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Spring 2010

Underrepresented minority students in STEM doctoral programs: the role of financial support and relationships with faculty and peers

Margaret Nkirote Mwenda
University of Iowa

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UNDERREPRESENTED MINORITY STUDENTS IN STEM DOCTORAL
PROGRAMS: THE ROLE OF FINANCIAL SUPPORT AND RELATIONSHIPS WITH
FACULTY AND PEERS

by

Margaret Nkirote Mwenda

An Abstract

Of a thesis submitted in partial fulfillment
of the requirements for the Doctor of
Philosophy degree in Educational Policy and Leadership Studies
in the Graduate College of
The University of Iowa

May 2010

Thesis Supervisors: Professor Donald Yarbrough
Associate Professor Christine Ogren

ABSTRACT

Beginning with the understanding that minority students are often underrepresented in STEM doctoral programs despite their growing proportions in the population, this study provides a description of selected minority doctoral students' experiences in STEM programs. Specifically, this study examines the influence financial support and relationships with faculty advisors and doctoral peers have on doctoral students' experiences and progress. Data for this research were obtained from 13 minority respondents enrolled during spring, summer, and fall 2009 and 73 majority respondents who provided some comparisons and contrasts. The participants were all Ph.D. students from several STEM programs at a research university in the Midwest.

Findings from this study suggest that financial support of doctoral students through fellowships and research/teaching assistantships enables students to interact closely with their faculty and their peers and consequently become integrated into the social and academic systems of their programs. Further, through their experiences in teaching and research minority students report acquiring skills and competencies useful not only for graduate school success (e.g. time management; course reading; dissertation writing) but also for successful transition into their respective professions and careers. Funding takes a different form and plays a different role in shaping students' positive experiences in each of the three stages of doctoral study: fellowships during a student's transition year(s), teaching/research assistants during the middle years, and fellowships during the final year(s). Students reported that this sequence of funding supports successful transition into the doctoral program, development of academic and professional competencies during the middle years, and successful doctoral completion during the final year.

Faculty-student relationships are important in socializing minority doctoral students into their disciplines and professions. Faculty advisors and mentors are

especially important in developing students' academic competencies as well as in preparing them for their professions. In addition, faculty-student relationships characterized by faculty availability, approachability, interest in developing students' academic and professional competence, and support and encouragement are important, perhaps especially so in the absence of mentoring by faculty of color. Peer to peer interactions primarily offer academic combined with social support. Further, interactions and group dynamics among minority students and their transition into PWI doctoral programs seem to be affected by their undergraduate educational backgrounds.

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Graduate College
The University of Iowa
Iowa City, Iowa

CERTIFICATE OF APPROVAL

PH.D. THESIS

This is to certify that the Ph.D. thesis of

Margaret Nkirote Mwenda

has been approved by the Examining Committee
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To my family Mwenda, Nkatha, & Gatwiri
and
my parents Dorothy & Stanley Tirima

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ABSTRACT

Beginning with the understanding that minority students are often underrepresented in STEM doctoral programs despite their growing proportions in the population, this study provides a description of selected minority doctoral students' experiences in STEM programs. Specifically, this study examines the influence financial support and relationships with faculty advisors and doctoral peers have on doctoral students' experiences and progress. Data for this research were obtained from 13 minority respondents enrolled during spring, summer, and fall 2009 and 73 majority respondents who provided some comparisons and contrasts. The participants were all Ph.D. students from several STEM programs at a research university in the Midwest.

Findings from this study suggest that financial support of doctoral students through fellowships and research/teaching assistantships enables students to interact closely with their faculty and their peers and consequently become integrated into the social and academic systems of their programs. Further, through their experiences in teaching and research minority students report acquiring skills and competencies useful not only for graduate school success (e.g. time management; course reading; dissertation writing) but also for successful transition into their respective professions and careers. Funding takes a different form and plays a different role in shaping students' positive experiences in each of the three stages of doctoral study: fellowships during a student's transition year(s), teaching/research assistants during the middle years, and fellowships during the final year(s). Students reported that this sequence of funding supports successful transition into the doctoral program, development of academic and professional competencies during the middle years, and successful doctoral completion during the final year.

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CHAPTER I INTRODUCTION

Introduction and Background

Graduate education is an important element in the pipeline to the professoriate, as well as in the supply of qualified citizenry to industry, government, and nonprofit organizations. The science, technology, engineering, and mathematics (STEM) disciplines, in particular, have received attention from federal government agencies, non-governmental organizations, and private institutions because they not only have a direct impact on the long-term global competitiveness of the U.S. but also serve a vital role in problem solving within local communities, regions, and states (Council of Graduate Schools, 2007).

In the last decade, the U.S. global leadership in scientific and technological innovation has faced more and more challenges from emerging Asian economies such as India, China, and Japan. Governments in these nations have continued to build more knowledge-intensive economies backed by growth in science and engineering infrastructure, expansion of research and development, and expansion of higher education systems (National Science Board, 2010). As the challenge from these nations has continued to mount in the past several years, various political administrations have issued a clarion call to return the U.S. to its original global leadership position by investing in science and technology as well as in research and development to sustain its eroding leadership. In 2005, a report by the President's Information Technology Advisory Committee stated:

Civilization is on the brink of a new industrial order. The big winners in the increasingly fierce global scramble for supremacy will not be those who simply make commodities faster and cheaper than the competition. They will be those who develop talent, techniques and tools so advanced that there is no competition (National Coordination Office for Information Technology Research and Development, 2005).

In November 2009, President Obama said about the future of America's leadership:

The key to meeting these challenges -- to improving our health and well-being, to harnessing clean energy, to protecting our security, and succeeding in the global economy -- will be reaffirming and strengthening America's role as the world's engine of scientific discovery and technological innovation. And that leadership tomorrow depends on how we educate our students today, especially in those fields that hold the promise of producing future innovations and innovators. And that's why education in math and science is so important (Obama, 2009).

Key to the U.S. sustaining its scientific leadership is graduate education. A report by the National Academy of Sciences (2007) suggests among other things increasing the talent pool of potential scientists by improving the K-12 education. In addition, the report suggests creating an attractive environment in the higher education setting to attract, recruit, and develop the best and brightest students in science and engineering especially at the graduate and doctoral level, which in the past, has played a significant role in steering U.S. economic and scientific growth, and positioning it as a global leader in science and technology. These strategies suggest that for the U.S. to achieve this important goal, higher education institutions must "expand the participation of underrepresented groups in all fields, especially those essential to American competitiveness and national security" such as STEM programs (Council of Graduate Schools, 2007, p.2).

Leading scholars and legislation have also articulated the case for diversity in STEM fields. For instance, scholars such as Chubin and Malcom (2008) have argued that diversifying the STEM workforce in academe enhances students' complex thought development and allows for thinking about scientific problems in new ways. Further, legislation advocating for equal opportunity in science -- specifically the Engineering Equal Opportunity Act of 1980 -- states that "it is in the national interest to promote the full use of human resources in science and engineering and to ensure the full development and use of the scientific and engineering talent and skills of men and

women, equally of all ethnic, racial, and economic backgrounds" (Malcom, Chubin, & Jesse, 2004, p. 10). Further, the rationale for diversity in the STEM workforce, particularly in higher education, is to utilize the intellectual talent that diverse faculty bring to the institution and to enhance the quality of post-secondary education, while providing role models for successive generations of underrepresented scholars and citizens (Chubin, May, and Babco, 2005). These arguments illustrate the need for diversifying the STEM workforce in higher education, particularly through increased participation of African Americans, Hispanics, and American Indians/Alaskan Natives who have historically been underrepresented.

In the last fifteen years, concerted efforts by institutions, the private sector, and state and local government agencies have endeavored to increase diversity in STEM fields, resulting in increased graduate degree enrollments especially for under-represented minority groups in STEM fields. Minority students enrolled in graduate degree programs in STEM disciplines recorded impressive growth between 1993 and 2006. In that period, African American STEM doctoral enrollments almost doubled with an 85 percent increase; Hispanic enrollments grew by 91 percent; American Indians/Native Alaskans by 74 percent; Asians/Pacific Islanders by 36 percent; and White students by less than a percent point (National Science Board, 2010). Table 1 illustrates doctoral enrollment trends by race/ethnicity for 1993, 2003, and 2006. These enrollment statistics consist of U.S. citizens and permanent residents only.

Table 1: Graduate Enrollments in STEM by Race/Ethnicity --1993 to 2006

Race/Ethnicity	1993	% of Total	2003	% of Total	2006	% of Total	% change 1993-
							2006
White	212786	78.5	201391	69.9	213713	68.9	0.44
Asian/Pacific Islanders	22528	8.3	31593	11.0	30737	9.9	36.44
Black	10794	4.0	17312	6.0	20055	6.5	85.80
Hispanic	9549	3.5	16025	5.6	18273	5.9	91.36
American Indian/Alaskan Native	925	0.3	1408	0.5	1613	0.5	74.38
Other/Unknown race/ethnicity	14313	5.3	20459	7.1	25951	8.4	81.31
Total Enrollment	270895	100	288188	100.00	310342	100	

Source: Compiled from Table 2-17: S & E Graduate Enrollment by Citizenship, Field, and Race/Ethnicity -- 1993 to 2006 (National Science Board, 2010)

Notes: These statistics do not include social and behavioral science enrollments.

