a short period of time so as to prevent any analysis between participants that might influence a subsequent interview (Green & Bowden, 2005). This looks very different from the theoretical sampling of a grounded theory, which also calls for the interview protocol to change as findings emerge throughout the study. The only piece that should be changing or varying in a phenomenography are the participants themselves, so that the variations in their perceptions can clearly come from their individual lived experiences.

Other methodological considerations The temporal nature of recruitment, interview, and analysis of a phenomenography also yields a different approach and understanding of the notion of *saturation*. In both phenomenology and grounded theory, the researcher(s) seeks a saturation in their data in the sense that they continue to recruit and interview participants until no new experience or testimony of the participants' lived experience is uncovered. In phenomenology, seeking a saturation is important because one seeks to expose the essence of an experience for a group of people. In a grounded theory, saturation is sought throughout the recruitment stage through theoretical sampling, as mentioned above. The analysis of each interview, or set of interviews, determines the next set of participants in an effort to capture the most complete picture of the reality under investigation. Saturation in phenomenography differs in several ways. Firstly, much care must be taken to clarify the factors or demographics of the participants in the beginning of the study so that diversification can be established up front through maximum variation sampling (Creswell, 2003). This enables the researcher to interview the participants in a short, succinct timeframe, which is done in an effort to prevent the researcher from allocating current and future participants into bins or preconceived categories. To have an idea of what 'type' of participant to seek next implies that the researcher has an idea of what she is already hypothesizing she will hear. Secondly, the protocol can shift and change from one participant to the next in both traditions of phenomenology and grounded theory, whereas in a phenomenography, the semi-structured protocol changes very little except for follow-up questions (Bowden & Walsh, 2000). In fact, modern phenomenography scholars urge that if new questions or variations to the interview protocol are brought in, that section of the transcript should be discarded (Green & Bowden, 2005). Saturation is not sought formally in phenomenographic studies when deciding if an appropriate amount of interviews have been conducted. The researcher, during the interview phase of the study, can sense that repetitious accounts and themes are appearing to provide some assurance that they have conducted a sufficient number of interviews (Salzman, 2014). The appropriate phase to consider saturation in a phenomenography is in the iterative process of finalizing the distinct categories of description and the relationships between them; the final iteration occurs when no new organization or structure to the categories and outcome space emerges, thus reaching saturation.

In summary, the use of phenomenography as the methodological framework is synergic with the overarching transformative aims of this study. Phenomenographic research is conducted in order to

determine how people experience and conceptualize a phenomenon, and then seeks to enable them or others to change the way their world operates (Bowden & Green, 2005). Phenomenographic studies that are developmental in nature are designed so that the conclusions are informative to influence change, traditionally in an educational setting, whereas a pure phenomenography's research conclusions are an end in and of themselves (Green & Bowden, 2005). The purpose of this work, therefore, is to utilize the outcomes to advocate for the participants and other stakeholders in graduate education (current and future graduate students, current and future faculty, and administrators).

3.4 Phases of Research

I employed two pilot studies to inform and shape this project. In the first pilot, I interviewed four chemistry Ph.D. students; in these interviews I focused broadly on questions about their overall experiences, institutional and departmental climate and culture, and relationships with peers, their advisor, faculty, and the university. This pilot was integral in that the most common and salient theme that emerged was the student-faculty advisor relationship.

I then undertook extensive shaping of the interview protocol, guided by several theoretical frameworks. In the second pilot study I interviewed four STEM Ph.D. students. I used the second pilot to focus on refining and testing the interview protocol. This step was critical because interview transcripts are the only source of data in a phenomenography. The interview protocol itself needs to be carefully constructed, so that it may be used and remain unchanged for each participant. Keeping a steady protocol conducted by one researcher allows for the variations in what the participants have to say, as opposed to a changing protocol or interviewer variation.

The recruitment and interview of participants was conducted in early 2017. Arranging travel and accommodations over the course of several days proved to be beneficial, as it allowed for some unexpected snowball sampling with participants, and some extra time for participants with last-minute schedule changes.

3.5   Participant Selection

In a phenomenography, it is important to seek diversity in the sample in an effort to ensure that the breadth of experiences is exposed. I focused on underrepresented students within the population of chemistry doctoral students. The National Science Foundation currently recognizes 'underrepresented' in STEM to include women, minorities (Black/African-American, Hispanic), and disabled (NSF, NCSES, 2015). There are other minorities recognized but not included in the sample such as American Indian, Alaska Native, Native Hawaiian, and Pacific Islander. To diversify the sample, I recruited for gender and ethnicity (Black/African-American, Hispanic, and White females). By recruiting participants for maximum variation across these factors, I ensured that differences and commonalities among students emerged through the range of variation. I intended to interview approximately 20 doctoral students who are at the candidacy stage of the Ph.D. journey in physics and chemistry. Twenty participants is a generally acceptable number for a phenomenographic study (Green & Bowden, 2005; Bowden & Walsh, 2000). I successfully recruited 17 participants for the study; 16 participants were in chemistry and only one was from a physics and astronomy department, so was not included in the analysis. Although I did not reach my goal of 20 participants, I felt comfortable with the number I ultimately had due to recurring themes that I heard in the interviews as I moved forward to my last institution. See Table 3.2 for a summary of participant demographics. Participants' institutions are not included in this table in order to preserve anonymity.

Participants were sought from four public, land grant universities of "highest research," or R1 classification in the southeastern United States (Carnegie Foundation for the Advancement of Teaching, 2017). This decision was made to ensure that all demographics had voice in the participant sample because each university alone does not have adequate numbers of underrepresented Ph.D. students to ensure successful recruitment. Due to unsuccessful recruiting at one of the sites fulfilling all of the demographics decided upon, I opened up recruitment to an additional site, which met all other demographics, but is classified as an institution of "higher research," or R2 status (Carnegie Foundation for the Advancement of Teaching, 2017). It is possible that aspects of the university climate and culture, which can then influence the climate and culture of individual departments, may be different at an R2 institution aside from their R1 peers. However, as the focus in this work is on the perceptions of student-advisor relationships, and less on the larger climate and culture

Table 3.2: Participant Demographics

Participant	Sex	Ethnicity
Abby	Female	White
Amelia	Female	White
Anna	Female	Hispanic
Brittany	Female	White
Charlie	Female	African-American
Diego	Male	Hispanic
Kayla	Female	White
Kody	Male	African-American
Leigh	Female	White
Lioness	Female	African-American
Matilda	Female	African-American
Melissa	Female	White
Renee	Female	White
Siberan	Male	African-American
Sophia	Female	Hispanic
Tom Sawyer	Male	African-American

that may be influencing them, I cannot make a claim for certain. I employed purposive sampling by networking with other current/recent graduate students, and by recruiting based on information I could find through each respective university's department research pages (Flick, 2007). Although I initially sought to recruit only Ph.D. candidates, I opened recruitment to students who had made it through the qualifier stage that occurs just before candidacy (pre-candidacy). Additionally, all participants had different advisors despite the small pool of potential participants within the bounds of this work.

3.6 Interviews

I interviewed all participants on their respective campuses in-person, and in a neutral location such as the library or a reserved room in a student center for both privacy and quality recording. All one-on-one interviews were recorded with a digital recorder and transcribed verbatim by a third party. Participants selected pseudonyms themselves so that I would not impart any bias. Additionally, some participants chose psuedonyms either to imply ethnicity and/or gender, or to mask ethnicity and/or gender.

3.6.1 Interview Protocol

I asked open-ended questions through the semi-structured interview protocol so that subjects had the freedom to elaborate and describe their experiences in detail (Bowden & Walsh, 2000). The interview duration was a range from 45 minutes to 160 minutes, with the average interview lasting about 75 minutes. In keeping with the goals of this study, the questions were designed to reveal the differences in the ways of understanding and experiencing their doctoral studies for graduate students, with a focus on the relationship with the faculty advisor. Of great importance in a phenomenography is the use of an interview protocol that has been tested through a pilot study, although the results of the pilot study are excluded from the full study (Bowden & Green, 2005). I formed and tested the interview protocol in this study through peer debriefing meetings and a pilot (the second pilot) of four Ph.D. students. As shown in Table 3.3, I have crafted the interview questions with specific intent, as well as theoretical backing in the field. In addition to the full, IRB-approved interview protocol, I include in Table 3.3 the groupings of questions, organized by capital letters, used to guide the analysis.

Table 3.3: Full Interview Protocol with Analysis Groupings

	Question	Intention/ Theoretical Connection	Group
1	I am going to ask you some questions to get started so that we may have a conversation about your experiences in grad school. As you know, I am particularly interested in studying how you see the impact of the relationship with your faculty advisor on your experiences. So I would like this to be conversational so I can see how you experience and conceptualize graduate school.	Setting the tone of the interview	n/a
2	Can you describe for me your educational journey up to the present (degrees and where from, etc.)?	Setting the tone, background information	n/a
3	Why did you choose to go to grad school/ earn a Ph.D.?	Background information	A1
4	Can you walk me through a typical day for you in grad school?	Setting the tone of the interview; Critical Incident Technique	n/a
5	Please tell me about how/ why you chose your advisor.	Background, relationship	A2
6	What expectations did you have for your advisor when you started grad school?	Socialization, relationship	B
7	Are there any other responsibilities that your advisor has to you?	Quality Engagement, relationship	B
8	What are your responsibilities to your advisor?	Quality Engagement, relationship	B
9	Can you share a story of how your advisor is helping you move forward?	Critical Incident, Quality Engagement	G
10	How else is your advisor helping you? What are the other ways?	Quality Engagement, Socialization	G
11	How does your advisor run the research group?	Quality Engagement, Socialization	n/a
12	Can you share a story or a situation where you did not receive the help you needed from your advisor? Or were even hindered?	Quality Engagement, Socialization	G
13	If you were advising graduate students, how would you carry out the roles of a faculty advisor/run your research group? *or* Describe for me the ideal advisor.	Quality Engagement, Critical Incident, Socialization	C
13a	Does this describe your advisor? *(if not already made clear)*	Quality Engagement, Socialization	C
14	Would you describe the best/ happiest conversation you have ever had with your advisor?	Critical Incident Technique	D
15	Would you describe the worst conversation you have ever had with your advisor?	Critical Incident Technique	D
	Continued on next page		

	Question	Intention/ Theoretical Connection	Group
	Table 3.3 – continued from previous page		
16	Write down 5-10 words that describe your relationship with your advisor.	Free-listing	E
17	Can you tell me how these have an impact or influence on your experiences in grad school?	Experience, relationship	E
18	Please describe for me the most recent milestone you have accomplished.	Experience, socialization	n/a
19	What things would have better helped you along the way?	Quality Engagement, Socialization	G
20	What things do you wish your advisor would or could have helped you with?	Quality Engagement, Socialization, relationship	G
21	Do you have any other mentors? Who are they?	Socializaton	n/a
22	What is the role of the department in your Ph.D.?	Quality Engagement, Socialization	F
23	In what ways have you been supported by your department in moving forward?	Quality Engagement, Socialization	F
24	Please list 5-10 words to describe your graduate school experience.	Free-listing, Socialization	H
25	Can you directly link your relationship with your advisor to any of these attributes you just listed?	Socialization, relationship, experience	H
26	Knowing what you know now, what do you wish you knew when you either started grad school, or perhaps even before coming to grad school?	Experience, wrap-up	n/a

3.7 Analysis

3.7.1 Team Analysis Approach

With the supervision of my advisor, I led a team of junior graduate students in an effort both to expose my analysis to scrutiny, and to gain experience in mentoring. It is recommended by Bowden to have a team analysis approach for reasons of mitigating bias, having a formal mechanism for feedback and scrutiny, and for refining the analysis into solid categories of description in the outcome space (Bowden & Green, 2005). For a deeper discussion of reliability and validity reasons for a team approach to analysis, as well as steps the team took collectively to ensure quality and mitigate bias, see Chapter 6.

My analysis team consisted of a female of color with a background in chemistry, a female of color with an engineering and mathematics background, a non-traditional white female graduate student with a biology background who is currently a faculty member at another institution and returned to graduate school after a decade away, and a white female with a background in statistics. All were Ph.D. students in the pre-candidacy stage of their doctoral programs at the time of analysis. This team approach allowed me to hold sub-team meetings as well when writing manuscripts for conference paper submissions and journal submissions that began to branch out of the analysis, in addition to whole-team meetings throughout the analysis phase.

In the following sections, I place excerpts of a piece of the transcript being analyzed in phases to give the reader a clearer idea of the steps taken closely in the analysis with the team approach.

3.7.2 Coding Cycles

Before introducing the phases of coding used to ultimately determine the categories of description of how underrepresented doctoral students in chemistry experience their relationship with their faculty advisor, it should be noted that transcripts were put through what I term a 'blender process.' This process allowed for all of the transcripts to be analyzed so that meaning could be extracted across all transcripts and not just within a transcript. Although the experience of each participant was honored in its entirety, and excerpts were not stripped of the context from which they came, the variations in participants' experiences were analyzed and considered as a whole. The blenderizing of transcripts and subsequently analyzing them as a whole added to the overall research quality as discussed in Chapter 6. This is in line with the phenomenographic methods as outlined by John Bowden and his colleagues (Bowden & Green, 2005; Green & Bowden, 2005; Bowden & Walsh, 2000). It is best described by Green and Bowden:

> "The reading that is such a large aspect of the analysis process is always focused on extracting meaning, across transcripts, but without losing the intra-transcript context (and hence contextual meaning) for any utterance (whole of transcript approach)" (Green & Bowden, 2005).