Despite this overall impressive trend in graduate enrollment, doctoral degree statistics indicate that the proportion of minority students receiving doctoral degrees in STEM fields has not only remained significantly lower than their proportion of the population but also continued to lag behind that of Whites.¹ In 1995, for instance, out of nearly 15,000 STEM doctoral recipients consisting of U.S. citizens and permanent residents, 79 percent (n=11812) were Whites, two-percent (n=297) were African Americans, slightly less than two percent (1.8%, n=292) were Hispanics, less than one percent (0.2%, n=30) were American Indians/ Alaskan Natives, and 11 percent (n=1755) were Asian/Pacific Islanders. The remaining five percent were of unknown race/ethnic backgrounds. Similarly, in 2007 out of 21,000 recipients, Whites constituted 76 percent (n=16316), African Americans almost five percent (n=781), Hispanics almost four percent (n=757), American Indians/Alaskan Natives less than a percentage point (0.32%, n=70), and Asian/Pacific Islanders nine percent (n=1959). The remaining eight percent were students of unknown race/ethnicity (National Science Board, 2010). Table 2 shows these statistics.

Although African Americans, Hispanics, and American Indians/Alaskan Natives constitute almost a quarter of the entire U.S. population (U.S. Census Bureau, 2000), they collectively earned 10 percent of the doctoral degrees in 2007. By contrast, although Asian/Pacific Islanders and Whites constituted almost four percent and 75 percent of the U.S. population respectively, they earned nine percent and 79 percent of the total doctoral degrees awarded in 2007 respectively. Whites and Asians are, therefore, considered overrepresented in STEM fields while African American, Hispanics, and American Indians/Alaskan Natives are considered underrepresented in STEM fields (NSF, 2010).

¹ The U.S. Census bureau (2000) indicates that Whites constituted 75.1% of the total population while Black or African Americans constituted 12.3%, Hispanics or Latino were 12.5%, American Indian/Alaskan Natives made up 0.9%, and Asians made up 3.6%.

Table 2: Earned STEM Doctoral Degrees by Race/Ethnicity -- 1995 to 2007

Race/Ethnicity	1995	% of Total	2001	% of Total	2007	% of Total	% change 1995- 2007
White	11812	79.49	11232	78.85	16316	75.62	38.1
Asian/Pacific Islander	1755	11.81	1380	9.69	1959	9.08	11.6
Black	297	2.00	406	2.85	781	3.62	163.0
Hispanic	292	1.97	474	3.33	757	3.51	159.2
American Indian/Alaskan Natives	30	0.20	43	0.30	70	0.32	133.3
Other/unknown race/ethnicity	674	4.54	710	4.98	1693	7.85	151.2
Total STEM	14860	100.00	14245	100.00	21576	100.00	

Source: Compiled from Table 2-30: Earned doctorate degrees by citizenship, field, and race/ethnicity: 1995-2007 (National Science Board, 2010)

Notes: These statistics do not include social/behavioral science enrollments.

In addition to their underrepresentation in STEM doctoral enrollments and degree attainment, minority groups also remain underrepresented in the STEM workforce. The workforce demographics indicate that 77 percent of the workforce in STEM occupations is predominantly white, while 12 percent is Asian but only 11 percent is African American, Latino, and American Indian/Alaskan Native (Chubin, May, & Babco, 2005). In academia, the situation is more dire, with minority faculty (African Americans, Hispanics, and American Indians/Alaskan Natives) comprising only eight percent of the total faculty (n=215,000) in STEM programs compared to 82 percent representation of Whites and Asians on the faculty (NSF, 2009).

The above statistics show that although the number of underrepresented minority students enrolling in graduate STEM disciplines has increased significantly over a fifteen-year period (almost doubling for all underrepresented groups) a significant gap still remains in the doctoral degree attainment rates as well as in the STEM workforce. Therefore, given the small proportions of underrepresented minority students entering STEM doctoral programs, the lower proportions attaining doctoral degrees in STEM fields, and the low levels of minority participation in STEM occupations, especially higher education, it is imperative that doctoral programs make special efforts to recruit and retain minority students in order to expand and diversify the pool of talented American scientists. These underrepresented groups have to be included in the science and engineering talent development if the U.S. is to sustain its science and technology leadership in the global arena and if, at the national level, the U.S. is to sustain its economic growth and increase diversity in the overall STEM occupations and in higher education.

The understanding that minority students are underrepresented in STEM doctoral programs and that minority groups are underrepresented in the workforce, coupled with the knowledge of their potential to make significant contributions in these two areas, gives impetus to my study. My study, therefore, examines the experiences of

underrepresented minority doctoral students within a majority context at a research university in order to increase the understanding of factors that influence their ability to succeed and complete their doctoral programs, and consequently provide a pool of talented individuals who will contribute to diversity in the STEM workforce.

Specifically, my research explores how the different forms of financial support allow for the integration of minority students into departments' social and academic activities and how faculty members socialize minority students into their disciplines and professions.

Further, I explore the role of minority students' doctoral peers in facilitating the integration of minority students into their departments.

Significance of Study

This study of minority students' experiences in STEM doctoral programs contributes to scholarship on minority student experiences in STEM disciplines. Findings can be useful to STEM doctoral programs as they target participating departments' recruitment and retention policies and practices for change. Findings from a department or a program within an institution, as is the case with this study, enhance the total understanding of access, persistence/retention, and departure because localized institutional contexts, policies, and initiatives provide more relevant understanding of student experiences than overall national trends for the particular institution under study (Metz, 2004). This is because graduate school policies and practices are unique to institutions and programs and therefore studying individual institutional experiences of students creates a more focused understanding of their experiences in a specific context.

In addition, understanding minority doctoral students' experiences, and thereby attempting to strengthen factors that increase retention and address those that contribute to attrition, will reduce the waste of students' energy and money on the one hand and faculty time and effort on the other. This understanding will also help graduate school deans and other policy makers to reduce the waste of institutional resources as well as

state and federal funds, which occurs when students drop out of programs prematurely (Nerad & Miller, 1996).

Further, understanding minority doctoral students' experiences, and attempting to increase their participation at this level, can in turn increase their participation in the labor market. The Bureau of Labor Statistics' (2010) report on labor projections for the 2008-2018 decade, takes into account the current recession, and still projects a 10 percent increase (15.3 million) in jobs in the overall labor market during the decade. For mathematics, engineering, and medical fields, the Bureau projects 22 percent, 11 percent, and 40 percent increases in job opportunities respectively. The Bureau further notes that Ph.D.s and M.D.s are likely to experience the best opportunities in these fields. Thus, even when the effects of the recession are taken into account, the projections of job growth are favorable for some sectors such as mathematics, engineering (especially biomedical) and medical fields. Therefore, understanding racial/ethnic minority students' experiences and thereby increasing their participation and persistence in advanced level training, particularly in these science fields, is a crucial step in meeting future workforce needs.

Theoretical Framework and Research Questions

My analysis uses two theoretical frameworks to understand minority students' experiences in doctoral programs: Tinto's (1993) theory of doctoral student persistence and Weidman, Twale, and Stein's (2001) socialization theory. Tinto's doctoral persistence theory recognizes that the process of graduate persistence is a longitudinal one whereby past events such as academic experiences and anticipated future events, continually shape doctoral students' experiences. For Tinto the process of doctoral persistence has three stages: the transition stage, which covers the first year of study, the candidacy stage, which culminates in comprehensive exams, and the completion stage, when doctoral student embark on their research project culminating in a

thesis/dissertation. During each of these stages, the roles played by faculty and by peers -- in facilitating doctoral students' acquisition of membership in their academic and social communities, in preparing for candidacy, and in the final research project -- change in their level of importance. For instance, one faculty member or a group of faculty advisors may play a more significant role in the final project stage, particularly in the technical aspects of the research project, while doctoral peers may play a more significant role in establishing membership in the social community during the transition stage of the doctoral process. In addition, various types of financial support may be more useful at different stages of the doctoral process. For instance, a fellowship that requires no teaching may be especially useful for the final stage to allow doctoral students to focus on and to complete their dissertations.

Weidman, Twale, and Stein's (2001) work on the socialization of graduate and professional students in higher education provides another theoretical framework for student persistence. In this theory, Weidman et al. see graduate and professional school as socializing agents that give students knowledge, skills, and values necessary for inclusion and success in their professions and disciplines. Socialization for Weidman et al. occurs in the following four stages: the anticipatory stage in which students become "aware of behaviors, attitudes, and cognitive expectations" of their discipline or profession (p. 12); the formal stage in which students go through some form of apprenticeship, observing their mentors, advisors, and other faculty members in practice and learning from them in the classroom or laboratory; the informal stage in which students learn from their peers in the discipline and department; and the personal stage in which students' cognitive and behavioral practices reflect habits and orientations of the discipline or profession.

Together these theories allow me to place financial support and relationships with faculty at the center of both integration and socialization to understand minority students' experiences in STEM doctoral programs. I will discuss these models at length in Chapter II.

Guided by Tinto's (1993) and Weidman et al.'s (2001) theoretical frameworks, my study examines the role of faculty advisors, peer groups, and different forms of financial support in shaping the experiences of doctoral students at various stages of their doctoral programs. Specifically, my study strives to answer the following questions:

1. What forms of financial support do underrepresented minority students in STEM programs receive during the course of their doctoral programs?
2. What role do different forms of financial support play in facilitating underrepresented minority students' integration into their programs' social and academic communities?
3. In what ways do minority students' relationships and interactions with faculty members and with peers facilitate their socialization into the academic and social systems of their disciplines and their professions?

Research Methodology

This is a descriptive study of the experiences of a small number of underrepresented minority students in STEM doctoral programs within a research university in the Midwest.² The participating students were from six disciplines of the institution's Graduate College: mathematics, engineering, biological and biomedical sciences, earth, atmospheric and ocean sciences, chemistry and other physical sciences, and computer sciences.