Therefore, it is easier to think of taking all of the transcripts, placing them into a blender, and pulsing a few times before entering the contents into NVivo for analysis, as shown in Figure 3.1. The natural tendency to analyze a transcript as a whole, so as to better understand the individual, is eliminated here with the blender process, thus mitigating researcher bias on the individual participant. It is important to focus on extracting meaning in an ethical manner from the participants' words and bringing to light their experiences and perceptions as they understand them.
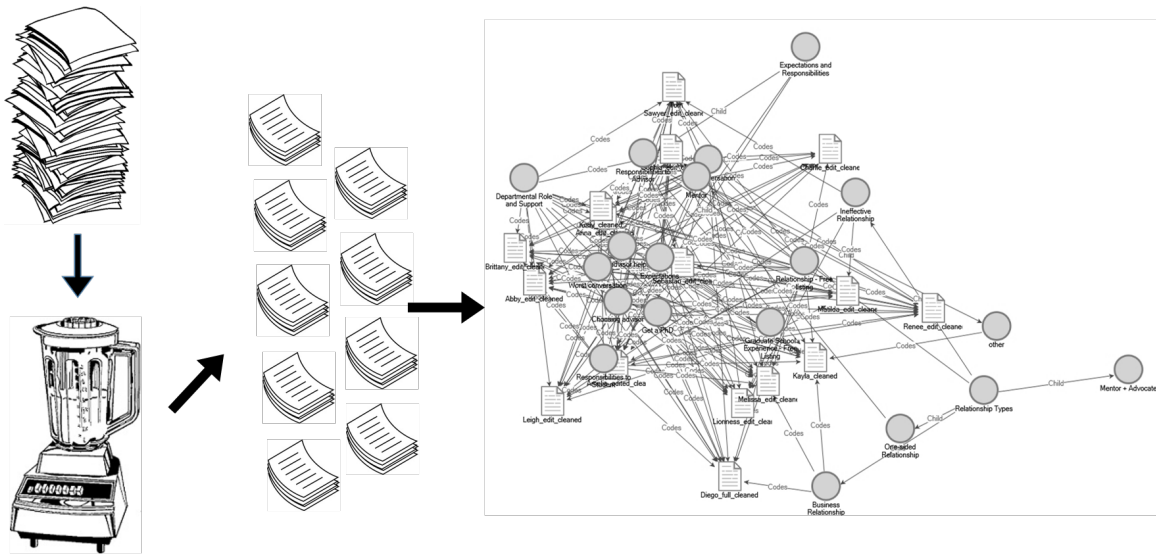
Figure 3.1: "Blender" Approach to Analyzing the Transcripts as a Whole, with the Final Coding Map in NVivo

3.7.2.1 Structural Coding

NVivo 11 Pro software was used to analyze the selected subset of interview questions by pulling all of the relevant pieces from the interview transcripts and exporting for further analysis. Specifically, all direct answers from participants to selected pieces of the interview protocol were coded together. Coding is the act of pulling statements, words, and sentences out of the interview transcript and attributing to those selected bits of spoken word a phrase, category, or other demarcation in an effort to organize and sort data (Saldaña, 2015). Structural coding was used here in this first cycle

of coding, and corresponds to step 1 in Figure 3.2. According to Saldaña, structural coding is used to pull out specific pieces of the transcript from the entire "data corpus" in order to answer a specific research question (Saldaña, 2015), or in this case, to answer specific pieces and individual questions of the protocol. Additionally, if the participant answered some piece of this question earlier in the interview prior to the question being directly asked, those relevant pieces were also coded. Structural coding was used to separate chunks from the transcripts and analyze them at one time with the team. These analysis chunks are noted by capital letters in Table 3.3. The two prompts, labeled A1 and A2 for analysis grouping, were initially coded together (A1) in the structural coding phase, but became very distinct in the following phases of coding and were later separated with the labels A1 and A2. The piece that I will show excerpts of throughout the following subsections was coded for "Advisor Choice" and corresponds to Group A2 in Table 3.3. Additionally, the groupings shown in the table can be thought of as the result from the blending process as depicted in Figure 3.1.

Figure 3.2: Coding Cycle of Analysis

As shown in Figure 3.3, all of the conversation from one interview that has been coded into NVivo for 'advisor choice' is shown. The subsequent figures will illustrate the steps taken with this coded segment of Amelia's transcript.

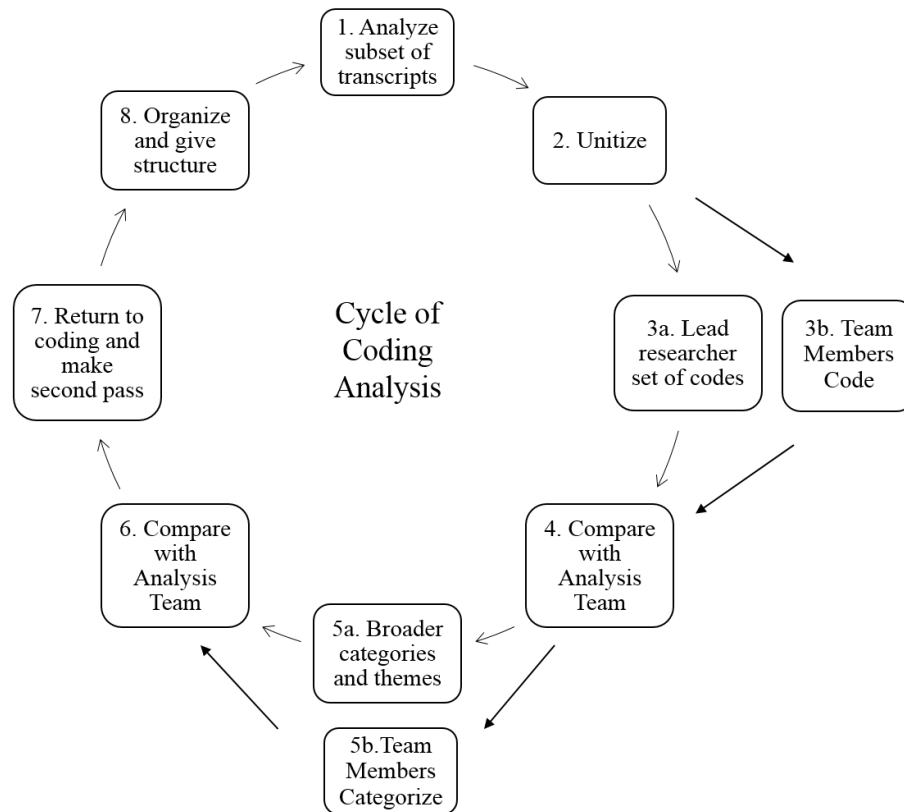Amelia: Yeah um, so I was looking for ... I was looking for a number of things. I was looking for someone who would be obviously supportive of my education. Um, someone who already had tenure, because sometimes one professor if you don't have tenure yet, um either just are insecure themselves and so aren't really nice to their students, or make their students work too hard, or things like that.

Aubrie: Hm-mmm (affirmative).

Amelia: Um, I was looking for someone who, if they were a male advisor (laugh), weren't going to be creepy.

Aubrie: Hm-mmm (affirmative).

Amelia: Because you hear about that sometimes.

Aubrie: Yeah.

Amelia: Um and I was looking for someone who had a good track record of getting students out in a timely manner and getting them into decent jobs.

Aubrie: Hm-mmm (affirmative). Where do you think that you um, came up with this sort of criteria for, for choosing an advisor?

Amelia: Um, I think I came up with them through ... I guess I came up with them through talking to um, my professors in undergrad to some extent. Um, I had one female professor actually who was a really good mentor to me in undergrad. Um, yeah talking to them about what makes a good advisor. Doing a little bit of undergrad research with various people and sort of seeing what that felt like, based on their personalities and their expectations. Um, and then just you know, reading random articles and hearing stories about some of the things that can go wrong with that relationship.

Figure 3.3: Sample Excerpt of a Transcript Coded for Advisor Choice

3.7.2.2   Unitization

I unitized the large segments that I structurally coded, which corresponds to step 2 in Figure 3.2 (Campbell, Quincy, Osserman, & Pedersen, 2013). Unitization was used as a first step in the analysis in order to organize the participant responses in the coded pieces, so that analysis across several team members could be systematized. The units themselves can be thought of as portions of language-based data pulled from the larger segments so that it can more easily be coded, as shown in Figure 3.4. As such, codes, as defined by Saldaña to be "[a] word or short phrase that symbolically assigns a summative, salient, essence-capturing, and/or evocative attribute for a portion

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of language-based or visual data" (Saldaña, 2015) were attributed to the identified units, shown as each individual cell in Figure 3.4, and compared among team members.

Amelia:	Yeah um, so I was looking for ... I was looking for a number of things.
	I was looking for someone who would be obviously supportive of my education.
	Um, someone who already had tenure,
	because sometimes one professor if you don't have tenure yet, um either just are insecure themselves and so aren't really nice to their students,
	or make their students work too hard, or things like that.
Aubrie:	Hm-mmm (affirmative).
Amelia:	Um, I was looking for someone who, if they were a male advisor (laugh), weren't going to be creepy.
Aubrie:	Hm-mmm (affirmative).
Amelia:	Because you hear about that sometimes.
Aubrie:	Yeah.
Amelia:	Um and I was looking for someone who had a good track record of getting students out in a timely manner
	and getting them into decent jobs.
Aubrie:	Hm-mmm (affirmative). Where do you think that you um, came up with this sort of criteria for, for choosing an advisor?
Amelia:	Um, I think I came up with them through ... I guess I came up with them through talking to um, my professors in undergrad to some extent.
	Um, I had one female professor actually who was a really good mentor to me in undergrad.
	Um, yeah talking to them about what makes a good advisor.
	Doing a little bit of undergrad research with various people and sort of seeing what that felt like, based on their personalities and their expectations.
	Um, and then just you know, reading random articles
	and hearing stories about some of the things that can go wrong with that relationship.

Figure 3.4: Sample Excerpt of a Transcript Unitized for Advisor Choice, where each cell is a unit

This added structure allowed the team members to be burdened less with delineating and deciding upon the meaningful chunks of text so they could focus on the participants' words and attributing meaning. For many of the team members, this was their first experience in qualitative analysis. I unitized the coded pieces of the transcripts, and undertook the load of the first pass of organization and analysis. Each team member took time and employed open coding in various styles to develop themes, write individual memos on the overall big-picture, and organize codes. I coded the unitized pieces individually before incorporating and considering the work of the other team members, making note of similarities and differences in the themes and codes they developed.

3.7.2.3 Open coding

Open coding was employed by all team members so that meaning would be derived directly from the participants' accounts and perceptions, as shown in steps 3a and 3b of Figure 3.2. Open coding, as compared to *a priori* coding, implies that the researcher analyzes the data openly and without predetermined codes. An *a priori* approach implies that the researcher has a set of predetermined codes, either from a guiding theoretical framework, from a previous study or pilot, or from the analysis of quantitative data in a mixed methods study for example. In the open coding phase, we also employed *in vivo* coding, or coding using participants' voices by attributing their terminology and words to the actual codes (Saldaña, 2015). As seen in Figure 3.2, the open coding was employed in step 3a, where I coded the unitized pieces and the team members also coded, individually as shown in 3b. Figure 3.5 is an example of one team member's open coding of pieces that I had coded into "Choose Advisor" in NVivo, further unitized, and distributed to team members.

Figure 3.5: Sample Excerpt of Amelia's unitized transcript that has been subject to open coding by analysis team member

I compared the team members' codes and themes with my own codes and themes before sifting them into categories of meaning to examine the various perceptions and reasons of the underrepresented doctoral students in this study. As can be seen in Figure 3.5, the team member underlined the word 'tenure' and wrote in 'statuses' for the segment of transcript where Amelia said, "Um, someone who already had tenure . . .". She also wrote 'non-tenure characteristics' in the margin for the piece

of transcript where Amelia said, ". . . because sometimes one professor if you don't have tenure yet, um either just are insecure themselves and so aren't really nice to their students." A second team member coded this same area as, "Supportive professor who has the student's best interest in mind." A third team member coded this area as both "teaching/advising style: supportive" and "tenure status: tenured." I coded this area as "tenure - advisor characteristic." Through team meetings, we initially came to the agreement of using the categorization "tenure" as one of the advisor characteristics that doctoral students used for *why* they chose their advisor. This step in the analysis corresponds to step 4 in Figure 3.2.

3.7.2.4   Focused Coding

Throughout the phases and iterations of categories with the team members, we ultimately decided upon the term "academic rank" for advisor choice. This was decided upon by each team member looking at all of the "advisor choice" codes as a whole, attributing broader themes to our more specific codes of how and why students chose their advisors, and by narrowing in on what the most salient terminology was for both the participants (*in vivo* coding) and for the audience. See Chapter 6 for more discussion on communicative validity. This process of categorizing findings into broader categories, coming back to compare with team members once again, making another pass through the data in the cycle of focused coding, and organizing the codes into an intermediate model of findings corresponds to steps 5-8 in Figure 3.2.

Chapter 4

Intermediate Results

The results presented in this chapter are intermediate results in the sense that they do not directly answer the overall research question. As will be discussed, some of the analysis of the results presented here fed into an intermediate model that helped to develop the categories of description of the student-advisor relationship. The analysis groupings (A-H) discussed in Chapter 2 are listed in alphabetical order of when they were analyzed, but do not correspond to the order in which they appear in this chapter. Additionally, some of these results appear almost verbatim elsewhere as proceedings or in manuscript development, and will be noted and cited where appropriate.

4.1   The Big Picture

The free-listing activity and subsequent discussion with the participants were analyzed last of all of the pieces in this study. I present them here first in the intermediate results to help set the tone of this body of work. As discussed in Chapter 2, free-listing was employed to elicit words and phrases from participants in a manner other than through speech.

Figure 4.1: Wordcloud to Present Free-listing Exercise during the interview for 'Words of Phrases that Describe Your Relationship with your Faculty Advisor'

Relationship   In the first interview free-listing prompt, I asked the participants to take as much time as they needed and write down approximately 5-10 words or short phrases that describe their relationship with their faculty advisor. Some participants stifled laughter as they wrote down their list, indicating that some of their words were contradictory to one another. For example, one participant shared,

> "Tom Sawyer: (laughs) Uh. You're going to be really confused about some of these things. It's like a Dr. Jekyll and Mr. Hyde like-
>
> Aubrie: (laughs) That's what ends up happening for a lot of people tho. All right.