I use a mixed methods approach for this study. I administered a survey to all -- majority and minority -- doctoral students in STEM programs of the Graduate College with the aim of drawing a sample of minority students and interviewed underrepresented minority students from two of the STEM programs. I employed the constant comparative

² The specific research category of this institution is RU/VU (research university - very high research activity). These institution awards at least 20 doctoral degree per year excluding doctoral level degree for entry into professions such as JD, MD, PharmD, etc (The Carnegie Foundation for the Advancement of Teaching)

method for the analysis of interview data to develop common themes in students' responses and descriptive statistics for the analysis of survey data. The primary participants in my study were 13 underrepresented minority students (African Americans, Hispanics, and American Indians/Alaskan Natives) while the secondary participants were 73 majority students (Whites and Asian/Pacific Islanders).³ I used this latter group's data to provide comparison and contrast to primary participants' data where relevant.

Dissertation Overview

This dissertation has six chapters including this one. In Chapter II, I discuss empirical and theoretical work that underpins the study of college and graduate students' persistence. I begin by presenting a brief background of the literature and theories on undergraduate student persistence, which have formed the foundation of the study of graduate student persistence. I then discuss several key theories of graduate student persistence that provide different ways of studying graduate students' experiences. In the last section, I discuss the literature pertaining to two topics that form the core of this study: graduate students' financial support and relationships with faculty members and with peers.

Chapter III, the methods chapter, describes in detail the design of the study, the data collection and analysis methods, the population of the study as well as the achieved sample, the sampling procedures, and the limitations of the study.

Chapters IV and Chapter V present the findings of the study. In Chapter IV, I describe the types of financial support that doctoral students report and students' perceptions of the influence of various types of financial support on their academic and

³ African Americans, Hispanics, and American Indians/Alaska Natives are considered to be underrepresented in science and engineering programs while Asian students are not included in this list (NSF, 2010)

social experiences. In Chapter V, I describe students' relationships, first with their faculty advisors/mentors and then with their doctoral peers, highlighting those relationships students perceive to be important in facilitating their progress and those that they perceive as hindering their progress.

In Chapter VI, I provide a summary of the entire research project and synthesize the main findings from the two findings chapters. I also discuss the implications of this research for practice and for research. Briefly, findings of this research suggest that minority students perceive fellowships as valuable in facilitating their enrollment in their doctoral programs and providing dedicated time for the transition and dissertation years. Further, they perceive teaching and research assistantships to be valuable in providing skills and knowledge relevant for the doctoral program and for their future careers. Minority students also report that faculty members play a role in facilitating socialization into their discipline through academic development and into their profession through career or professional development as they approach the latter stage of their doctoral program. Students also report that their doctoral peers play a role in their academic success through study and social groups.

CHAPTER II

LITERATURE REVIEW

In this chapter, I review the literature on student persistence, primarily focusing on graduate student retention literature. I start with a brief review of undergraduate student persistence theories since the study of graduate student persistence has its foundation in the former. A brief review of literature on undergraduate students will demonstrate how the study of student persistence has evolved and developed, and how undergraduate persistence theories apply in the graduate school setting. Then I discuss two theories of graduate student persistence as well as literature relating to financial support and relationships between doctoral students and their peers and faculty that have a bearing on this research, outlining their key contributions to the study of doctoral student persistence. I conclude the chapter by highlighting the gaps in the literature and discussing two theories of doctoral persistence that guide my study.

Theories of Undergraduate Student Persistence

Undergraduate students' access to and persistence in college has been a topic of study for scholars of higher education in the last three decades. Numerous studies have posited different reasons for student withdrawal and persistence, but fewer scholars have examined these issues among students in graduate school in general and among minority graduate students in particular. Spady (1970) and Tinto (1975) are some of the most widely cited works in undergraduate student persistence in college.⁴ Even though they

⁴ Persistence: One of the simplest ways of conceptualizing student persistence is by looking at their enrollment patterns and degree attainment. Hagedorn (2005) defines a student who persists in college as one who enrolls, remains enrolled and completes a degree program. By contrast, a student who leaves college without earning a degree and never returns is a nonpersister. Hagedorn notes that the terms persistence and retention are used interchangeably but differentiates the two as follows: persistence has to do with a students' ability to stay enrolled while retention has to do with institutional measures to keep students enrolled in order to attain a degree. This is the simplest definition of a complex concept but it serves the purpose for this study.

developed their theories based on Durkheim's sociological theory on suicide, Spady and Tinto laid the framework for subsequent work in interactions between individual student attributes and institutional interventions (Pascarella and Terenzini 1980, 1986). One of the enduring arguments by Spady (1970) regarding student persistence regards how a student's departure from college is influenced by the interaction between the student's individual dispositions and attributes and the institution's social structures. Spady suggests that students' positive interactions enable them to integrate into the social system of the institution while negative ones have the opposite effect. Tinto (1975) expanded on this theory by Spady and argued that students whose personal attributes and goals interact positively with the social and academic systems in the institution (i.e., integrate), have a higher likelihood of persistence. This model of persistence and Astin's (1975) model of involvement, which suggests that the level and intensity of student involvement in the college environment affect their willingness to remain enrolled, specifically show that students' unique background factors interact with institutional systems to influence their persistence. Scholars such as Pascarella & Terenzini (1986) have tested these theories while others have criticized them for omitting non-traditional students, two-year institutions, psychological factors, and important variables, such as financial aid, in analyzing student persistence (Pascarella & Terenzini, 1990; Tierney, 1992 cited in Metz, 2004; Bean & Eaton, 2001). In response to these limitations in the pioneering works of Tinto and Spady on student persistence, other works, such as those focusing on psychological perspectives of student persistence, emerged.

Pascarella and Terenzini (1986) tested the influence of institutional intervention, such as freshman orientation, on student persistence. Their findings show that students who participate in freshman orientation are positively influenced in their social integration and institutional commitment. However, their study also showed that minority students tended to not attend orientation and thus their findings did not provide conclusions that could be generalizable to all student populations. The contribution of

this study to the scholarship on student persistence was important in distinguishing the college outcomes of minority versus majority college students.

Other scholars approached student persistence from a psychological perspective. Developing their theory of integration using psychological constructs from attitude-behavior theory, coping behavioral theory, self-efficacy theory, and attribution theory, Bean and Eaton (2001) argue that students enter college with complex personality characteristics (including locus of control, beliefs and values, and efficacy), which interact with institutional environments to shape student persistence or withdrawal. As this interaction occurs, Bean and Eaton posit, several psychological processes take place within the individual student. Processes that confirm students' initial characteristics and result in "positive self-efficacy, reduced stress, and internal locus of control, lead to academic and social integration, institutional fit and loyalty, intent to persist, and persistence" (p. 58).

Besides psychological factors, other factors such as financial support also influence student persistence. As Astin's (1975) theoretical perspective suggests, financial aid is a key determinant of student persistence. He suggests that financial aid packages come in different forms (gift aid, loans, and work-study) but work-study tends to show the most positive results for persistence, with loans leading to a significant decrease in persistence. He argues that the positive effects of work-study on persistence are related to students' increased involvement in college life. Astin's seminal study on financial support distinguished the effects of different forms of financial support on college students' persistence. However, it was not conclusive about the impact of different forms of financial support, suggesting the need for further research on the topic.

Useful as these prior studies of student persistence may be in identifying salient factors, such as students' characteristics and institutional factors, that influence college student persistence, the above models fail to address the experiences of "nontraditional" commuter, part-time, and older students, which is problematic given that one of the

building blocks of each of the above models is the element of student integration into the college environment. Non-traditional students typically integrate less with faculty and peers; therefore, the models based on the college environment cannot fully explain their decisions to stay or leave based on the college environment. External environmental issues including hours of employment, outside encouragement by family and friends, family responsibilities, and finances play a more significant role than their college environment in their decisions (Bean & Metzner, 1985).

Bean and Metzner's (1985) work suggests a conceptual model of non-traditional student attrition, which builds on existing models of undergraduate student attrition/persistence and adds the element of the external environment. Their conceptual model presents four sets of variables that influence non-traditional students' decisions to leave college: 1) academic variables, including study habits, academic advice, absenteeism, and certainty about choice of major, which affect academic performance; 2) intent to leave, which is influenced by academic performance and psychological outcomes such as satisfaction, goal commitment (commitment to attain degree), and stress level; 3) background and defining variables such as high school performance and educational goals; and 4) environmental variables such as finances, hours of employment, family responsibilities, and outside encouragement. The addition of non-traditional students and the external element variable is a key contribution of Bean's and Metzner's (1985) model and may be useful in my study of the experiences of graduate students, some of whom may be older, part-time, or commuter students.

Overall, the above theoretical perspectives suggest several salient variables that are strongly associated with and have an impact on college student persistence, especially as summarized in Tinto's (1975, 1993) research. These variables include: students' pre-entry attributes (e.g. prior schooling and family background); goals/commitment (student aspirations and institutional goals); institutional experiences (academics, faculty interactions, co-curricular involvement, and peer group interaction); and academic and

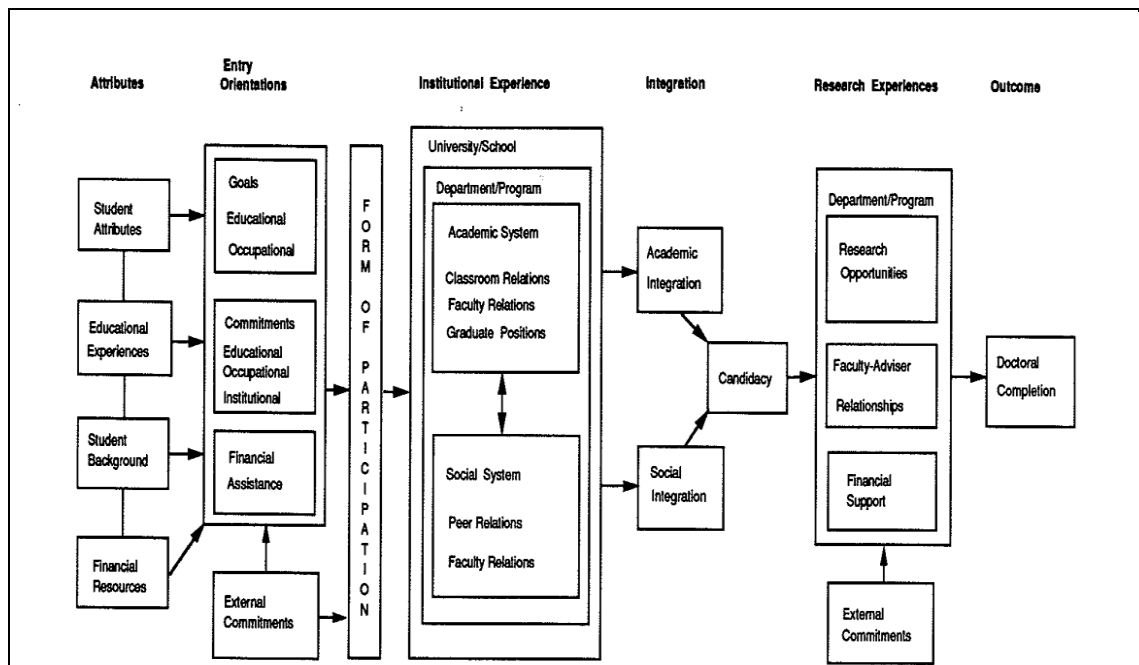
social integration (Metz, 2004, p. 192). In addition, the effect of financial aid on persistence (Astin, 1975; Tierney, 1992 in Metz, 2004) cannot be overlooked. These early works on student persistence have been instrumental in laying the foundation for many research studies on student persistence, including persistence of first-generation students in four-year colleges and universities (Pascarella & Terenzini, 1980, 1986), in two-year colleges, and in graduate school (e.g., Girves & Wemmerus, 1988; St. John & Andrieu, 1995; Golde, 2000). Nevertheless, we still need more research on many areas, especially graduate school student persistence as well as persistence in specialized areas such as STEM graduate program as well as minority students.

Theories and Literature on Graduate Students

Compared to the extensive research carried out at the undergraduate level to understand student college experiences, scholars have paid less attention to student persistence in graduate school despite the important role played by graduate education. The available research provides a limited number of comprehensive models or theories of graduate student persistence. Two major theories explain graduate student persistence: model of doctoral persistence (Tinto, 1993) and socialization theory (Weidman et al., 2001). Tinto's (1993) work on student persistence shows that student persistence in doctoral programs is influenced by student adjustment to academic and social communities, student development of a discipline's knowledge and skills, and completion of a dissertation. Tinto's theory of doctoral persistence largely builds on the concept of integration in which students consistently engage with the academic and social community in higher education through interactions with mentors, peers, the institutional and departmental environments, and the culture of the discipline itself. In this theory, Tinto conceptualizes integration at two levels: social and academic. Social integration pertains to student involvement in social aspects of the university including student organizations and interactions with peer groups, while academic integration describes

students' connectedness to the intellectual life of the institution. This theory consolidates findings from earlier studies such as those by Berg and Ferber (1983) and Girves and Wemmerus (1988) who show that students who are treated as “junior colleagues” tend to persist and finish their doctoral programs. Tinto’s theory recognizes the primary role played by the environment in which graduate students' experiences occur including schools, programs, and departments. As such, integration at this level is closely tied to social and academic memberships within the local department or program, meaning that at the doctoral level, social and academic interactions with faculty and with peers are closely linked to one's intellectual development and the development of skills required for degree completion. Figure 1 shows Tinto's model.

Figure 1: Tinto's Model of Doctoral Persistence



Source: Figure B.1 A longitudinal model of doctoral persistence (Tinto 1993, p.240)

Herzig's (2002) work on doctoral students in mathematics in one institution and Davidson and Foster-Johnson's (2001) analysis of cross-racial mentoring in business graduate school expand on Tinto's integration theory to show that student participation in the life of the department and discipline, especially through their relationships with mentors and advisors, leads to increased student integration, which is crucial for student success.

The work of Weidman, Twale, and Stein (2001) on the socialization of graduate and professional students in higher education provides another theoretical framework of student persistence. Weidman et al. see graduate and professional school as socializing agents and define socialization as the process through which students gain the knowledge, competencies, and values necessary for inclusion and success in their professions and careers requiring advanced specialized training. In this regard, Weidman et al. see socialization taking on the following four stages: the anticipatory stage in which students become aware of behaviors, attitudes, and cognitive expectations of their discipline or profession; the formal stage in which students go through some form of apprenticeship observing their mentors, advisors, and other faculty members in practice and learning from them in the classroom or laboratory; the informal stage in which students learn from their peers in the discipline and department; and the personal stage in which students' cognitive and behavioral practices reflect habits and orientations of the discipline or profession.

Weidman et al.'s theory reflects earlier work by scholars such as Abedi and Benkin (1987) and extends Golde's (1998) earlier work, which showed that graduate student persistence is highly shaped by the support (socialization) one gets in the program of study broadly defined and the department specifically. Lovitts' (2001) work on why graduate students leave their programs also emphasizes socialization, especially through faculty and peer support. Although, Weidman et al.'s (2001) model is limited in that it overlooks the variations among disciplines and institutional cultures (Gardner, 2008), it

enhances the understanding of the process of graduate students' preparation for careers and professions.

Few studies have combined Tinto's (1993) model of doctoral persistence and Weidman, Twale, and Stein's (2001) theory of socialization. Combining these two theories will contribute to the understanding of minority doctoral students' experiences from two different but important perspectives, namely, integration which shows the process through which students get engaged in their department's social and academic activities, and socialization which addresses how students acquire skills and knowledge about their disciplines and professions through interactions with faculty and peers. My research will do this by providing specific examples of how financial support provides opportunities for student integration or engagement in the academic and social aspects of their program and how relationships with faculty socialize students into their disciplines and their professions. Further, this study explores the role of peers in doctoral students' integration into their programs.

Below I discuss the literature pertaining to two factors that are the focus of this study: financial support and students' relationship with faculty and with peers. I also include a discussion on the role of the department as the central context in which these other processes occur.

The Role of the Department/Program

Graduate students' interactions, relationships, and experiences occur within the context of the department, program, or discipline, while undergraduate college experiences are closely linked to the college in general. The department or program is the "home" within which interactions between graduate students and their peers and faculty members take place (Tinto, 1993; Golde, 2005). Golde also observes that it is in the department where effects of policies play out through guidelines for admissions,

financial support, degree completion requirements, and curriculum, all of which affect graduate student experiences within a program.

The existing literature on the role of the department in shaping students' graduate experiences focuses on policies ranging from admissions to completion and how departments or programs interpret and implement these policies to influence graduate students' time to completion, persistence, and completion rates. Golde (2005), for instance, suggests that departmental characteristics such as interpretation of graduate school expectations of students and structural isolation, especially in disciplines where students work in isolation, may influence students' persistence. Others suggest that a program's culture of advising and the design of the program can determine whether students complete their programs (Bowen & Rudenstine, 1992; Bair & Haworth, 1999). Still others (Nerad & Cerny, 1993; Herzig, 2004; Vaquera, 2007; De Valero, 2001) posit that departments that provide more structure and supervision and are supportive and collegial increase the likelihood of student persistence and completion. The part of this literature that examines the practices and cultures that guide relationships and interaction align very well with my study, particularly the studies that highlight recurrent themes of faculty-student relationship such as the provision of moral support, consistent advising, and treatment as junior colleagues by faculty. In particular, the studies such as Herzig (2004), Vaquera (2007), and De Valero (2001) are relevant to my study because they focus on minority students.

Scholars also show that programs or departments that provide students with such financial aid as fellowships and research and teaching assistantships, increase the likelihood of student persistence and degree completion (Abedi & Benkin, 1987; Bair and Haworth, 1999; Bowen & Rudenstine, 1992; Girves & Wemmerus, 1988;). Bair and Haworth for instance, argue that science and engineering departments or programs tend to have higher retention rates than humanities and social science departments because they offer funding to a majority of their students. Moreover, departments that offer

teaching assistantships alone have slightly longer time to degree completion than those that offer a combination of fellowships, teaching and research assistantships (Bowen & Rudenstine, 1992; Nerad & Cerny, 1993); those which offer financial aid for the duration of a student's years of study shorten completion times (Nerad & Cerny, 1993); and those that avail fellowships during the dissertation year increase graduate students' likelihood to complete the degree (Bowen & Rudenstine, 1992). Besides completion and retention rates, financial aid increases graduate students' opportunities for involvement in their department's teaching and research communities, and therefore provides more interactions with faculty (Girves & Wemmerus, 1998; Border & Barba, 1998). These two studies note that teaching and research assistantships not only facilitate graduate students' inclusion in the teaching and research community but they also enrich students' overall graduate school experiences.