Tom Sawyer: Hopefully you can read my handwriting.

Aubrie: Mm-hmm (affirmative). So frustrating, rewarding, disappointing, neutral, respectful, draining and transparent.

Tom Sawyer: Yeah." -Tom Sawyer

This excerpt highlights the positive and negative experiences that a participant can have with their faculty advisor, which may have been more difficult to elicit if I had asked participants to verbally describe the relationship for me.

As can be seen in Figure 4.1, the largest words are those that appeared in higher frequency than the smaller words. Overall, one will focus on the larger words at first glance, and then see the smaller words and phrases that did not repeat among participants. While the larger, more frequently used positive words of 'respectful,' 'professional,' 'helpful,' 'understanding,' and 'encouraging' draw the reader in initially, we can see very negative descriptors of participants' experiences with a closer view. Words like, 'cold,' 'distant,' and 'reluctant,' as well as the phrase, 'not his favorite child' come to light with a finer focus. Other phrases and words, such as 'strictly business,' 'symbiotic,' and 'mentorly' were used to help anchor the final outcome space of this work.

Overall graduate school experience   In the second interview free-listing prompt, I asked the participants to take as much time as they needed and write down approximately 5-10 words or short phrases that describe their overall graduate school experience. Interestingly, there was less laughing and joking in this prompt, which took place slightly later in the interview. One participant, who up until this point in the interview was bubbly, friendly, and had used all positive words to describe her relationship with her advisor, turned sullen and depressive by the time she had completed her list. Here I include an extended excerpt, with her listed words in bold, to illustrate how the participant presented her list and further explained what they meant to her.

Kayla: "Hmm, (writes) ... All right. Well, this gonna get the little, a little more, uh, (chuckles) a little more depressing than I meant.

Figure 4.2: Wordcloud to Present Free-listing Exercise during the interview for 'Words of Phrases that Describe Your Overall Graduate School Experience'

Aubrie: (Chuckles) Okay, so can you describe them to me?

Kayla: Yeah.

Aubrie: And what they mean to you?

Kayla: So this has, this has been like a really **scary** experience for me.

Aubrie: Mm-hmm (affirmative).

Kayla: Um, which is the first one, because I don't know, I feel like most of it has just

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been kind of serendipitous like meeting up in a lab that I ended up in. Um, choosing here specifically, I ha ... I almost went to [another university] instead. Uh, and that kind of uncertainty is, uh, carried on throughout my whole experience pretty much.

Aubrie: The uncertainty of wanting to be here?

Kayla: Yeah, whether, whether I wanted to be here, whether like grad school is the right thing. Um, whether I should be in this field. Sometimes I feel like my research doesn't really apply to anything. Like, it's hard for me to think about what I'm going to do with it in the future.

Aubrie: Mm-hmm (affirmative).

Kayla: Um, um, as for **growth**, um, I feel like I've grown massively as a scientist in the past two years. Um, I did do some undergrad research, but really like a, I didn't know it at the time, but like it was nothing.

Aubrie: Right.

Kayla: Um, I never read papers. That was something I had to learn when I got here.

Aubrie: Yeah.

Kayla: Um, I had to learn how to like plan experiments on my own, how to like take things that people do in a paper and try to do it myself (laughter). Oh, it never works out right, which leads to **uncertainty**. Like, 'Was it me or was it the paper?'

Aubrie: It's the paper.

Kayla: Kinda unwrap it I guess not because I feel like I've grown rapidly, but I feel like the, the time has just gone really fast. Like I can't believe I'm, I'm in my second year. Because I feel like I, I'd still not only have I done nothing, I ... I can't believe it's been two years already.

Aubrie: (Chuckles) Right.

Kayla: But and then that also leads into **self-doubt** as to like whether, oh yeah that one was more depressing what I wanted to be. But, um, yeah like I said earlier like when you can't repeat an experiment or something like that, it's like, 'Is it my fault?' Um, I learned recently like a certain way that a molecule fra, fragment on mass spec. And, and maybe wonder about some of my old experiments like if it had been ... If my product had been fragmenting a certain way, maybe I just missed it like maybe I did actually make it.

Aubrie: Aah.

Kayla: But I just don't know how the molecule fragments, so I can't figure out if I actually made it or not. Stuff like that.

Aubrie: Yeah, tough. Um, so any of these things, uh, the way that you've described your grad school experience overall, um, do you see any connections with, with these and the relationship you have with your advisor?

Kayla: Hmm, not really. Um, maybe **growth**, because I feel like I have grown as a scientist, because I've given, uh, the environment to grow. Um, that's both good and bad. (Chuckles) Um, I guess maybe like something like **self-doubt** stems, because I don't really get validation from my advisor. Um, you see it from like classes and stuff, but now I stay in research full-time it's like ...

Aubrie: Mm-hmm (affirmative). Yeah. It's a different, it's a change for sure.

Kayla: Mm-hmm (affirmative). But that's like not really ... I feel like that's also on me, just you know as, as myself and with my own personal self-esteem like?"

This excerpt highlights that despite a very positive relationship with her advisor, Kayla articulated very different feelings when reflecting upon her overall experience. This also implies space for future work with graduate student perceptions and experiences in the examination of the whole person.

Despite her relationship being classified as a mentor relationship, she still sought a validation from her advisor that she was not receiving, at least to the level that allowed her to move past feelings of self-doubt and fear.

4.2 Why Underrepresented Students Embark Upon "The Perilous Passage" to a Ph.D. in Chemistry

The results in this section are drawn from the analysis of a single interview question from the full protocol, as shown in Group A1 in Table 3.3. Originally, A1 and A2 were to be analyzed together, but the themes were so different that this smaller study broke away as just A1. The question that was analyzed was, "Why did you choose to go to graduate school or to earn a Ph.D.?" Many participants had several reasons they offered as to why they chose to pursue a Ph.D. in chemistry. All of the reasons fell into three broader categories, or types of reasons, why they chose to earn a Ph.D.: attainment, avoidance, and inevitability.

4.2.1 Attainment reasons

It is not surprising that one would decide to earn a Ph.D. in order to attain something. It may even seem obvious that the pursuit of the Ph.D. is in itself an attainment. The types of attainment reasons, as seen in Figure 4.3, that participants offered, however, give insight into the complex reasons why students begin this journey that has many risks.

Status Status attainment as a reason for the pursuit of the Ph.D. is perhaps the most obvious because this reason conveys that participants wanted to become a head researcher, wanted to become a professor, and wanted to work in a lab. Interestingly, one participant, Anna, wanted to go to graduate school so that she could "transition into becoming more of an adult." Siberan stated that he wanted the Ph.D. to be a head scientist:

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"So my goal as a scientist is to be the head researcher over, um, I want just-just a random lab experiment. There was a time that I wanted to be a research head of a major think tank, but might be a little too ambitious, depending on ... Well, I'm not sure until I realize the line of work that I'll be doing when I get out."

Quality of life Quality of life attainment emerged as a thematic reason for some participants. Some of this was financial, in order to earn a higher paycheck with a Ph.D. as opposed to one afforded with a B.S. in their career. For one participant, there was family encouragement when she was undecided on her career path between English literature and chemistry, to pursue chemistry so that she could make more money. One participant had been a high school chemistry teacher and had become exhausted by the long days followed by the longer nights of grading and lesson plan preparation in the public school system, which caused her strain in her marriage and family life with her children. She saw that the terminal degree could afford her and her family the flexibility for a better work-life balance:

I really enjoy teaching. I enjoy teaching at the high school level. Um but frankly it was very exhausting and very hard on quality of life issues. Um I have three children and I was finding that it was spending ... I was not leaving my classroom everyday until 5:30. Um so I decided to do grad school if that makes sense. (laugh) But don't tell them I said that. (laugh) So some of it was 'So okay in the big picture what do I want to see myself doing in the long run.' Obviously if I kept teaching it would have been easier to some degree because you kind of develop a patterns and have more things on hand than you do the first few years you teach. Um I really wanted to teach upper level chemistry so the last year I taught ... I taught AP Chem and I really enjoyed teaching that level and I felt like I would really enjoy teaching even more specific than that. Um so I started wondering if there was a way I could work it out to go to grad school . . . but in the long run the goal was to teach at a ... really don't want to do research long term. I would prefer to be at a four year liberal arts university in a teaching capacity of some sort with some research but not the job dependent research." -Leigh

Knowledge and skill   Some participants simply loved and enjoyed science. Knowledge and skill attainment covers reasons such as a love for industry research, the ability to answer harder questions, the sheer enjoyment of research, to evolve more skills as a chemist, and to fulfill the desire to keep learning. Diego said he wanted a Ph.D. because,

"I wasn't satisfied yet. I wanted to keep learning. I wanted to keep doing research."

Similarly, Amelia stated,

"Um, I think I perceived that a terminal degree was where you kind of continued learning about the basic nature of the world and how it works . . . so I, I wanted to choose a program that would help satisfy my curiosity about the basic nature of chemical interactions." -Amelia

Ego   One participant, Tom Sawyer, said that

"[P]art of it was ego. Anybody that doesn't tell you that is lying . . . Ph.D. is part ego. There has to be some ego-driven element."

Although no other participants used this terminology, it did emerge similarly in the way they described being 'good' at chemistry when many others are not, or in the way their undergraduate professors simply told them they were smart enough to do so. Ego should be differentiated from status attainment in the way that ego is more of a sense of 'I can, so I will,' while status is more of 'The Ph.D. will allow me to be [this.]' Kody knew he was great at chemistry and teaching, and knew he could be in a professor role:

"I watch them teach, uh, professors, and I can do this, and I ... As a matter of fact, I felt that I could do better job.." -Kody

Social Identity Threat   This type of attainment has overlap with the other types aforementioned; however, a particular theme emerged here that stands alone from the others. Specifically, these participants talked about something bigger when they cited their reasons for obtaining a Ph.D.

Social identity threat typically engenders several types of responses from individuals who experience threats to their identity. Some individuals try to cover the aspect of their identity being threatened, some will remove themselves from the social situation or institution where the threat exists, and some will navigate towards distinction (such as earning a Ph.D.) to both prove the threat incorrect, and as protection against threat (Branscombe, Ellemers, Spears, & Doosje, 1999). Charlie wanted to be a 'black female scientist.' Kody described that throughout his undergraduate education, there were no faces that looked like his, and that earning a Ph.D. was much bigger than him:

> "[F]or me to get a PhD, uh, have a terminal degree, it was bigger than me. It was bigger than me. It's, it's for my community. It represents academic excellence for generations to come. It's for, it's for my children. It's for my children's children. Uh, it's for my community to say that, 'We have, you know, a black guy from the hood, um, yeah, he has a PhD in chemistry'." -Kody

Tom Sawyer said that as a black man, he had no choice in earning a Ph.D.:

> "I hate even having to say this, and verbalize it, but I feel like with black people specifically, they don't really pay attention to you unless you have that kind of title behind your name . . . If a white person says this is what it is about science, they're going to believe a white person. But, if I was trying to compete with that, what would I need to do? And the only logical explanation was I have to get a terminal degree. There's no other way to like even captivate that audience, they'd rarely even be remotely interested in what you're saying unless you get to that point." -Tom Sawyer

4.2.2 Avoidance reasons

While attainment seems the most obvious reason to pursue the Ph.D., the sixteen participants of this study had avoidance reasons as well. Many participants described the perceptions they had near the end of the undergraduate study that their career options were limited to that of a laboratory technician. Some said they simply did not want this job, while others stated they did not want the
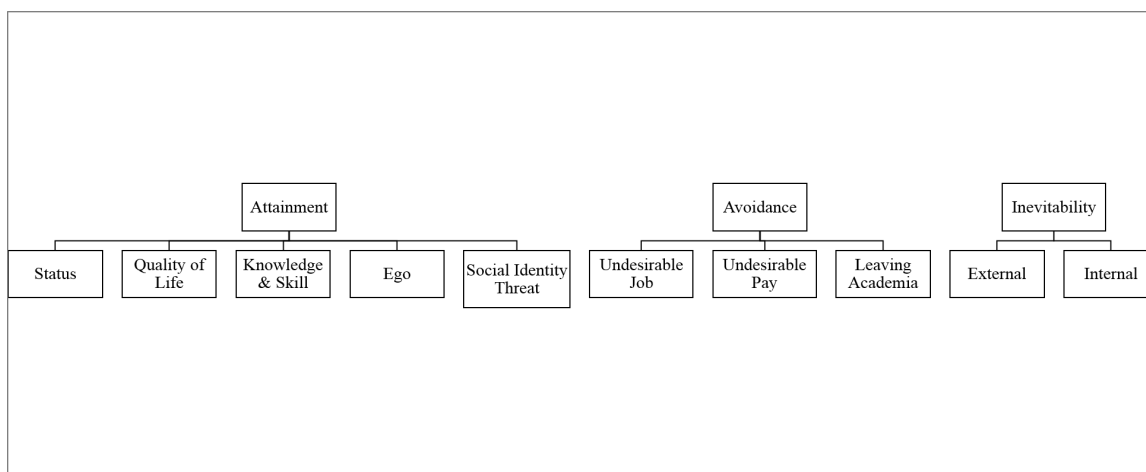
Figure 4.3: Why Students Choose to Obtain a PhD in Chemistry

accompanying salary. Another participant was avoiding the military after college. One participant realized she was not interested in any of the jobs that her chemical engineering B.S. would afford her, so she no longer wanted to be an engineer. Matilda stated,

> "Honestly . . . coming up to graduation within that like last year, I was like, I don't think I'm ready to, to leave school yet. I don't think I'm in the mindset of where I'm ready to start a job." -Matilda

4.2.3 Inevitability reasons

Participants articulated some reasons for pursuing a Ph.D. in such a way that it was their only real option. Some said they simply always knew, or always envisioned that they would go to graduate school or have a doctorate someday. One participant explained that he knew he wanted to be a professor, so the Ph.D. path was the only way. Melissa said that her family and every single one of her teachers expected her to get a Ph.D.:

> "it was always just like the undertone of, like, 'Well, naturally she's going to go to graduate school and get a PhD' . . . it never really occurred to me that I had other options." -Melissa

4.2.4 Implications and Contribution to the Model

The themes that emerged in this subset were not necessarily defined by the student being a chemistry doctoral student, as some of the reasons yield a broader rationale of going to graduate school or pursuing a degree. The desire to work in a lab and continue research is not unique to chemistry students. The desire to continue learning and answer higher questions are not limited to just STEM. The passion for teaching, or industry, or the desire to continually evolve skills is not limited to any field. The results of this work have broader implications for students, graduate student professional development, and career pathways for students, as well as mentoring implications for those working with students.