In addition, the literature shows that departments with the highest completion rates and shortest time-to-degree include those that have consistent faculty involvement in all stages of students' degree progress; positive faculty/student relationships; and a positive and supportive departmental climate (Tinto, 1975 & 1993; Girves & Wemmerus, 1988; Gonzalez, 2006; Herzig, 2004; Millet & Nettles, 2006a; Nerad and Cerny, 1993; and Vaquera, 2007). Further, departments that provide clear research expectations, a clear structure for progress towards the degree, and close supervision and evaluation of students' progress tend to increase the likelihood of students' persistence and shorten time-to-degree completion (Herzig, 2004; Bair & Haworth, 1999). On the contrary, departments that require a master's degree for doctoral program entry, field research, and foreign language proficiency tend to increase the time for student degree completion (Bowen & Rudenstine, 1992).

My discussion of the literature on the role of the department serves to illustrate how policies and practices within departments or programs guide advising/mentoring relationships and financial support practices and how these are embedded in the

department or the program. Below I expand on the above literature and specifically focus on the literature on financial support and faculty-student and peer-peer relationships.

Financial Support

The literature on graduate school financial aid focuses on three areas: the forms of financial support available to graduate students and their distribution by race and discipline; financial support and its effects on graduate school access, persistence/attrition, degree completion, and completion rates; and the role of financial support in facilitating integration and socialization of students in their disciplines, programs, or departments. Although much of the literature highlights the types of financial support available to graduate students and the effects of different forms of financial support on students' outcomes including persistence, time to degree, and completion rates, few studies discuss how financial support facilitates the integration of graduate students, especially minority students, into their departments' social and academic life. Below I discuss these three areas of literature on graduate school financial support.

The literature identifies the following modes of financial support available for doctoral students in STEM and other fields: fellowships, traineeships, research assistantships (RAs), teaching assistantships (TAs), personal funds, loans, and others⁵

⁵ Definitions of different types of financial support are from NSF (2000) Report: *Modes of Financial Support in the Graduate Education of Science and Engineering Doctorate Recipients*.

Traineeships: financial support awarded by individual academic departments or institutions including university related fellowships.

Teaching assistantship: university-related funding that requires teaching services

Research assistantships: university-related assistantship requiring research services as well as federal research assistantships, for instance, by NIH, NSF, USDA.

Fellowships: nationally competitive financial awards granted directly by a sponsoring organization to a student, e.g. fellowships from Ford Foundation, Mellon Foundation etc.

Loans: loans provided by federal government (e.g. Perkins) and other loans from market-based lenders.

(National Science Foundation, 2000; Hoffer, Mess, Welch, & Williams, 2007). Although all these types of financial aid are available to graduate students, the literature shows that a majority of Ph.D. recipients utilize three or more modes of financial support in the course of their degree program, while less than one third rely on only one mode, with the most frequently utilized modes of support being research assistantships, teaching assistantships and fellowships (NSF, 2000; Millet & Nettles, 2006a).

Further, the literature notes that the types of financial aid that graduate students receive vary by field of study. Within science and engineering fields, a majority of students (more than 50%) rely on research assistantships as their primary form of financial support while less than 20 percent in social sciences, mathematics, and psychology receive research assistantships (Hoffer et al, 2007; NSF 2000). Millet and Nettles (2006a) use a database of twenty universities and corroborate the fact the more science graduate students rely on research assistantships than students in mathematics and social sciences.

Last, the form of financial support that graduate students receive varies by race/ethnicity within and between different fields of study and may have varying effects on students' degree progress. Minority students, for instance, receive more fellowships in both science and non-science fields, while Whites and Asians depend heavily on research assistantships. They are also more likely to utilize their own resources compared to non-minority students (Hoffer et al, 2007). In addition, minority students sustain higher levels of educational debt compared to their Asian and White counterparts at the undergraduate level and during their doctoral programs (NSF, 2000; Hoffer et al, 2007; Brazziel & Brazziel, 2001), which according to Brazziel and Brazziel limits their access to graduate programs. Many of the studies above highlight three common forms of financial aid that

Personal funds: include resources from a student's own earnings, spouse's earnings, and family contributions.

graduate students receive, namely, fellowships, teaching assistantships, and research assistantships. Although the literature identifies the most common forms of financial support, it does not reveal anything about the patterns of financial aid over the duration of doctoral students' doctoral studies. My study will not only examine the forms of financial support that students receive but it will also examine patterns and duration of financial support to facilitate a greater understanding of the overall effects of financial aid on students' experiences.

The second strand of the financial support literature concerns graduate student outcomes such as access, persistence, time to degree, and rates of degree attainment, which are associated with financial support. There has been considerable interest in how graduate students' financial support affects outcomes such as degree completion rates, time to degree, access and persistence/attrition. With regards to graduate students' access, the literature is unequivocal about the role of financial support in facilitating access. These studies collectively show that without financial aid it would be difficult for graduate students to enroll and persist in graduate school (Curtis & Hunley, 1994; Border & Barba, 1998; Munoz-Dunbar & Stanton, 1999; Millet & Nettles, 2006a). Border and Barba's (1998) survey of 271 Ph.D. recipients in an institution in the state of New York, for instance, reveals that a majority (78%) of the graduate students who participated in the study could not have enrolled without financial aid. Similarly, Munoz-Dunbar and Stanton's (1999) interviews of 72 graduate admissions directors show that funding is important for access to graduate programs, but more importantly funding that is dedicated to minority students, such as grants, fellowships and assistantships contribute significantly to the ease of recruiting students for psychology Ph.D. programs. Although the initial offer of financial aid at entry is crucial for access, long-term funding is more important as students complete multiple years of graduate work; long-term funding thus affects other subsequent graduate school outcomes such as persistence and involvement (Millet & Nettles, 2006a).

Literature on the effects of financial aid on persistence shows that graduate students who have some form of financial aid are more likely to persist and finish their degree programs than those who rely on their personal sources of funding (Abedi & Benkin, 1987; Bair & Haworth, 1999; Bowen & Rudenstine, 1992). What the literature does not agree upon, however, is the effects of different forms of funding on graduate school outcomes such as persistence/attrition and degree completion. Some studies suggest that certain forms of financial aid are more effective than others in facilitating degree completion, time to completion, and persistence (Bowen & Rudenstine, 1992; Ehrenberg & Mavros, 1995; Herzig, 2004). For instance, while Bowen & Rudenstine (1992) and Herzig (2004) suggest that fellowship recipients have shorter times to completion compared to teaching assistants, others show that graduate students who receive fellowships and research assistantships are more likely to complete their degree programs and less likely to drop out than students who receive teaching assistantships (Ehrenberg & Mavros, 1995)

Other studies agree that a combination of several types of financial aid increases the likelihood of graduate student persistence (St. John & Andrieu, 1995; Bair & Haworth, 1999; Nerad & Cerny, 1993). Using the National Postsecondary Student Aid Study 1987 database and a sample 6529 graduate and first-professional students research, St. John and Andrieu (1995) found that when graduate students receive a financial aid package that includes three modes of aid concurrently, namely grants or fellowships and assistantships or loans, they are more likely to persist than when they receive only assistantships or only loans. They argue that the additional money received by a graduate assistant, in loans and grants, helps to offset the cost of living and increase the likelihood of persistence. Nerad and Cerny (1993), using a large sample of graduate students from UCLA, found that when students had an equal distribution of teaching assistantships, research assistantships, and fellowships, they tended to have shortened time to degree completion. In their review of literature, Bair and Haworth (1999) argue that research

assistantships result in higher rates of completion than other types of funding. All the above studies are explicit about the positive effects of financial support on graduate students' outcomes but they do not seem to agree about which type(s) of financial aid result in the best outcomes. Indeed, Bair and Haworth (1999) suggest that regardless of what type(s) of financial support a graduate student has, support "that requires no work (fellowships/grants) or reward[s] students for doing the type of research that leads to a degree, will be more likely to [enable the student to] progress rapidly towards a degree" (p. 159). These studies do provide some bases upon which to start research on the effects of financial aid forms; however, only Herzig (2004) explores how the outcomes of different forms of financial aid differ for different racial/ethnic categories of students, thus calling for more research in this area.

Besides having an impact on graduate students' access, retention, and completion, financial support provides opportunities for graduate students to learn the values, norms, and mores of their respective programs and professions through formal and informal interactions with faculty members and with peers (Girves & Wemmerus, 1988). Girves and Wemmerus' empirical model developed using a sample of 948 students entering graduate school at a Midwestern university in 1977 across 42 departments suggests that students with research and teaching assistantships become a part of the teaching and research communities within their departments as a result of increased formal and informal contact with faculty members and with peers. Thus, teaching and research appointments increase opportunities for student involvement in departmental activities, which in turn leads to persistence. Others (Bowen & Rudenstine, 1992; Border & Barba, 1998; Herzig, 2004) corroborate this conclusion, suggesting that financial support that requires teaching or research not only enriches overall experiences but also provides opportunities for apprenticeship and increases students' ability to adjust to graduate school. Bowen and Rudenstine (1992) aptly suggest that having a "teaching assistantship facilitates a structured engagement with one's colleagues" and such interactions are "a

vital factor for many students in successful completion of graduate study or at least in achieving ABD status” (p. 188). They, like Border and Barba (1998), also support the notion that fellowships which require no work may increase the likelihood that graduate students, especially those in humanities, get isolated or even “lost in the bowels of the vast research libraries and the complexities of the subjects hard to unravel without collaborators and some modicum of structure” (p. 188). Bowen and Rudenstine, however, distinguish between the effects of fellowships on graduate students in humanities and those in sciences. They suggest that in sciences, fellowships may not necessarily contribute to student isolation because the collaborative nature of research in sciences provides opportunities for students to interact closely with faculty and with peers. This therefore suggests that fellowships may contribute to isolation in humanities but not in science disciplines. Herzig (2004) provides evidence to support the usefulness of teaching and research assistantships in the socialization of doctoral students of color and women but also offers a slightly different conclusion. Her review suggests that both teaching and research assistantships provide students with the opportunity to interact with faculty and students and to learn about research and teaching norms within the field, which enhances their integration into their departments and professions.