Of major importance to the overall graduate student experience and broadening understanding are the reasons put forth by underrepresented students for obtaining a Ph.D. This was the most salient for Black participants in this study. As Kody explained, his Ph.D. was for his community, and his children's children. He spoke further on how important it was for him to earn his Ph.D.:

> "And, you know, we don't know anybody that even has a degree in chemistry, less know, a PhD in chemistry. And again, I mix all of this with religious talk. Um, I think about, uh, the African American national anthem. I don't know if you're familiar with it, but it's entitled 'Lift Every Voice and Sing,' it's a song. Uh, and there's a line in there that talks about, um, uh, the, 'stony the road we trod,' uh, 'Bitter the chastening rod, felt in the day when hope unborn had died.' My ancestors paved the way for me to be here. Uh, they tread a stony path, uh, but at the same time, they were paving a pathway of possibility for me to be here. And so it's bigger, it's bigger than me, um, to be here, um, and so this represents me. Um, those in the song as they're talking about, you know, 'Felt in the day when hope unborn had died.' My ancestors thought that there was no hope. The hope that didn't even exist, they thought it was dead. It was unborn, and they just thought it was dead. And so, getting a PhD for me is saying, 'Hope is not dead'." -Kody

Kody's approach and desire to leave a legacy of 'academic excellence' is powerful and exemplifies why, as a Black man, he chose to earn a Ph.D.

Although the reasons that students chose to embark on this "perilous passage" do not answer the overall research question of this larger body of work, they are nonetheless important for the contribution to the body of literature and understanding we have of underrepresented students in graduate education. The more we can understand of not only how students perceive their relationships with the faculty advisors, but also their overall experiences in embarking on the journey, staying the course, and where they go from the Ivory Tower, the better we can effect positive change.

4.3 Choosing an Advisor

The results in this section are drawn from the analysis of a single interview question from the full protocol, as shown Table 3.3 Group A2. As noted in Section 4.2, A1 and A2 analyses were split from their original grouping as one analysis chunk. The prompt that was analyzed was, "Can you tell me how you chose your advisor?" Participants answered this question as a combination of both *how* and *why* they chose their advisor. The results in this section appear nearly verbatim in a paper currently under review (Pfirman, Gallagher, Norton, & Patel, 2018).

> "I guess I was little bit uninformed uh, to be honest. Maybe I was looking for the quick and dirty way out of grad school. Actually when I was looking at grad school, I have no idea when I was searching for advisors, looking for a professor to work for even before even applying, I don't know what made me click on his information, or his picture. I didn't even know enough about chemistry to really decide what type of research I wanted to do. I didn't know enough. So, nevertheless, I chose him. He was the only person that I came and visited with. I didn't talk to any other professor at all. I just knew I was coming to [university] and I was going to work for him, and that he was gonna be the one to get me out of here in three and a half years." Kody

Some students, like Kody, had neither met a person with a degree in chemistry, nor a Ph.D. for that matter. His lack of knowledge about graduate school, finding an appropriate research group, and choosing an advisor led him to latch on to something that turned out too good to be true, as he did not continue to earn his Ph.D. working with his initial advisor. So how do students, deciding upon

graduate school, decide who will be their faculty advisor?

As a stark contrast to Kody's description of choosing his first advisor, the following excerpt from Amelia's interview highlights how some students approach advisor choice very differently. Amelia had structured mentoring from undergraduate experiences and had specific criteria that she was seeking in an advisor. Some participants, like Amelia, built this knowledge base from advice from undergraduate academic advisors, and undergraduate research experiences that made them available to graduate-level research and graduate students, and other workshops.

> "Yeah um, so I was looking for ... I was looking for a number of things. I was looking for someone who would be obviously supportive of my education. Um, someone who already had tenure, because sometimes one professor if you don't have tenure yet, um either just are insecure themselves and so aren't really nice to their students, or make their students work too hard, or things like that. Um, I was looking for someone who, if they were a male advisor (laugh), weren't going to be creepy, because you hear about that sometimes. And I was looking for someone who had a good track record of getting students out in a timely manner and getting them into decent jobs." -Amelia

Although this cannot be used for evidence that strong undergraduate mentoring towards graduate school will ensure a successful match with an appropriate doctoral advisor, it can convey to potential graduate students to think about things like finding what they need in a mentor. Strong undergraduate advising and mentorship towards graduate school does not guarantee a good, successful, or beneficial relationship in the future. It can aid, however, in the student taking more intentional ownership of their degree program and future. Many assumptions are made when students choose advisors and do not know that what awaits can be a "perilous passage" until they find themselves far off course.

4.3.1 *Why* Students Chose their Advisors

The participants' reasons for *why* they chose their particular advisors are categorized primarily by either advisor characteristics or the research area itself. Lioness chose her advisor purely based upon

research area of interest:

> "So my advisor is actually the only person, at [university] in the Chemistry Department that's doing something forensics related . . . forensics is kind of my passion, so I was like, 'Okay, it makes sense for me to actually do a project that's actually in my interests'."
> -Lioness

Lioness explained various difficulties throughout her Ph.D. journey and felt that within the chemistry department, she does not have a mentor. Her advisor told her that he doubted she has what it takes to finish a Ph.D. from their institution. For a struggling doctoral student to hear those words from an advisor is crushing, no matter how passionate she is about her research. Luckily, Lioness has other mentors outside of the department who have aided in her academic progress. This is an example of how students need guidance in choosing an advisor for reasons other than simply research area.

The advisor characteristics that students were seeking from their advisors were academic rank, work style, enthusiasm, and ethics. As quoted from Amelia above, she sought someone who had tenure (academic rank) and who would not be 'creepy' if a male (ethical). In contrast to Amelia, Abby was seeking someone who was young and full of energy, and not necessarily tenured. Abby explained that her first advisor, nearing retirement, doled out projects to people and left them alone to work on them. Abby was seeking more enthusiasm and a better match of work style with her own, as an independent person wanting to contribute her own project. This led her to meet her current advisor:

> "We just clicked, and I was like, you know this is where I should've been . . . she's just very excited to teach and like, she wants you to know and do everything that she does and so . . . I definitely wanted somewhere where I would have my own thing like, I'm very independent. I mean, not that it's hard for me to work with other people, because it's not at all. But I wanted something that I could lead and you know, develop and feel like I deserved a PhD, when I was done. And, um, also a professor that maybe was younger and more enthusiastic. Maybe not even younger, just more enthusiastic about everything." -Abby

Abby found the enthusiasm for all aspects of the Ph.D. process with her current advisor, as well as the energy and work style to match and complement her. She also explained how the techniques she developed in her two years working in her former group fit very well and her expertise and skill were valued highly by her new advisor, who gave Abby her own project using those skills in a new area.

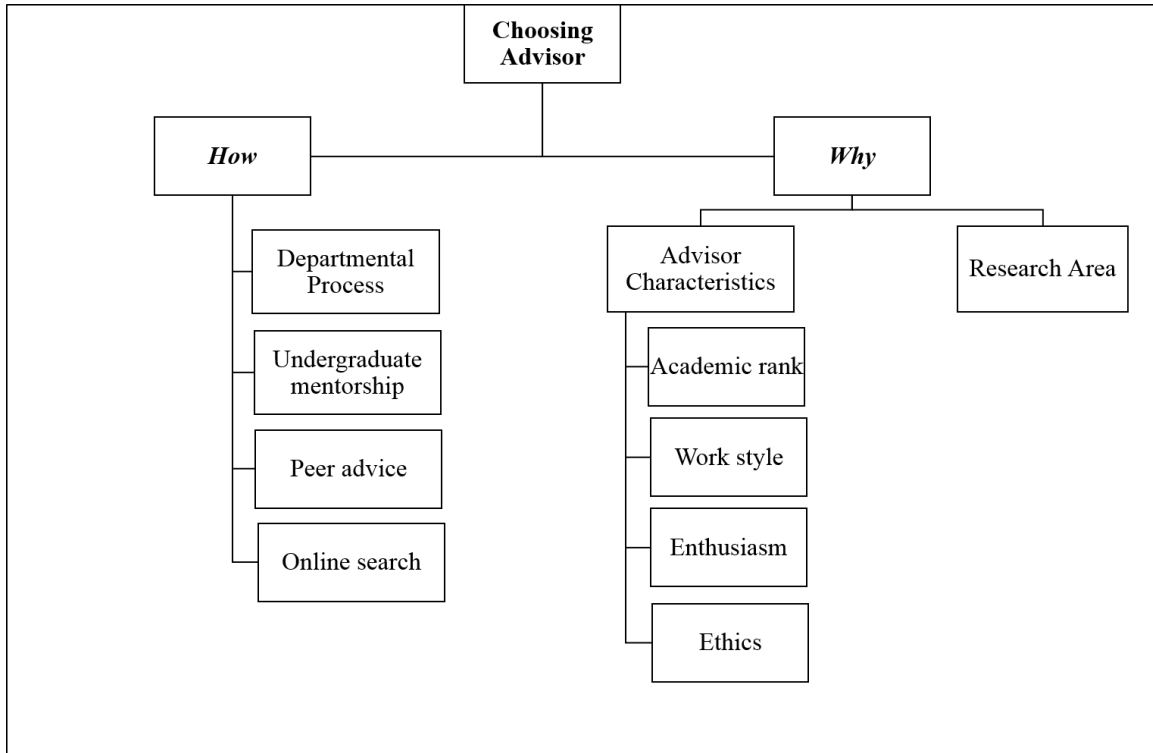Figure 4.4: How and Why Students Choose their Faculty Advisors

4.3.2 *How* Students Chose their Advisors

Participants' processes for *how* they chose their particular advisors fall into four categories: departmental process, undergraduate mentorship, peer advice, and online search. When asked how she chose her advisor, Anna replied,

"So, just from like reading online, talking to classmates, and my own mentor from un-

dergrad."

Anna hits several of the main reasons here of online searches, undergraduate mentorship, and peer advice. Brittany outlined her department's process of having graduate students match up with advisors:

"Brittany: So at [university], we have to say ... we have to turn in some, uh, piece of paper towards the end of our first semester, so I think like around November it's due, and you have to put ... And so up until then ... They change it like every year, but when I did it, you had to meet with I think five or seven different faculty advisors-

Aubrie: Wow. Okay.

Brittany: ... and they would ... sometimes they would schedule like group talks, sometimes it would just be one on one and they would be like, you know, 'This is the research I'm doing,' and you also by then had to think about declaring what your, your concentration was. Well, we ... I guess we had did that kind of going in, but it was still kind of loose 'cause a lot of the pre-reqs kind of were across concentrations. So I knew I wanted to do analytical, um, and so (laughs) I, um, interviewed with all the people and I wasn't just feeling any of it- um, and then the one I was feeling, uh, wasn't feeling me and he was like, 'Sorry, like I don't really want you in my group,'

Aubrie: Aw.

Brittany: ... and I was like great 'cause I didn't have great grades coming in from undergrad. I've always b- ... done well, like standardized testing wise, but I've never been a great student. I'm like a B average and so they want ... you know, when a faculty advisor's picking students, they want like the best of the best and I was not really that. And then I met with, um, my boss because he did mass specs but he was organic, so I was a little confused um, but then once I met with him, I realized that he did kind of both and they were getting a bunch of new instruments in December. Like, they were getting orbitraps, which are like the creme de la creme of like mass specs so I was very

wooed by that and um, he would say that I was the wildcard, so if- There were three student- ... three first years that he took that year. One ended up ... And I was the wildcard." -Brittany

4.3.3 Implications and Contribution

The findings of this smaller study are essential to areas outside of the sciences where quality mentorship and advising practices are critical. This study, although bounded to underrepresented chemistry doctoral students, illuminates through the participants' stories how the actual relationship between advisors and students has an impact on opportunities for collaboration, confidence as a researcher, overall graduate school experiences, teaching and instructor experiences, and success in progressing through the degree. The themes that emerged in this study were not defined by whether a student worked in a laboratory, but rather by the foundations and substructures of their interactions with their faculty advisor. Additionally, although the broader study is focused on the perspectives of specifically underrepresented students, the particular analysis in this part of the study did not yield any salient data pertaining to diversity and inclusion issues, or participants' experiences in identifying as underrepresented.

Although the *how* and the *why* students choose their advisors do not answer the overall research question of this larger body of work, the breakdown of these reasons into a preliminary model, shown in Figure 4.4, contributes to the overall model discussed in Chapter 5.

4.4 The Ideal Advisor

The results here are drawn from the analysis of a subset of the interview questions from the full protocol. The two primary questions that were analyzed as Group C as shown in Table 3.3 were, "If you were advising graduate students, how would you carry out the roles of a faculty advisor/run your research group?" and "Describe for me the ideal advisor." In some cases, participants made relevant comments in response to other prompts as well. Five broad themes emerged from the analysis of

these prompts, and these themes were central to the final outcome space. The results in this section appear nearly verbatim in published work (Pfirman & Gallagher, 2017).