Some studies have suggested that fellowships and research assistantships are the best predictors of persistence (Girves & Wemmerus, 1988), while others have emphasized the importance of teaching and research assistantships and fellowships combined (St. John & Andrieu, 1995). Still others assert that while assistantships in general have positive effects on persistence, teaching assistantships deter or slow completion (Ehrenberg & Mavros, 1995; Herzig, 2004). Despite these different conclusions, all of the literature shows that different forms of financial aid have different effects, positive or negative, on persistence and completion. One common factor among all the reviewed literature is that no research study or review of literature has specifically shown how financial aid affects students based on their racial or ethnic identity. No

research, for instance, has examined the impact of different types of financial aid on minority students in STEM doctoral programs. This research gap raises questions of how minority students in STEM doctoral programs experience different modes of financial aid and how their minority status may affect their overall persistence and completion.

Relationship with Faculty and Peers

Relationships in this context include interactions that students have with faculty and peers and the quality of those relationships. There are two sets of environments within which these relationships exist, namely the internal environment (primarily the department) and the external environment (work groups, family, and friends) (Golde, 1996; Tinto, 1993; Bean & Metzner, 1985). The relationships that students build within the department are most critical to students' progress and degree completion as they provide intellectual, social, and emotional support. The external environment relationships, primarily the support of family, friends, and partners are also important to students' progress (Golde, 1996; Tinto, 1993; Girves & Wemmerus, 1988). Tinto notes that these external relationships overlap with institutional and departmental relationships and may result in conflicting demands on students' time and commitment in both the environments. External communities may also limit the level of students' involvement with the departmental social and academic communities, isolating the student -- particularly the non-traditional student--from important social and academic life of the department. Overall, a student must be able to negotiate the expectations of these two environments to make progress in his or her program (Bean & Metzner, 1985; Tinto, 1993).

The literature focusing on the internal environment relationships focuses on three key topics: the role of faculty in graduate student recruitment; graduate student integration and socialization and their effects on persistence; and the nature of student-faculty relationships. First, the literature on graduate student recruitment demonstrates

that the recruitment of minority students into graduate programs is aided by having, among other things, faculty and students of color and funding dedicated to minority recruitment (Curtis & Hunley, 1994; Munoz-Dunbar & Stanton, 1999; Hill et al, 1999; 2001). Curtis and Hunley's (1994) study of 178 undergraduate students from Historically Black Colleges and Universities (HBCUs) and non-HBCU institutions demonstrates that a majority of African American students identified culturally diverse faculty and students as factors that would influence their decisions to attend graduate school. Similarly, Munoz-Dunbar and Stanton's (1999) interview of 72 directors of admissions revealed that having ethnic minority faculty and graduate students aids recruitment efforts of minority students. These studies demonstrate that minority faculty and minority students, among other factors such as financial aid, are an important consideration for minority students' decisions to enter graduate programs.

Second, the literature on graduate student integration/socialization suggests that at the graduate level, relationships with faculty are the most important to students' doctoral progress. Girves and Wemmerus' (1988) conceptual model of graduate student degree progress using a sample of 948 graduate students (both master's and doctoral) from one institution shows that doctoral level departmental characteristics and students' perceptions of faculty contribute directly to degree progress. They argue that graduate students get socially and academically involved or engaged in their departmental activities through financial support, which allows them to interact with faculty. Through these interactions, faculty members socialize graduate students to the norms, values, and expectations of the department and their profession. Consequently, students' relationships with advisors and faculty are more important to degree progress than their relationships with peers at the doctoral level, although peers provide implicit knowledge that students need to navigate departmental requirements and culture.

Building on this conceptual model, Tinto (1993) underscores the importance of relationships with faculty and peers at the department level, suggesting that students who

are able to integrate into the established customs and expectations which underpin the discipline, are more likely to transition, attain candidacy, and complete their dissertation. Several studies (Oden, 2003; Gonzalez , 2006; Vaquera, 2007) have utilized these models of integration and involvement to examine minority students' graduate school persistence. Vaquera (2007), using a sample of 295 students from a Hispanic serving institution, argues that social integration with peers is a weak, but significant predictor of student persistence, while academic integrations -- specifically satisfaction with the academic experience, participating in academic activities, and having advisors who show interest -- is a strong predictor of persistence. Vaquera concludes that at the doctoral level, in contrast to the undergraduate level, academic integration is a more important predictor of student persistence than social integration. Vaquera's study is important because it one of the few to focus on a minority group. It also demonstrates the usefulness of Tinto's (1993) model to examine the impact of socialization on minority students' graduate school persistence. Because of its quantitative nature, this study identifies factors that predict minority students' persistence but it does not explain how or why this is the case. Therefore, Vaquera's study is important in pointing out the factors that are likely to influence minority students' persistence.

Oden (2003) compares experiences of minority and White students in graduate STEM programs. His study suggests that African American students, especially those in Predominantly White Institutions (PWIs), experience feelings of isolation and often do not integrate into their departments owing to few or no minority peers and faculty, a lack of acceptance by White peers, and hostile racial attitudes regarding social, academic and personal work and study groups. Similarly, Gonzalez's (2006) study shows that Hispanic students face experiences similar to those of African American students, but those who integrate successfully into their departments seek strong support from like peers, faculty, and their communities. These studies reveal the importance of minority peers and faculty in the socialization and integration of minority students into their disciplines and

departments. Davidson and Forster-Johnson (2001) identify cross-cultural competence as important for successful mentoring of minority students in graduate school, suggesting questions about how such mentoring can occur in institutions where minority students do not have mentors from corresponding minority backgrounds. Do such students lack the socialization and integration into the department and profession necessary for success in doctoral studies? My study uses financial support and faculty-student relationships as important platforms through which to analyze this phenomenon.

Other studies (Golde, 2000; Austin, 2002; Weidman & Stein, 2003) using mixed samples of minority and majority graduate students have also considered the socialization approach to demonstrate the importance of faculty in socializing graduate students in their disciplines and profession and the effects of socialization/integration or lack of it on persistence or attrition. Golde's (2000) study of three doctoral students who dropped out of their programs, for instance, shows that one of the contributing factors in attrition is the absence of academic integration and nurturing relationships with faculty. Austin (2002), using qualitative data on 79 doctoral students from two institutions to examine how doctoral students are socialized into careers in the professoriate, suggests that the doctoral experience is the first stage of the socialization process, where doctoral students learn by observing and interacting with faculty and with peers. Although this study cites other stages of student socialization into their professions outside of the doctoral program, it emphasizes that the socialization process begins during students' doctoral studies. Weidman and Stein (2003) suggest that specific departmental climates foster or hinder socialization of students into the norms and values of their academic departments. Specifically, they suggest that departments which have a supportive climate, characterized by, among other things, departmental collegiality and supportive student-faculty interactions, prepare students well for their scholarly roles. These studies are important in showing the role played by faculty in socializing doctoral students into their

disciplines and their careers. None of them, however, shows how the socialization process works for minority doctoral students.

Last, the literature suggests several important faculty-student interactions that facilitate or hinder graduate student success. The faculty/student relationships that increase the likelihood of students' persistence include faculty availability, consistent academic advising, faculty feedback on projects, faculty interest in students' research, and quality of professional advising and job placement by faculty (Millet & Nettles, 2006a). Other similar relationships nurturing students through consistent, wise, fair, and firm mentoring and the provision of moral support and encouragement, advice and strategies on how to negotiate departmental politics in order to learn the "rules of the game," and treatment of doctoral students as junior colleagues positively affect persistence (Herzig, 2004, p. 192; Girves and Wemmerus, 1988; Nerad & Cerny, 1993). By contrast, student-faculty relationships that are characterized by a lack of trust, integration, and intellectual support tend to increase the likelihood of graduate student attrition (Golde, 2005). These studies are important in identifying important aspects of student-faculty relationships that I use as a guide in investigating student-faculty relationships that facilitate minority students' successful mentoring by faculty. Most of the studies examining the nature of student-faculty relationship above (except for Herzig, 2004) use mixed samples of minority and majority students. Therefore, there is a need to examine what types of student-faculty relationships/interactions work specifically for minority students' integration into their academic disciplines.

The literature in general pays little attention to peer relationships. Most studies in this review suggest that relationships and interactions with faculty at the graduate level are more important than the relationship with peers (e.g., Girves & Wemmerus, 1988; Vaquera, 2007). Only a few studies focus on the importance of friendships and intellectual supportive relationships among students (Gardner, 2007; Golde, 1996). Gardner notes that students' peer support, particularly during the first year of graduate

school, is important in alleviating feelings of being overwhelmed by the new environment. In addition, peer support of new students by those who are more advanced in the program, helps with finding advisors and providing emotional support. In this respect, therefore, peers are useful in providing support at the graduate level.

The importance of faculty in influencing doctoral students' recruitment, socialization, and progress toward completion cannot be overstated. Three important issues emerge from this review of literature. First, academic integration (represented by faculty-student interactions) seems to be a stronger predictor of student persistence and progress than social integration (peer social interactions) at the doctoral level. Second, there is some evidence to support the fact that the nature of faculty-student relationships/interactions is important in determining students' doctoral outcomes. Last, relationships in the external environment are also important, particularly for non-traditional and minority students who find both support and challenges emerging from these relationships. The literature also raises some questions: since some studies suggest that peer-to-peer relationships are secondary to faculty relationships in the integration and socialization of doctoral students, what secondary role(s) do peers play and how do these role(s) influence doctoral students' experiences? How do minority students interact with faculty and peers at predominantly white institutions? What kinds of interactions do minority students have with their advisors/mentors and how is this useful in their socialization process?

The above literature review provides an overview of doctoral students' experiences pertaining to financial aid and student-faculty and student-peer relationships and interactions. Two major observations arising from this literature give impetus for this study. First, most of the studies in this review of literature, with the exception of a few (e.g., Gonzalez, 2006; Oden, 2003; Golde, 1996, 1998, 2000, 2005; Austin, 2009; Gardner, 2007), have employed quantitative methodologies and as a result they identify important factors that influence doctoral students' outcomes including persistence and

time-to-degree. However, these studies are limited in their explanations of why and how these factors affect students' doctoral degree outcomes, from students' points of view. In this study, therefore, I employ a mixed methods approach with emphasis on qualitative strategies to provide nuanced data on minority students' socialization into their academic disciplines and careers through relationships with faculty and with peers and through opportunities provided by different forms of financial support.

Second, with the exception of a few studies (e.g. Oden, 2003; Gonzalez, 2005), most research studies have used mixed samples of minority and non-minority students. The inherent strength of this is that they are able to compare the experiences of these two groups. However, they also risk overlooking the experiences and perceptions of minority students in particular. Therefore, selecting a sample of minority students for this study allows for a focused understanding of their doctoral experiences.

Theoretical Framework

Most researchers of doctoral persistence have found that a combination of factors interact to determine graduate student persistence. Their contributions to the topic of graduate student persistence are important in highlighting salient factors that influence persistence, two of which I examine in this study. I use Tinto (1993) and Weidman, Twale, and Stein (2001) as my guiding frameworks because these theories suggest stages in the doctoral process which moderate the effects of these factors. I specifically apply Tinto's (1993) model of doctoral student persistence and Weidman et al.'s (2001) theory of student socialization to minority students in STEM doctoral programs. I explore the role of financial support in providing opportunities for student integration and that of students' relationships and interactions with faculty and peers in their socialization into their departments and professions. Tinto's (1993) model suggests that individual success in this integration and socialization is shaped by attributes and background factors that students bring into the doctoral experience. These attributes, including gender, race, and

education experiences (among other things) together with external commitments (e.g., family, friends, work, finances), influence students' educational, occupational goals and institutional commitments. These initial orientations interact with social and academic systems within the department to yield academic and social integrations if the outcomes are positive, or a lack of integration and departure if the outcomes are not rewarding. My analysis takes into account Tinto's stages of doctoral process, namely transition, candidacy, and completion, as well as Weidman et al.'s stages of socialization (the anticipatory, the formal, the informal, and the personal stages) through which the processes of integration and socialization occur.

CHAPTER III

METHODOLOGY

Introduction

This chapter builds on the theoretical and empirical considerations in Chapter II and discusses the research methods and procedures for this study. The chapter begins with a description of the research design and data collection strategies. Next, it presents a detailed description of the study's sampling procedures followed by description of the participants. It presents the research questions and the data analysis procedures as well as methods for addressing validity and trustworthiness of findings and interpretations. It concludes with discussion of the limitations of this study.

The following are three research questions that guide the study:

1. What forms of financial support do underrepresented minority students in STEM programs receive during the course of their doctoral programs?
2. What role do different forms of financial support play in facilitating underrepresented minority students' integration into their programs' social and academic communities?
3. In what ways do minority students' relationships and interactions with faculty members and with peers facilitate their socialization into the academic and social systems of their disciplines and their professions?

Research Design

This is a descriptive study of minority students' experiences in STEM programs. It relies on a mixed methods strategy encompassing a cross-sectional survey of volunteering doctoral students in STEM programs of the Graduate College with the aim of attaining a sample of minority doctoral students in these programs. A smaller sample of volunteering minority doctoral students from two of the STEM programs participated in semi-structured, in-depth interviews. This mixed methods approach lends itself not

only to answering questions of how and why phenomena occur but also how often, when, and in what forms such phenomena occur (Creswell, 2003). In other words, a mixed methods approach can help capture the complexity of phenomena within a specific context.

Further, a mixed methods approach provides a number of other advantages, including triangulation of findings (Greene, Caracelli, & Graham, 1989; Rossman and Wilson, 1994; Creswell, 2003). Methodological triangulation is based on the "logic of convergence" which requires the methods to be different in strengths and limitations but to be used to explore the same phenomenon (Greene et al., 1989, p. 266). Method triangulation or the use of a combination of methodologies provides for the convergence or correspondence of results across different methods (Green et al., 1989). Further, the simultaneous use of qualitative and quantitative methods to study the same phenomenon generates data that will "pinpoint the values of phenomena more accurately by sighting in on it from different methodological viewpoints" (Rossman & Wilson, 1994, p. 319). This purpose of using a survey and interviews in this study is for the convergence of findings and interpretations across the two methods. As such, I used a survey and interviews to collect data on students' financial support and student-faculty and student-peer relationships and interactions. The implementation of the mixed method strategy was concurrent whereby the interview and survey data collection phases occurred simultaneously or concurrently (Creswell, 2003).

Data Collection Methods

Both the survey and the interview were based on the theoretical and empirical findings from the literature review and were designed to facilitate an understanding of minority doctoral students' experiences and perceptions in their own words (Taylor & Bogdan, 1998). For both instruments, I relied on Tinto's (1993) model of doctoral persistence to identify the main topics -- financial aid and relationships (with faculty and

with peers) -- while for the more specific questions I relied on empirical findings and studies on doctoral students in the literature (see Abedi & Benkin, 1987; Border & Barba, 1998; Millet & Nettles, 2006a; Weidman & Stein, 2001). I collected the survey data using WebSurveyor, an online data collection service, and the interview data using individual face-to-face and telephone interviews.

Sampling Procedures

In January 2008, I requested and received a list of all students enrolled in STEM doctoral programs of the Graduate College from the Office of the Registrar. I had originally requested a list of minority students in doctoral STEM programs which included directory information (names, email, phone number, degree program, and race) but because of the Family Educational Rights and Privacy Act's (FERPA) restrictions on student information pertaining to race I could not get direct access to minority students. I modified my request to include all students enrolled in Ph.D. STEM programs, which meant the omission of the "race" identifier. My rationale for requesting students' directory information was to be able to contact students directly and to follow up my initial communication with emails and telephone calls, which would not have been possible if I had used the institution's Information Technology Services bulk email. I felt that with a list of students' names, emails and telephone numbers, I would be in a better position to conduct telephone follow-ups, especially for the interview candidates. The Office of the Registrar provided a list of all doctoral students enrolled in STEM programs including directory information that did not list students' race. The final list of my study's population comprised 307 students enrolled in STEM doctoral programs in the Graduate College. Because the study required two levels of data, it relied on a two-stage sampling procedure: the first procedure involved recruiting minority participants for interviews or focus groups from two STEM programs which had the highest number of minority students while the second involved recruiting minority students from all other programs

outside of the two programs in the first procedure.⁶ For the first procedure, I contacted 103 doctoral students (both majority and minority) in the two programs with the highest numbers of minority students and for the second I contacted 204 students in other STEM programs, a total of 307 graduate students.

I contacted the first group, 103 students enrolled the two programs with the higher proportions of minority students, through an initial pre-survey email on March 11, 2009. In this email, I presented them with three choices of participation: 1) combined focus group and survey; 2) individual interview and survey; and 3) survey only. My rationale for offering these choices was to recruit several students with whom I would begin a snowball sampling procedure for interviews or focus groups. I invited this group to take the survey because I wanted to accomplish two goals: a) capture the general perspectives of majority students to provide contrast and comparison with minority students' responses, and, b) recruit minority students for the interview aspect of the study. For the students who chose the "survey only" option, I sent two reminders on March 23 and April 6, 2009 respectively. On April 22, 2009, I sent thank you notes to those who had participated. Appendixes A.I to A.III and A.VII contain the emails that I used to communicate with this group.

On March 23, 2009, I contacted the second group of students, 204 doctoral students in STEM programs other than the two selected programs, by sending them a pre-survey notice email in which I introduced the purpose of the study and explained eligibility for the study. I provided three options for student participation: "yes, I am interested," "No, I am not interested" and "maybe, contact me." On March 30, 2009, I sent another email containing the URL address of the survey to all students who had

⁶ The Graduate College enrollment data show that between 2000-01 and 2007-08 two of the selected STEM programs had the highest number of minority students overall. In 2007-08, for instance, the two programs had Fall enrollments of 19 and 22 (a total of 41) minority students respectively while all others programs put together had 21 minority students (see Table 4 and 6 for list of programs).

responded, "Yes, I am interested" as well as those who had not responded in any way. I removed all the students who had responded, "No I am not interested" from my list. I sent two reminders with the URL links to the survey, one on the April 6, 2009 and the other on April 13, 2009. One week after the second reminder, I sent a thank you note to all who had responded but kept the survey open to allow for any further responses. The rationale for the multiple contacts with survey respondents was to improve response rates (see Dillman, 2000) Appendixes AIV to VII contain the emails that I used to communicate with this group of survey respondents. For all the survey communication with students, I used WebSurveyor, an online survey service.