4.4.1 Initial direction and guidance with projects (Scaffolded Direction)

In various ways, participants described being lost in the beginning of their Ph.D. journey by not knowing what they were trying to do on a certain project, not being able to see the big picture, or not knowing why they were running experiments they were simply told to carry out. When asked what they could change, many expressed the desire to go back and ask for more guidance on their first project so that they did not waste time and material. Participants also explained that guidance should naturally taper off as students grow more independent in the lab and develop confidence and skill in their area:

> "I would set up research projects at the beginning, that I thought had a fairly clear direction, sort of guide them through one and then, then give them a little more freedom to say, 'Okay, here are a couple of choices. Let's look at this.' Um, so I think I would be decently involved in data generation and collection for the first couple of projects and then I would give them more freedom gradually." -Amelia

In order for faculty members to provide the advice, support, and encouragement that graduate students need in order to view their advisors as mentors, faculty should develop clear understandings of what is appropriate in the discipline for initial tasks and projects to fit program requirements and set their students up for growth and success. Department chairs and deans can support these efforts by helping facilitate those conversations and by providing support for new faculty members as they take on advising duties.

4.4.2 Formal and recurring feedback on progress

Participants who experienced formal feedback mechanisms acknowledged that it was stressful to complete semester reports, for example, but also that it set them up with skills for conference talks,

segments that went into manuscripts for publication, and the backbones of dissertation chapters. Participants who experienced no formal feedback mechanism, did not have regular meetings, and never addressed areas of needed improvement talked about the detriment to motivation, the time wasted straying away from their goals, and overwhelming feelings of never really knowing what kind of progress they were making towards their degree. It seems a very simple task, but one participant explained that even a list, made and understood by both the student and the advisor, can make a big difference:

> "Sometimes I think advisors think they are being clear with the goals and directions. But, I would write it down. I mean I don't really hear of many people that do that; but like that yearly or semester meeting where you have with your boss, where you are like, 'how am I doing?' Where they are like, 'okay, these are the, your goals for the semester, you can add or like modify as needed. But this is what I see.' And actually have it written down and give it to them. Cause, I think that would be a nice thing to have. Where you can just, tape it up to your desk. Like, this is what I am doing. Yeah, cause I think that's where a lot of relationships diverge." -Renee

It is crucial for both the students and the faculty advisors to have some type of formal feedback mechanism to assess student progress in their Ph.D. Written progress reports on a regular schedule will ensure that both the advisor and the student are in agreement on goals, appropriate tasks to reach the goals, timelines, expectations, and responsibilities. Having a formal mechanism in place and on paper allows for tracking of progress and directions that projects have taken.

4.4.3 Less micromanaging, balanced with presence in the lab

Most participants articulated a desire for their advisors to have a greater presence in the laboratory with them. Some described that there was a lot more micromanaging if their advisor was in the pre-tenure stage, sometimes followed by absence once tenure was achieved. Many participants shared stories of how they strayed too far off course if they did not see their advisor often, or felt lost and unmotivated if they rarely saw their advisors in the laboratory. Those that experienced the other extreme, micromanaging, talked about what was perceived as a lack of trust in their scientific abilities

and the negative impact on their overall well-being. Despite students' personal and individual needs and preferences, it seems that a balance can be achieved, according to one participant:

> "But it is kind of a matter of 'Hey if you stick your head in every once in a while at least acknowledge. Hey that's what that person is working on and that's what this person is working on' and if she's there we can say 'Hey I have this quick question about this' instead of I don't know" -Leigh

Both 'micromanaging' and 'absence' were recurring ways that participants described their interactions with their advisors that undermined mentoring possibilities. Since micromanaging and absence seem to be correlated to stage of the advisor's career (within our limited sample), this may provide an opportunity for department chairs and deans to encourage and support the development of a healthy balance for their advising faculty through targeted professional development.

4.4.4 Professional yet open relationship, while maintaining boundaries

One participant described the ideal relationship with an advisor as being that of her current relationship:

> "It is a personal relationship. I think for me an ideal advisor give[s] me some help, but then gives me some space, because that's how I think I build up the best intrinsic motivation . . . As an advisor, you always want to maintain some sort of professional distance between yourself and your students, just respect and not like...I couldn't ever picture myself hanging out on the weekends, like downtown with my students. You want to make sure that you give them some space for a number of reasons, but I think that that professional relationship is still personal and that the personalities of the people involved are going to be important to making it work or not work." -Amelia

This desire for a balance between professionalism and openness, and a mutual respect for boundaries, was expressed throughout the interviews in various ways. Several participants stated that an advisor who is very open to talk about research and scientific ideas without ridicule is important. Another

stated that a friendship is important so long as his advisor is not showing up for dinner at his house, and is respecting his personal life. This is also an area in which department chairs and administration can provide mentoring for new faculty members in order to help them achieve and establish practices for appropriate mentoring and advising as they make the transition from being graduate students or postdoctoral fellows themselves.

4.4.5 A symbiotic relationship with each other's best interests in mind

One participant in this study described the ideal relationship between a doctoral student and a faculty advisor to be symbiotic, in that both parties should be investing and mutually benefiting from working together.

> "I don't know if this is the right word but it's like when some, when in biology rather, when one helps the other, another helps the other . . . so symbiotic, like I feel like he helps me and I help him with different things" -Diego

The same sentiment was also described by several other participants who expressed that within their research groups the individuals who worked harder and more honestly would receive more attention and guidance from their advisors, in a mutual give-and-take. Others described responsibilities they felt were theirs as students, such as running experiments, putting in the hours, and collecting substantial data for funded work and dissemination; in return, they expected their advisors to help them move forward through the milestones to achieve candidacy, publish papers, and gain professional experience for their careers. One participant also described a symbiotic relationship of mutual effort:

> "The more work you put in, the more attentive I am to what you're doing. Of course if you're coming in and just doing nothing and just leaving, then yeah, I'm probably don't pay that much attention to you. Me personally . . . I'm one of those people I don't expect someone to do something that I wouldn't do myself. And also, I don't want to be one of those advisors who will come up into the lab and be like, 'I haven't really done anything in like 5 or 10 years, so I'm not going to touch anything.' I would prefer to be

one of those professors like, 'Alright, we're gonna do this so I'm gonna run it and then you're gonna run it. And we're just going to compare our results.' That way you have multiple people doing this multiple times and we can get good results, instead of just being, 'Do this. Go do that'." -Sibaran

This theme stresses the importance of developing mutual responsibilities, goals, agreements for authorship, and roles in the research group for both students and advisor. Department chairs and deans can aid in this area with training for their faculty and for setting guidelines within the department to ensure responsible and ethical conducts of research. As a participant stated,

"I would definitely try to be as good and positive, encouragement as my advisor is and yeah, just try to keep good standards for obviously ethics and research quality and try to be a good example for my students and hope that they would follow that." Amelia

4.4.6 Implications and Contribution

The categories of description that emerged from analysis of informant responses to prompts about the "ideal advisor" show the qualitatively different ways chemistry doctoral students conceptualize *ideal* relationships with their faculty advisors. Although there is not a singular answer to how students perceive the ideal advisor, the themes that emerged were ones that describe a mentor. Students are seeking a professional and friendly mentorship from their faculty advisors. They want to feel valued in their scientific ideas and exploration, and have a balance of firm guidance and critique. They want to be trusted to do their research and fulfill their roles in the laboratory, yet know they can depend on their advisor to work alongside them at the bench when the occasion arises. This is useful and pertinent to all invested in improving the quality of graduate education because it can be used to inspire departmental policies, guidelines, and cultural norms. The official title of 'advisor,' as shown in the literature and illuminated through the voices of the participants, does not assume the title of 'mentor.' If an 'ideal advisor' is someone who is also a mentor, then perhaps our policies should necessitate that doctoral advisors be mentors. The themes that emerged here were not solely defined by whether a student works in a laboratory, but rather by the foundations and substructures of their interactions with their faculty advisor.

Perhaps what is most important about the analysis of this subset, and the connections made with the analysis of other subsets from the blender approach outlined in the previous chapter, is how the intermediate pieces contribute to the overall outcome space of this phenomenographic investigation. As seen in Figure 4.5, when all of the categories from analysis groupings A (choosing advisor) and C (ideal advisor) were examined for any ties or relationships, the basis of a model began to form. In conjunction with further analysis of subset B about student and advisor expectations, a larger connection can be seen, as shown in Figure 4.5. This also aided in using participants' own words to help determine categories of description and the definitions therein, because the manner in which participants talked about both their ideal advisor, and how and why they chose their advisor, were very similar. They were similar in that they were able to reflect upon facets of their relationship, and characteristics of their advisor that they appreciated, disapproved of, or that were absent.
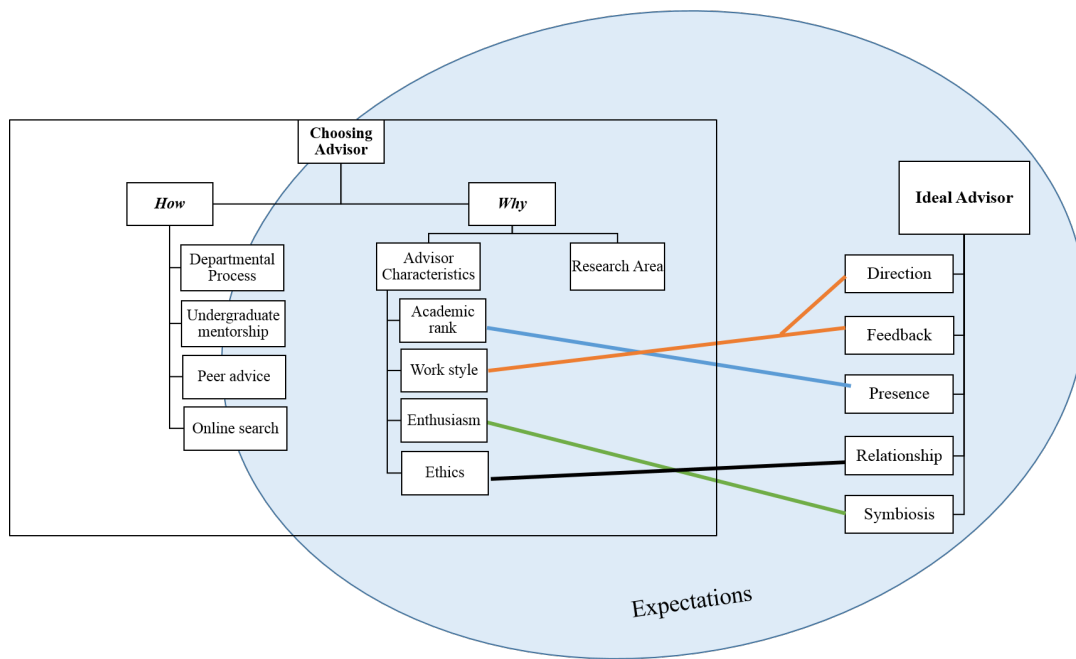

Figure 4.5: How Intermediate Results and Models Contribute to the Categories of Description in Full Phenomenographic Study

The lines drawn to show connections in Figure 4.5 made it clear to examine the things that participants both experienced and did not experience but wish they had when discussing their relationship

with their faculty advisor. Academic rank, as one of the advisor characteristics for *why* participants chose their advisor, directly relates to presence of their advisor in the lab, according to the participants' words. Amelia saw an untenured faculty advisor as someone who may be 'insecure' and make students 'work too hard.' For Kody, his first advisor just achieved tenure when he began his doctoral journey:

> "He was never really present so it was ... I think that once he got tenure, uh, from my understanding, that he was around a lot less. So I didn't really get the one on one attention because I, I was really looking forward to, uh ... I talked to his students and they told me, that 'Hey, this advisor is different. He's always in the lab with the students. You're really gonna learn,' and you know, right when I came in he got tenure, uh, and I, I'm assuming that that's why it changed. That's the only correlation that I can make, uh, so why it changed. I'm sure there, there are probably other factors that are beyond, uh, me ever being able to know. Um, but I guess that's kind of why I chose him. I mean I thought that he was gonna be hands on." -Kody

The type of direction given by the faculty advisor to the student was ideally scaffolded and appropriate for a student's progression through a program to the Ph.D. The type of formal and recurring feedback that students craved, along with the scaffolded direction, are both tied to "work style" of an advisor that participants spoke of as reasons for choosing their advisor. The ideal relationship, as being professional and yet open and friendly, is related to the ethics piece in the why participants chose advisors. Here, ethics is referring to both research ethics, as well as an ethical relationship with maintaining boundaries and behaving in an ethical manner. The symbiosis that participants described would be ideal in a student-advisor relationship related loosely to the enthusiasm participants cited for choosing their advisor. They wanted someone to share similar enthusiasm for learning, teaching and teaching methods, collaborations, publication, and science. If both parties in this relationship are enthusiastic and therefore on the same page about the importance of these matters, both will contribute time and energy to them and benefit from the resultant symbiosis.

As is outlined in Chapter 5, the types of relationships that are discussed are all characterized and compared in terms of the degree to which they align with the characteristics of an ideal advisor. The intermediate results helped to organize the structure of the categories of description and final

outcome space in this manner. This intermediate work was refined and supported by responses to the prompts not explicitly discussed here. Analysis groupings D-G were all utilized to support and corroborate findings.

Chapter 5

Ways of Conceptualizing the Student-Advisor Relationship

> "Um, so how was my relationship with my advisor? I, personally, think your relationship with your advisor like is the core of your grad school experience. Like, it is the most important part." -Brittany

This chapter presents the major results of this work, which are five qualitatively different categories of description of the the student-advisor relationship as experienced by underrepresented doctoral students in chemistry. Section 5.1 is a presentation of the categories as an outcome space. A more in-depth description with participants' quotes that shaped their development is presented in Section 5.2, followed by the relationships and differences between the categories in Section 5.3.

5.1 Outcome Space of Doctoral Student-Advisor Relationships

The outcome space presented here is the five qualitatively different ways that underrepresented doctoral students in chemistry experience their relationship with their faculty advisor.

Type	Category Name and Description		
Mentorship	**1. Mentorship + advocacy***		
	Advocacy is the missing piece in what would seem to make an ideal mentorship in addition to all of the qualities as described in a Mentorship, as below.		
	2. Mentorship		
	Meets all basic qualities that participants discussed: scaffolded direction, professional and open relationship, balanced presence, formal and recurring feedback, and symbiosis.		
Absentee Relationship	**3. Absentee relationship**	**Boss-Employee Relationship**	**4. Business Relationship**
	Inefficient due to lacking of one or more of balanced presence, formal and recurring feedback, and scaffolded direction. This relationship may also lack symbiosis and is therefore really only defined as an on-paper relationship.		There is direction, presence, and symbiosis; yet the relationship is lacking (and is more professional). Additionally, the direction is more in the form of tasks that should be completed, and the advisor presence is more on as-needed basis, or bare-minimum at times.
			5. Autocracy
			There is scaffolded direction with *some* feedback, but is in the form of directives for task completion. This relationship lacks the balance of the professional and open relationship, the balanced presence, and the symbiosis

Figure 5.1: Outcome Space: Categories of Description of the Doctoral Student-Advisor Relationship. The vertical spacing from top to bottom indicates a hierarchy from best student-advisor relationship, and decreasing moving down.

5.2 Categories of Description of the Doctoral Student-Advisor Relationship

The five qualitatively different categories of description of the student-advisor relationship emerged from the sixteen interview transcripts. There were eight iterations of the categories before the

model was complete and hit saturation in terms of producing no new ways of understanding and organizing the structure. Of the five presented herein, four were explicitly experienced and perceived by the participants. A fifth category is presented here to highlight an experience explicitly discussed as missing. For each of the five categories, I present a definition with rich description through participant quotes from the interviews.

5.2.1 Category 1: Mentorship with Advocacy

A mentorship, as described in Category 2, is characterized by including all of the traits of scaffolded direction, balanced presence, formal and recurring feedback, a professional yet open relationship, and symbiosis. The missing piece, however, that became apparent as something that is lacking even in the mentorship, is the advocacy piece. The underrepresented students in this study, persons of color and females, would have benefited greatly from advocacy, particularly with respect to race and gender issues.

As discussed in the Political Climate in Chapter 1, race relations in the United States have been at the forefront of the media both leading up to, and following the inauguration of our 45th President. The types of tensions and issues that students are facing on a daily basis infiltrate all areas of life, including the ivory tower of higher education. There were stories told in the interviews of times when an advisor could have been an advocate for their graduate student, but fell short.

Throughout Tom Sawyer's interview, he explained frustrations of being a black man in a mostly white department in a predominantly white university. He discussed microagressions from both faculty and students, and lingering stares throughout the department because he looked different than your average graduate student. He described a particular incident involving biological samples that he had carefully prepared, labeled, secured, and stored in a freezer for an overnight experiment. The next morning, the samples were distributed among random places and boxes in the freezer, without the rubber-bands securing them any longer. When trying to discuss the tampering of samples with his research group, he received no valid responses from anyone, including his advisor:

"I sent an email out and it's like really no response from [advisor]. And it's just like,

that's not the first time that's happened. And it's like, sometimes he'll step in and he'll be like, 'hey, like you guys can't do this.' But a lot of times its just like really laissez-faire hands-off and [I'm] just like, 'I need you to come in here and say something to somebody because people just looking at me, you know **I'm already stereotyped as angry black man**.' So it's like, a lot of times, they're just not going to listen to what I'm saying anyway. But, if you come in here and you say, 'Hey, this isn't right, you guys need to do this,' maybe it holds some weight." (emphasis added) -Tom Sawyer

Additionally, Tom Sawyer also shared an important event near the very end of his Ph.D. journey in chemistry, as he was finishing up at the time of the interview. He was fired from his teaching assistant position in the department over a small infraction that he claims was unjust, unfair, and was done by people who had it out to get him from day one. This was another scenario, he felt, in which his advisor could have stepped in and advocated for his remaining three months of his teaching position until graduation. Instead, he remained silent in the termination meeting itself.

"Like, there's no way you can fire somebody over this. Without, well without following proper escalation procedures. There's no way you can do that. Second of all, the fact that you know, I keep showing this letter to other people and they keep thinking that I did something totally different from what actually happened–screams that this is false. Like, the pictures being painted of me is completely different. So he's like, 'Well, you know, I understand that, but at the same time, if you want to justify firing somebody, like the language tends to be harsh.' And I'm like, 'That's my point. The fact that you even have to put extras on the language to justify me being fired, means that I shouldn't have been fired. Like if you have to go, if you have to jump through that many hoops to say, 'Yeah, this is why we did this,' you really weren't justified in doing it in the first place.' So, that was really disappointing because it was like, that was one time I really needed you to have my back and it was just like, you just kind of let me just like fly out of the wind." -Tom Sawyer

5.2.2   Category 2: Mentorship

This relationship is characterized by all of the traits that participants spoke about as being the best parts of having a faculty advisor. The basic tenets or traits of this relationship included scaffolded direction, a professional yet open relationship, balanced presence in the laboratory, formal and recurring feedback on progress, and symbiosis.

When asked if, in what way, his relationship with his advisor may have any influence or impact on his overall graduate school experience, Diego could not separate the two:

> "I really feel like he's changed, um, maybe he, once he got tenure I feel like maybe he's realized, I don't know, maybe he's starting to care about himself too and not just like, work, and getting tenure and stuff like that. He is realizing that people have lives outside of here and he can have a life as well but I think that without that relationship I don't think I would ... I don't know if I would still be in graduate school without his support and, um ... I just, it's a hard question because like, how can you not have an advisor in grad school . . . I don't think I can separate them because, yeah, I just, I feel like he's done a lot for me and like I said he's molded me and if I wouldn't be the same person if it wasn't for him and his mentorship. Um, and so I don't, I can't see grad school, or at least how I am now, I can't see that without him there." -Diego

This excerpt from Diego's interview is also important because it highlights how relationships can change over time. Several other participants discussed how their advisor achieving (or not achieving) tenure had an impact on their relationship and on their advisor's style of running the laboratory. Renee felt the pressure and discusses her responsibility in her advisor achieving tenure:

> "With her being untenured it's almost like I feel a lot of pressure to make sure that she gets a portfolio going into that like tenure meeting. I mean it's her responsibility too, but like, to give us reasonable projects. And to like, make sure we are staying on track. But, it's like, I feel, like, no matter who I was with I'd feel pressure to get papers and produce something. Um, but with her I feel a little bit more pressure. That, like she needs a good portfolio to walk in that room." -Renee

5.2.3 Category 3: Business Relationship

A business relationship was described as being professional, yet there was lacking a certain open or friendly component. As one of the two types of boss-employee relationships, the faculty advisor served more of a role of boss, as opposed to advisor or mentor, and the student fulfilled the role of employee. In this type of relationship, there is typically some type of direction and in fact it may be scaffolded as the student grows in skill and confidence. The direction, however, is intended for task completion in the laboratory for data collection. This leads to an advisor's presence in the lab being on more of an as-needed basis to check on and monitor task completion. Melissa's advisor, who was very hands-off, would be around from about 7:00am until noon daily, so she would leave at noon after being present for visibility's sake. This went on for several years:

> "I spend the first two to three days of the week doing nothing but playing Minecraft game in my computer. Um, and then I realize that I need to get something done and so I run the experiment on Thursday, crunch all the data on Friday, and then talk to my boss about it on Monday, and then start the process over again . . . all of last semester, like in the fall, the boss was asking, like, um, you know, 'Are you working on this thing? Are you writing?' And I'd be like, 'Yeah.' (Laughter.) Just alt/tab, you know, pull up an empty Word document, it's fine." -Melissa

.

Although it is clear that Melissa's advisor would check in once a week to see if she completed the experiments he gave her to complete, it is less clear just how productive her Ph.D. experience was overall. Although she did complete her Ph.D., Melissa felt that her advisor lowered his standards due to her lack of enthusiasm and creativity, and stated:

> "I've come to realize that's more of a factor of how close he is to retirement than his actual personality (laughs)." -Melissa

While Melissa certainly could have chosen to handle her responsibilities and productivity in a different way, her perceptions of this relationship shaped how she carried out tasks and to what degree

she invested time daily toward her research. Melissa's actions were consistent with the expectations of this type of boss-employee relationship.

5.2.4 Category 4: Autocracy

An autocracy, as the second type of the boss-employee relationship is very one-sided and missing the symbiosis between the two individuals. This relationship includes some feedback between the doctoral student and the advisor, but is directed solely at the completion of tasks. This relationship lacks the balance of the professional and open relationship because there is only interaction in an effort to complete tasks. This relationship can be thought of as really having only direction coming from the advisor to the student to do work and collect data in the laboratory.

> "Sophia: We also do our own [computation], we don't do any collaboration . . . So we do our own thing. Um, so I have to learn myself because he never help me.
>
> Aubrie: You never got help learning programming or-
>
> Sophia: No, no, I has to do everything myself.
>
> Aubrie: mm-hmm
>
> Sophia: When he tried to teach me, he gave me a book on computational chemistry, it was like, 'oh, um, just practice every single exercise in this book and you will learn'."

5.2.5 Category 5: Absentee Relationship

An absentee relationship is one characterized by a major lack of most of the tenets of a mentor, particularly that of the balanced presence. Students expressed that this type of relationship with their advisor manifested in a lack of balanced presence in the sense that their advisor may show up to the laboratory very little if at all. Some advisors had taken other roles in addition to their faculty status at the university, either within the university in administration, or outside of the

university with a company, so that their time in the actual chemistry department was minimal. Those situations are not exclusive, however, as this relationship can also take place when an advisor is nearing retirement and has just several students left completing their degrees. While there may be some feedback to the student on progress in this relationship, the formal or recurring piece is often lacking. Students may receive feedback randomly or quite superficially, relating to their tasks in the laboratory and not to their progress to completion. This absentee relationship also lacks symbiosis. With minimal contact and an imbalanced presence, neither party benefits greatly here.

> "I think a lot of this is just benign neglect. And I think it's benign because he just wants to stay out of everything, but it's just like, in doing that, you're being very dismissive and it's like, I, I still feel comfortable enough to come talk to you, like if I have a problem about something, but if it's something that, you know, I could just solve on my own, I'm just gonna do it (laughs)." –Tom Sawyer

Tom Sawyer's choice of the phrase 'benign neglect' is important here because it implies that his advisor does not mean any harm and does not set out to influence Ton Sawyer's doctoral experience in a negative manner. However, it is in the neglect where the harm is done in this relationship. This benign neglect can overshadow many other good qualities of a relationship between a student and his faculty advisor, as with Tom Sawyer. He felt that he did not have someone in his corner to help him when needed. For a deeper discussion of implications here, please see Chapter 7.

Similarly, Matilda found her relationship with her advisor to be lacking in support. She felt that with him nearing retirement, he was out of touch and lacked contacts in the field to help her find a job. She felt that most of her experiments and training in graduate school were on her own.

> "'You have no role in what happened there, then we don't have anything else to discuss. We're going to discuss business and then we're going to go our separate ways.' Like, I don't even talk to my boss that often. He'll come to me ask a question, I'll answer it and I'll turn back and I'll look at my computer. I may talk to my advisor once a month and I'm totally okay with that . . . So, yeah, because there was never any like hand holding or support within my condition. Like, heres what you need to do, let me know when you're done, I'll let the committee know, and I'll send the relevant emails to like

the graduate school and everything else. And do everything that needs to be done and then you can get back to work as usual. Like, okay, that's it? So, no. There wasn't much there at all." –Matilda

5.3 Relationships Between Categories of Description

The relationship between the categories of description form a hierarchy by the extent to which each relationship, as perceived by participants, embodies certain attributes. These are defined by having all of the traits (and more) of an ideal advisor as defined by participants, to having the least. Visually, Figure 5.2 presents the similarities and differences between the categories of description of how underrepresented doctoral students perceive their relationships with their faculty advisors.

The larger parent categories of mentorship, boss-employee relationship, and absentee relationship organize these relationships broadly. In an ideal situation, doctoral students describe their relationship with their faculty advisor as a mentorship, where advocacy is present. Although this was not present for any of the sixteen participants, it was the missing piece in the relationships that was hinted and discussed several times over. Excerpts from the transcripts were used to highlight just how important and integral an advocate really is for a doctoral student. It should be noted that the relationships categorized as mentorships in this study could very well have also had advocacy pieces as part of them. However, if they were not explicitly discussed by the participant during the interview, they are not categorized as such.

5.3.1 Boss-Employee Relationships

The main differences between the two boss-employee type relationships is the balance of advisor presence and the symbiosis experienced by both student and advisor. In the business relationship, participants described their advisor as being present in a way that may allow them to ask questions or to check in, but it was rare for their advisor to step in to the laboratory in a hands-on manner.

	Mentorship		Absentee Relationship	Boss-Employee Relationship	
	1. Mentorship + Advocacy	2. Mentorship	3. Absentee Relationship	4. Business Relationship	5. Autocracy
Direction	Scaffolded		Inconsistent	Tasks and Directives	Directive
Presence	Balanced			Imbalanced	
Relationship	Professional and Friendly			Professional	Professional
Feedback	Formal and Recurring		Inconsistent	Recurring	Inconsistent
Symbiosis	Mutually beneficial			Task completion	
Advocacy					

Key				
Balance of Presence (From dark to light, existence of characteristic in relationship)			May or may not be present	Not present

Figure 5.2: Relationships between Categories of Description

For example, Melissa described her Ph.D. experience with her advisor as just doing what he told her to, and when to do it:

"So, in terms of, like, the minutiae, that's kind of how he runs the group. Um, and generally it will be like, 'Oh, you know, we should start writing up this into a manuscript,' or, 'Oh, you should start making a presentation for this conference,' or, 'Oh, I think you should really go to this conference this year,' or whatever . . . But it's, it's not authoritarian." -Melissa

The phrase 'imbalanced presence' was chosen deliberately to convey that the opposite could be true: a more micromanaging presence, or 'boss.' As a boss, the advisor in this relationship also offers some scaffolded direction to her students, with tasks, next steps, and in some cases, even a plan into

the future for students to reach benchmarks.

The autocratic relationship is characterized really only through direction, given in the form of directives. In this case, the direction students receive is typically not scaffolded. They can be characterized as more strict directions, or directives from their boss that they are to simply follow. Kody experienced what he called a feeling of being in the 'wilderness' within this type of relationship:

> "Wilderness, wilderness. Sometimes I, I didn't know where I was going. I didn't know why I was doing this. I mean, I was just roaming around. Um, you know, fishing around for results, I mean, I'll say for at least three years in [advisor]'s group, I don't think he really provided me with any direction. You know, just, 'Go do this experiment.' Put you on an experiment for three of four months and then you do something else. Like, you have no idea why you're doing this, and later on you find out, that oh, you know, you're gonna be a part of a publication that someone else is first author on, because you were making the supplies for another project, and you had no idea why you were doing it."

Sophia described her relationship with her advisor as strictly professional. She determined beforehand which questions to ask him about, or which were better to approach committee members, which also caused issues:

> "Sophia: And, I learned to group meeting, I show my data, and he, he hate it. Um, so, sometimes it's really hard to him because like, if you are not doing it his way he's going get really mad at you.
>
> Aubrie: Oh, okay. So it was the fact that it was done differently, not necessarily he was angry about the results?
>
> Sophia: It wa, It was not about results. He was mad that I didn't ask him. He was mad that I was not using what he had told us to do, because how I use was something different.

Aubrie: Right.

Sophia: But the thing that was, like, madness, that he made the maddest, because I told him, no, I asked [committee member]." -Sophia

Sophia's advisor was famous in his field and so his status made him particularly unavailable to her on most occasions. He had a very hands-off approach and did not find the need to check on her in the laboratory. She felt alone, and even discussed topics she was not comfortable to share with her boss (such as her marriage, pets, wish to grow a family).

Feedback is a possible trait in both of these relationships, as shown by shading in Figure 5.2. For some participants, there was at times feedback from their advisor. Some participants in these relationships also spoke of their frustration in finding themselves down a rabbit-hole after receiving no structured feedback for upwards of a year. Students actually crave formal, and recurring feedback, so that they do not waste their time and valuable resources. It helps keep both the student and advisor on the same page with progress for both the project underway and for the students' progress to degree.

5.3.2   How the Absentee Relationship Stands Alone

The absentee relationship stands alone as its own category. It is really only characterized here with one trait: a relationship. It is certainly a relationship on paper and in name, and while the trait is labeled as 'professional, open relationship,' it may not be both of those descriptors. Leigh described facets of her relationship with her advisor in terms of how the entire research group was run:

"One of the big things I would change is I would actually have her evaluate us. That's one thing that I would like to see. So once a year I would love to have an evaluation that says 'Hey you made good progress on X, Y, and Z but you really need to spend more time focusing on A, B, and C' . . . So that's probably one way I would really see like my relationship with my–I need the feedback. I'm a needy person. Maybe that's the needy person in me. I need the feedback. Not that I need her to pat me on the back all

the time I just want the direction because she's kind of hard to read as far as what she thinks about how you're doing on things. Um we have a girl in our group routinely like is never in lab I mean it's like she shows up once or twice a week sometimes and like last summer she was gone almost the whole summer. And but it's like I don't know if my boss even realizes that she's not there because she's not in our lab." -Leigh

This relationship may, or may not, include several other traits to some degree but is overall lacking in the traits necessary to view or experience an advisor as a mentor or even as a 'boss'. When asked about the best conversation he ever had with his advisor, Tom Sawyer said,

"Uh, Alabama winning the national championship like two years in a row (laughs)."
-Tom Sawyer

This is in contrast to other answers from participants that largely focused on passing proposal examinations, getting a paper accepted to a journal, and overcoming difficult experiments in the laboratory.

5.3.3 What if no characteristics are present?

One may wonder where a student-advisor relationship would fall if all traits were absent. From this work, I do not have an answer because all of the participants were current Ph.D. students, or had defended within the week of the interview. It is possible that students who perceive their relationship with their faculty advisor to fulfill none of these traits, have left their research group, department, program, or university. Persons who chose to leave programs, or were forced to leave due to failure or other reasons, were not within the boundaries of my study. Additionally, students who never placed with advisors by the time and date set by either the graduate school or the department likely left as well. One participant in this study discussed how the only other Black student in her program left after the first semester because he never placed with an advisor. One other person that I contacted during the recruitment stage told me that she had left graduate school so was not eligible to be a participant, and that she had not had an advisor while in graduate school anyway.

Students who have left programs, however, can shed a lot of light on the possible expansion of this model, and can expand our knowledge base of the underrepresented graduate student experience.

5.4   Distribution across Categories

In between the last and second-to-last iterations of categories, I read through the transcripts again to place them into the categories. This measure of theoretical validity, as discussed in Chapter 6, allowed me to check that the categories of description do expose the social reality under investigation (Walther, Sochacka, & Kellam, 2013). Additionally, this measure ensured that the context of the participants' experiences and perceptions were not lost in the blender approach to analyzing across all transcripts as a whole. As discussed previously, no participants fit well into the category, Mentorship + Advocacy, as this was the missing relationship that could fulfill the advocacy piece for participants. While I can argue that I obtained the variation in the study that I sought for the other four categories, I can only declare that the mentorship + advocacy is the missing piece that I hope future work can confirm.

In summary, eight participants described their relationships to be that of a mentorship, four in an absentee relationship, three in a business relationship, and one in an autocracy. It is important to note that the distribution of the participants across the categories is not absolute in a temporal sense because of shifting dynamics. Rather, the distribution reflects their overall descriptions of their experiences at the time of the interview. Asking participants to describe their relationship with their advisor with the free-listing activity, and their overall graduate school experience in the same manner, helped to clarify an overall and holistic description from their point of view.

Additionally, the distribution into the categories of description that I constructed along with my analysis team, is my interpretation from the transcripts. As the transcripts are the sole means of data analysis, the distribution reflects the transcripts and not the actual participants.

Chapter 6

Reliability and Validity

I used the Qualifying Quality in Qualitative (Q3) Research framework to guide the design of this entire research study (Walther et al., 2013). The framework, which comes from a need to qualify the quality of work grounded in interpretive engineering education research, provides language, rigor, and a typology for both making and handling the data in a qualitative study. As seen in Table 6.1, the definitions I used are taken directly from the framework (Walther et al., 2013). I outline below features of the study, in both the making and the handling of the data, that satisfy the quality framework. 'Making the data' refers to the entire research process through the data collection, and 'handling the data' refers to how the data is analyzed and disseminated.

6.1   Theoretical Validation

The theoretical validation of the quality framework is concerned with the ability to expose the reality under investigation, in this case, the students' perceptions of the student-advisor relationship. The intention of creating a model to show the critically different perceptions of the participants served as a guide for the direction of the entire study. Knowing that critical differences would inevitably be exposed and shared (handling the data) helped to shape the interview protocol through the second

Table 6.1: Q3 Framework, definitions from Walther et al., 2013

Validity Type	Definition
Theoretical Validation	Focuses on the fit between the social reality under investigation and the theory produced
Procedural Validation	Suggests incorporating features into the research design to improve the fit between the reality studies and the theory generated
Communicative Validation	Accounts for the co-construction of knowledge in the social context under investigation, as well as within the research community and appropriate audiences
Pragmatic Validation	Examines the extent to which theories and concepts are compatible with the empirical reality
Process Reliability	Provides the necessary conditions for developing overall validation through strategies aimed at making the research process as independent from random influences as possible
Ethical Validation*	Concerns aspects of integrity and responsibility throughout the research process
*not originally part of the framework, but included in the 2014 Q³ Workshop at Purdue University, and later published[63].	

pilot (making the data) so that I crafted the proper questions for my participants in a succinct order.

The blender approach to analyzing across all of the transcripts helped greatly to expose the participants' experiences and perceptions. While taking the context of all the excerpts from the transcripts into consideration so as not to lose the individual from the experience, I was able to see the variations and nuances of the perceptions emerge. My tendency to want to analyze the person as a whole and draw connections was mediated greatly with the blender approach, so that I could better seek participants' varying perceptions of the phenomenon under study. The balance between the blenderized pieces and the analysis of the transcripts as whole to ensure fit with the model worked as a measure of theoretical validity.

6.2   Procedural Validation

Procedural validation takes into account that my methods and features of the entire research design allow me to see the social reality. In other words, I continually ask myself, "How can I see the reality under investigation to its full extent?" This was done in part by the careful construction and attentiveness of the questions in the interview protocol through Pilot 2.

Critical incident technique and free-listing are two techniques in making the data that I used to gauge

the reality of the participants to the full extent. These techniques, and the anchoring of the questions in the protocol with theoretical backing, are features of the protocol that allowed me to engage with the participants for an authentic view of their reality. To mitigate threats to the participants' authentic view of their reality, I bracketed my own experiences and thoughts. Additionally, my team members bracketed when working on segments of the analysis and the iterations of categories of meaning. See Appendix C for the bracketing prompts. Following bracketing, team members also self-ranked the perceived bias for the analysis groups from the interview protocol. Each subteam within the analysis team was formed in order to exhibit the least amount of bias for their particular groupings. All of this was done to minimize our own voices, and to maximize my participants' voice to see the most authentic view of the social reality (Starks & Trinidad, 2007; van Manen, 2006). Although I used frameworks as the foundation to shape this study, I bracketed my knowledge and understanding of them to prevent 'fitting' participants and their perceptions into preconceived categories formed before the iterative process (Bowden & Green, 2014; L. Mann, 2009). Bracketing is important in all phases of this project, in both the making and handling of the data, and is explained in greater depth below as a feature of both process reliability and communicative validation.

The triangulation of intermediate results, as reported in Chapter 4, with the categories of description as they were forming through multiple iterations, was a measure of procedural validation. Specifically, this allowed me to mitigate the risk of inaccurately constructing the social reality from the participants' perceptions.

6.3   Communicative Validation

I use communicative validation in two ways. First, I concerned myself with making sure that I was co-constructing meaning of my participants' realities and perceptions as they experienced them. This included follow-up questions during the interview process to make sure I understood their viewpoint. I also employed *in vivo* coding by using participants' own words when constructing codes and themes so as to honor their reality and to make sure that I was communicating their perceptions appropriately.

Flick reminds us that beneficence and respect to the participants, an understanding of their part, and an accurate interpretation of their stories are of utmost importance in ethically sound qualitative research (Flick, 2007). Transparency from the very beginning, with clearly outlined roles and expectations, helped to build trust with participants and ensure that sensitive information did not slip through the cracks. In addition to my transparency with the participants, I dressed in casual attire so that I did not exert any power dynamics or negative influence in the interview space. Rather, in an effort to build rapport and increase trust and comfort, I abstained from professional or formal attire. The interviews also took place in neutral locations like a library or a student center so that we would not be in their office or laboratory. Bracketing, or acknowledging and setting aside my own biases and assumptions, is important in qualitative interpretative research and particularly in this phenomenographic study where I constantly strove to expose the participants' perceptions (Chism, Douglas, & Hilson, 2008; L. M. Mann, 2005).

Secondly, I used communicative validation as a way to make sure that I am communicating the findings and implications meaningfully to the community that I present them to. This happens first within the research community of my analysis team, and secondly as the community of stakeholders in doctoral education. Presenting results as simply results in and of themselves does not align with my overall transformative paradigm of striving to bring about change and to advocate for participants. Therefore, it is important that the results and implications are communicated in a meaningful and robust way to the community that can benefit and make change. In this case, the important members of the community are potential graduate students, current graduate students, current faculty members who currently or in the future will advise (and hopefully mentor) graduate students, and members of the administration who have the power to advocate for the training of students and faculty alike in the mentor-mentee realm.

6.4 Pragmatic Validation

I use pragmatic validation to determine if the theories that I bring to the study survive the reality under investigation. In other words, are socialization theory and the engagement theory of quality graduate education compatible with the social reality as my participants experience? It is important

to acknowledge the two frameworks that I brought in to guide the study and the interview questions. In the construction of the interview protocol in making the data, and as described in the pilot study summaries in Chapter 2, questions were tied to both frameworks and techniques for enabling participants to open up with rich stories. Using my participants' perceptions through interview transcripts as the only form of data is important in phenomenography (Green & Bowden, 2005; L. M. Mann, 2005), and in line with pragmatic validation in handling the data. The utility of the model as the outcome space will also be used to build future research, which is doable because all of the interpretations are meaningful in illuminating student perceptions.

6.5   Process Reliability

Mitigating random influences on the entire research process was done with process reliability. The process of continually bracketing my perceptions and biases has been carried out throughout the entire process in several ways. One way has been a log trail of my methodological decisions, observations, and thoughts along the way. The second is through the scrutiny of my research team. Continual bracketing, otherwise known as dynamic bracketing (Smith, Flowers, & Larkin, 2009), writing memos, and log trail were all used in order to mitigate the bias on the research process (Walther et al., 2013). This dynamic approach to bracketing allowed for me to continually revisit my positionality in the project throughout the making and the handling of the data, as opposed to a more static bracketing that is typically done once to set aside biases and move on.

Another feature of process reliability is the consistency of the interview protocol with each and every participant. As discussed previously, the piloting of the interview protocol in a phenomenographic study is important so that when the participants were interviewed in the full study, I was able to use a solid, tested interview protocol that remained largely unchanged for each participant. Follow-up questions were used appropriately and allowed for emergent themes such as political topics (see Chapter 1). This was important so that the only variations that emerged from the interviews were the participants' perceptions, and not the interview questions themselves. The consistency of the interview setting was important as well, as all interviews were conducted in private rooms in either a library or an academic building such as a student center on the participants' campuses. Finally, I

wore casual clothes to the interviews so that the participants were comfortable and I could minimize any imposed power structure that dress, such as wearing business casual or a suit, may have imported in the interview setting (Seidman, 2013).

6.6   Ethical Validation

Beneficence and respect to the participants, transparency and communication so that they understand their part in the study, and my best efforts to accurately interpret their stories are all of utmost importance in ethically sound qualitative research (Flick, 2007). Approaching this work with transparency about my own experiences and my agenda to be a change agent for underrepresented doctoral students was important for my participants and my team. The blender approach to data analysis allowed me to focus on the participants' experiences and perceptions of the phenomenon under study - the relationship - and not just the individual. My own natural tendency to focus on the individual, and less on the bigger picture of the phenomenon under study, was mediated with the blender approach so that I could focus on perceptions and experiences of the relationship and honor my participants voices. Blenderizing, and analyzing the subsequent chunks of data with my team, allowed for a measure of integrity to be brought into the handling of the data.

Having an analysis team was integral for ethical considerations in keeping me in check with my interpretations and having continual, engaged discussions to ensure that our findings will do justice to the lived experiences of the participants. The team analysis approach helped to ensure that I made responsible and equitable decisions when analyzing chunks of data and when going through the iterative process of building the categories of description. By making a last pass at the conclusion of the iterations to place participants into the categories of description, I was able to ensure that the model did in fact speak to the reality of the participants as they experienced it. Using thick descriptions in the handling of the data through the dissemination of the work to create empathy and resonance with the appropriate communities were aspects quality that align with of ethical validation.

Chapter 7

Conclusions and Discussion

7.1 Discussion

The concern for both our future scientists and the expanding need for all highly skilled, highly trained, graduate-degree-holding professionals (Taylor, 2011; Wendler et al., 2012) situates this work to yield insight in fields beyond doctoral chemistry education. The findings of this study are essential to areas outside of the sciences where quality mentorship and advising practices are critical. This study is limited to chemistry doctoral students, but many experiences illuminated in the participants' stories focused on how the actual relationship with their advisor had an impact on adherence to departmental requirements, confidence as a researcher, overall graduate school experiences, teaching and instructor experiences, and success in progressing through the degree. The themes that emerged in this study were not defined by whether a student works in a laboratory, but rather by the foundations and substructures of their interactions with their faculty advisor.

The categories of description that emerged from analysis of informant responses to prompts about the "ideal advisor" show the qualitatively different ways chemistry doctoral students conceptualize ideal relationships with their faculty advisors. Although there is not a singular answer to how students perceive the ideal advisor, the themes that emerged were ones that describe a mentor. Students

are seeking a professional and friendly mentorship from their faculty advisors. They want to feel valued in their scientific ideas and exploration, and have a balance of firm guidance and critique. They want to be trusted to do their research and fulfill their roles in the laboratory, yet know they can depend on their advisor to work alongside them at the bench when the occasion arises. This is useful and pertinent to all invested in improving the quality of graduate education because it can be used to inspire departmental policies, guidelines, and cultural norms. The official title of 'advisor,' as shown in the literature and illuminated through the voices of the participants, does not assume the title of 'mentor.' If an 'ideal advisor' is someone who is also a mentor, then perhaps our policies should necessitate that doctoral advisors be mentors, and receive training for that role.

As many of the participants were not considering graduate school until they were nearing their undergraduate completion, this points to the pertinence of career training in high schools. Teacher and guidance counselors can begin talking to their students about differences in career pathways and what types of jobs may require different levels of training and degrees. Professors who advise students at the undergraduate level also have a responsibility to students to help them decipher where their current degree can take them, and help them to see the types of jobs and opportunities they will be open to with their current training.

7.2 Answering the Research Question

The overarching research question, *What are the different ways underrepresented doctoral students in chemistry perceive their relationship with their faculty advisor?* This phenomengraphic investigation of underrepresented doctoral students at public land-grant institutions in the southeastern United States has yielded five qualitatively different categories of description as a model of student perceptions of the student-advisor relationship. The types of relationships that have emerged from the participants' voices are mentorship + advocacy, mentorship, absentee relationship, business relationship, and autocracy.

7.3 Considerations Specifically for Underrepresentation

The largest piece of the model to speak specifically to participants' identities as underrepresented is the mentorship + advocacy relationship. The fact that this was the missing piece of the relationships that emerged speaks to potential factors that stem from boundaries set in this study such as the geographical location of the southeastern United States. The long history of social disparities along racial lines and the fact that the four institutions did not even admit students of color until the 1950s and 1960s, yet still received federal funds to make education more accessible at White-only institutions speaks to this missing piece. Future work to broaden across not only the Southeast but also into other fields outside of chemistry and the physical or hard sciences can perhaps broaden the pool of participants so that the mentorship + advocacy relationship can be investigated further.

While the other four relationship types that have emerged as part of the model do not speak specifically to participants' identities as underrepresented, the supporting data for the model, particularly the reasons *why* students chose to embark on the perilous passage of the Ph.D. journey, were quite salient. Future work into engagement between students, faculty, and administration within departments and within graduate schools can help to bridge some of the gap. In a truly engaged program, faculty will be supported to in turn support their students' goals and aspirations, while also working toward their own goals and aspirations as scholars and researchers. This symbiosis should be achieved through mentorships that are strongly supported and encouraged by department chairs throughout the graduate school.

Additionally, many of the implications in this work are not defined solely by the participant working in a laboratory to achieve the Ph.D. With much of the focus on the characteristics of the relationship between an advisor and an advisee, this model can extend and speak to facets of similar relationships for students who do not identify as underrepresented (by the definition used in this work) such as White males and Asian-American males and females. Future studies to expand the boundaries of recruitment to include other racial and ethnic demographics will shed light on the transferability and applicability of the model and relationship-types.

7.4 Key Implications

There are implications for students, faculty, and administrators in higher education. Taking the Engagement Theory of Quality Graduate Education (Haworth & Conrad, 1997) into account makes implications very clear. Firstly, faculty and administrators must seek continually to attract, hire, and retain both faculty and students with diverse, progressive, and active perspectives in teaching and learning. Seeking a **diverse and engaged** body of people will aid in cultural reproduction and advocacy of more faculty and students who identify in similar ways, and help to fill the gap for underrepresented students who do not have a mentor. Second, stakeholders and administrators must develop and sustain **participatory cultures** by having bold direction, cultivating a community of learners, and supporting their faculty and students. Faculty should feel that their time in engagement with pedagogy and mentor training, for example, is meaningful not only for their classrooms and labs, but for tenure and promotion as well. Participatory cultures will also encourage the balanced presence, the scaffolded direction, and the formal and recurring feedback between faculty advisors and their students. Third, faculty, students, and administrators alike should engage in **interactive teaching and learning**. Again, support for faculty mentor training and other areas of professional practice should be available, advertised, and required. Interactive teaching and learning also implies the symbiosis for both advisor and student, as they will be engaged in the process and supported by the administration. Fourth, **connected program requirements**, aimed at helping students develop into independent researchers and scholars, should have an appropriate purpose towards student development. Faculty and administrators should be knowledgeable about the how and the why their students are to fairly progress through these program requirements. This also necessitates that there should be a structure in place to monitor and track student's performance and progress through the program requirements. Lastly, **adequate resources** are necessary for a degree program's sustainability and success. This will help to support the symbiosis between students and their advisors when they have to worry less about infrastructure and funds. Financial support for students and faculty are important for the livelihood of research programs. Other non-monetary resources to support program needs and people are also important to invest in.

Outside of graduate education, there are important implications for undergraduate advisors as well. Advice and guidance to students who may go to graduate school can go a long way. Some participants

had a clear idea of what advisor characteristics they were searching for, and were knowledgeable about what practices were both professional and ethical in student-advisor relationships. Workshops and seminars for undergraduate students who may be considering graduate school, or who may have never known graduate school was an option, are invaluable.

Appendices

Appendix A Recruitment Email to Participants

Subject: $20 Amazon Card to Participate in a Science Education Research Study

Message Body: I am writing to invite you to participate in my dissertation study here at Clemson University. I am a Ph.D. candidate in the Department of Engineering and Science Education, advised by Dr. Eliza Gallagher. I am interested in learning about your experiences as a graduate student, especially about how you perceive your relationship with your faculty advisor and any potential impacts or influences on your Ph.D. experience. Your account will be one of several used to help create a better understanding of the experiences of science graduate students.

Your identity and any identifiable information are anonymized to protect you. Your information is never shared with anyone, and a pseudonym is associated with all documents pertaining to your part in the study.

Each participant will receive a $20 Amazon card as a token of appreciation for helping me conduct this important research.

If you accept the invitation to participate, I would like to interview you in person. The interview will be scheduled at a time of mutual convenience on your campus and is expected to last about 60-90 minutes.

If you are interested in participating in this study, please reply to this message with the following information: Name, degree(s) obtained and year, current status (pre-candidacy, Ph.D. candidate, dissertating, etc), race/ethnicity, gender identity, and times between [February 1] and [March 15] you would be available for an interview.

Thank you in advance for considering this invitation,

Aubrie L. Pfirman

Ph.D. Candidate in Engineering and Science Education

Clemson University

Appendix B   Participant Consent Form

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Information about Being in a Research Study

Clemson University

The Student-Advisor Relationship: Exploring Science Ph.D. Students

Conceptualizations

</div>

Description of the Study and Your Part in It

My name is Aubrie Pfirman and I am a Ph.D. student in the Department of Engineering and Science Education, advised by Dr. Eliza Gallagher. I am conducting this study as part of my dissertation research, to collect the experiences of current doctoral students who are in the process of obtaining a Ph.D. in the physical sciences (chemistry and physics & astronomy). I am focusing particularly on how underrepresented students conceptualize and experience their relationship with their faculty advisor.

Your participation consists of a one-on-one interview, in-person on your campus. I will ask you questions about your experiences as a Ph.D. student, focusing on milestones along the way, and your relationship with your faculty advisor. The interview will be scheduled at a time of mutual convenience and is expected to last 60-90 minutes. I will audio record the interview with your permission.

Some participants may be invited later for a follow-up interview or to help us check the validity of the results. You may participate in this interview without any obligation to participate in a follow-up.

Risks and Discomforts

I do not know of any risks or discomforts to you in this research study

Possible Benefits

I do not know of any way you would benefit directly from taking part in this study. However, this

research may help contribute to understanding experiences of doctoral students as they pursue their Ph.D. in science.

Incentives

You will receive a $20 Amazon.com card for your participation in the interview.

Protection of Privacy and Confidentiality

I will do everything I can to protect your privacy and confidentiality. I will not tell anybody outside of the research team that you were in this study or what information I collected about you in particular. Each participants name will be replaced with a pseudonym, and other identifiable information will be obscured. Your name (and identifying information, such as the college you are attending and your advisor) will never be associated with your interview responses or in any research outcomes. Audio recordings will be destroyed at the end of this study.

Choosing to Be in the Study

You do not have to be in this study. You may choose not to take part and you may choose to stop taking part at any time. You will not be punished in any way if you decide not to be in the study or to stop taking part in the study.

Contact Information

If you have any questions or concerns about this study or if any problems arise, please contact Dr. Eliza Gallagher at Clemson University at 864-656-4320.

If you have any questions or concerns about your rights in this research study, please contact the Clemson University Office of Research Compliance (ORC) at 864-656-0636 or irb@clemson.edu. If you are outside of the Upstate South Carolina area, please use the ORCs toll-free number, 866-297-3071.

A copy of this form will be given to you.

Appendix C   Analysis Team Bracketing Prompts

1. Write a brief summary of your educational journey up to the present (schools, degrees, etc).

2. For each degree/school/group/etc, Why did you choose to attend graduate school?

3. If you have departed previous groups, schools, or programs, what are your reasons for having done so?

4. For each degree/school/group/advisor, How did you choose your current, and past advisors?

5. For each advisor you have had in graduate school, How would you describe your relationship with your advisor(s)?

6. How would you describe your graduate school experience?

7. What responsibilities do you have to your advisor? What responsibilities does your advisor have to you?

8. Reflect on a recent milestone you have accomplished of gotten through in grad school. What are the ways in which your advisor helped you through the process or helped you succeed?

9. Reflect on a time or scenario in grad school in which you wish that you would have gotten the help, guidance, or advice from your advisor that you did not receive. What are the ways in which your advisor could have helped you? What did you need that you did not receive?

10. What are your beliefs about the student-advisor relationship in graduate school?

11. When you think about a typical chemistry PhD student, what do you think of?

12. When you think about a typical physics & astronomy PhD student, what do you think of?

13. What are your thoughts about underrepresented populations?

14. What are your thoughts about underrepresented populations in STEM?

Appendix D   Selected Iterations of Categories of Description

Iteration 3
1. Mentorship + advocacy
5+
2. Mentorship
5
3. One-sided/exploitative relationship
D + P - R - S
4. Business Relationship
D + P - R with S
5. *Well-intentioned,* but ineffective mentorship
R + S - (P, F, D)

Figure D.1: Iteration 3. D here is for direction, P for presence, R for relationship, S for symbiosis, and F for feedback.

	Relationship (5)
Mentorship	Mentorship + advocacy
	This is the missing piece in what would seem to make a perfect mentorship.
	Mentorship
	Meets all qualities
Boss/Employee Relationship	Business Relationship
	There is direction, presence, and symbiosis; yet the open and professional relationship is lacking
	One-sided/exploitative relationship
	There is direction and presence, but is lacking in the balanced relationship and symbiosis
Relationship/ Nominal Advisorship?	
	Lacking in the feedback, presence, and direction

Figure D.2: Iteration 5

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