While the survey was in progress, I asked one minority student who had agreed to participate in an interview to nominate others to participate. In addition to using this participant to start the snowball sampling process, I relied on four other methods to recruit participants. 1) I matched the names of students on the list provided by the Office of the Registrar with names and pictures of graduate students listed on the various Ph.D. program websites. Specifically, I identified students that I assumed to be minority students based on their appearance or their name. I telephoned approximately 30 of these students and invited them to participate in interviews or focus groups. 2) I requested fellow minority students in my education program to introduce me to minority students that they knew in STEM Ph.D. programs. I did this informally by speaking with specific students or by sending them an email. 3) I wrote emails to three faculty members in STEM programs explaining the objectives of my study, and requested an introduction to minority students in their programs. Only one faculty member acknowledged my email but there was no way of knowing if any of the faculty members talked to their STEM doctoral students about participation in my research. 4) I contacted student organization leaders and requested that they introduce me to Ph.D. minority students in their organizations. Two of the student leaders acknowledged my request. One wrote an email, introducing me to about seven minority students in his discipline. I contacted

these students through email, introducing my research and the objectives, and inviting them to participate. The second student organization leader invited me to several student meetings. My ability to attend these meetings was limited by the distance between the university and my place of residence approximately six hours away by car. As a result, this limited the potential pool of doctoral students from which I could recruit participants for my study.

Despite employing these four strategies to recruit minority students for interviews or focus groups for this study, few minority students responded to the invitations. The first and second strategies yielded one response each while the fourth yielded two responses, providing four potential participants. I followed up with these three contacts by sending them a brief email stating how I received their names and the purpose of the study. I requested their participation, and all four agreed. Thus, including the minority student who responded to the survey invitation, five minority students agreed to participate in interviews. They, in turn introduced me through email communication to several of their peers. This yielded three more responses to make a final sample of eight. Before conducting each interview, I sent the participant a copy of the Informed Consent letter (See Appendix C) and then made arrangements, through email and telephone communication, for mutually appropriate times and venues for the interview. I conducted six face-to-face and two telephone interviews between April and September 2009, which on average lasted 60 minutes each.

The process of recruiting minority students for interviews for this study was a challenging one and called for the use of several strategies to increase participation. This challenge was compounded by the fact that I commuted to the research university (approximately a six-hour drive one way) for six of the eight interviews because participants had different schedules. In some instances, interviewees canceled or rescheduled meetings on a short notice due to unforeseen scheduling conflicts requiring that I return to the university a different day. Although the travel to the university was

long and tedious, I chose to do it to have a face-to-face rather than telephone interaction with the participants. One of the advantages of face-to-face interviews that I experienced was that the process created rapport with the participant and as a result some agreed to recommend participation to their peers. One student said the following after the interview: "I think I have some [peers] I might tell [about the interview] I know now what it is. This isn't boring and I think that's the fear of anyone doing a survey. This was fun." This student recommended seven other students for this research and one of them agreed to participate.

The survey recruitment process was not as challenging but I had less control over how I contacted the potential participants. I sent two reminders to all the potential participants (both minority and majority) to increase the likelihood of participation. I also left the survey on the website for approximately three months after the second reminder with the aim of increasing participation of those doctoral students who might have postponed the survey or suspended the survey for a submission at a later date.

Participants

The survey yielded responses from 73 majority students (Whites and Asians) and five underrepresented minority students. Eight underrepresented minority students who had not filled out the survey participated in the interviews. Altogether, 13 underrepresented minority students and 73 majority students participated in the study (See Table 3). The total number of minority students who participated is very small, approximately 22 percent of the total number of minority STEM graduate students (citizens and permanent residents) enrolled in 2008-09 academic year ($N = 58$, according to enrollment statistics provided by the Graduate College). This limitation is discussed at the end of this chapter.

Table 3: Total Number of Participants and Modes of Participation

	Modes of Participation		Total
	Interview	Survey	
Minority Students	8	5	13
Majority Students	0	73	73
Total Participants	8	78	86

The 73 majority survey respondents were from a wide variety of STEM programs, including engineering, mathematics, and biological sciences and included 48 male and 25 female students. Twenty-nine of the students were married while 45 were single. Sixty-five were White and eight were Asian Americans. Table 4 illustrates majority doctoral students' background characteristics.

The 13 underrepresented minority participants were from several STEM departments including engineering, mathematics, and biological sciences. There were six male and seven female students; 11 were African Americans, one was Hispanic, and one was American Indian/Alaskan Native. Eight were single and five were married students. The students were at various levels of their doctoral program ranging from first to seventh year. Table 5 illustrates minority students' background characteristics.

Table 4: Characteristics of Majority Students -- Race, Gender, Marital Status, and Year in Doctoral Program

Background Characteristics	Number of Participants
Race	
White	65
Asian American	8
Gender	
Male	48
Female	25
Marital Status	
Single	29
Married	41
Other	3
Year in Doctoral Program	
First Year	21
Second Year	9
Third Year	14
Fourth Year	10
Fifth	6
Sixth Year	12
Seventh Year	1

Table 5: Characteristics of Minority Students -- Race, Gender, Marital Status, and Year in Doctoral Program

Background Characteristics	Number of Participants
Race	
African American	11
Hispanic	1
American Indian/Alaskan Native	1
Gender	
Male	6
Female	7
Marital Status	
Single	8
Married	5
Year in Doctoral Program	
First Year	4
Second Year	2
Fourth Year	2
Sixth Year	4
Seventh Year	1

Research Instruments & Data Analysis

Survey

The survey has four sections, which I discuss below.

1) *Academic-Related Information*: This section includes items on students' academic major and program, year of Ph.D. program entry and anticipated year of completion, and the number of publications and conferences attended. The responses provide participants' academic information and academic experiences.

2) *Financial support*: this section asks about the types of financial support participants received through six years of graduate school. It also asks participants to rate (from "very beneficial" to "not at all beneficial") their perceived value of the financial support vis-à-vis their ability to remain enrolled. The section further provides participants with a number of statements about outcomes that may have occurred as a result of graduate education and asks them to indicate the extent to which their financial aid may have contributed to these outcomes. The respondents are required to indicate their level of agreement or disagreement with the statements. The purpose is to determine the forms of financial aid students receive in STEM and their perceived effect on doctoral students' success.

3) *Advisor-Advisee & Peer-Peer interactions and relationships*: This section provides a list of advisor and peer characteristics and behaviors and asks participants to rate their importance to their success in graduate school. The rating is on a four-point scale from "very important" to "not at all important." Further, the section asks participants to indicate the extent to which they have experienced these behaviors and characteristics in their graduate school programs. The scale for this is "Always," "Sometimes" and "Never." The last part of this section has an open-ended item that asks participants to describe ways in which their advisors and peers helped them become

successful in graduate school. The survey defines success as good academic performance (GPA), collaborative research, passing comprehensive exams, and dissertation progress.

4) *Demographic/Background Information*: This section asks students to indicate their racial background, age, sex, marital status, and dependents and further asks them, in an open-ended format, to describe the impact of these background/demographic factors on their success and progress in their graduate school programs. The survey is included in Appendix B.I.

I analyzed the survey data using SPSS v.16 for windows. I imported the data from WebSurveyor, an online data survey service, into a Microsoft Excel file. I then imported the data onto SPSS v.16 for Windows. Since this study is descriptive rather than inferential, I used simple descriptive statistics to analyze the four items. For data analysis, I included all the cases that were complete and omitted those cases that had more than half of the data missing. I omitted five cases and was left with a final sample of five minority students and 73 majority students.

Interviews

The interview questions were similar in theme and substance to the survey items and included the same four topics. The interview items were open-ended, semi-structured and flexible enough to allow respondents to discuss their unique experiences. Although I used a list of questions to guide the interview process I did not strictly adhere to the order of the questions or use the exact words in order to be responsive to the unique perspectives of the participants and to the emerging and serendipitous topics (see Merriam, 1998).

I started the interview process with an introductory question that asked how respondents had developed an interest in their particular disciplines. This question served as an icebreaker. The main interview questions asked respondents about: 1) their academic backgrounds, including the program in which they were enrolled and when

they started and anticipated completing their programs; 2) the types of financial aid they had received in the course of their doctoral programs and their perceived value/benefits to respondents' graduate progress; 3) the nature of their interactions with mentors/advisors and peers and how these shaped their graduate school experience; and 4) their background factors and their influence (positive or negative) on their graduate school experiences. The closing question asked respondents to identify and explain which of their experiences had contributed most significantly to their success in graduate school and which had presented the toughest challenges. Appendix B.II contains a list of guiding questions that I used for interviews.

Because I had used a digital recorder to collect the data, I transcribed each respondent's interview verbatim to ensure accuracy in the analysis and interpretation. After transcribing the interviews I read through each transcript and cleaned the data by correcting typographical errors and removing identifying remarks such as names of people (students, professors, teachers & staff), places (cities, states, universities), and background information that was too specific. I did this to protect the identity of the respondents. Further, I marked each transcript with a unique number for identification. Then I matched these unique numbers with participants' initials and programs and stored this list in a separate file. I imported the transcripts into Atlas Ti v. 5.6.1.

I employed the constant comparative method developed by Glaser and Strauss (1967) for survey-open ended and interview data analysis. This method entails organizing data into meaningful categories and, as the name implies, constantly comparing units of categories and grouping them with units that share similar meanings to form new categories (Merriam, 1998). For this study, I started the analysis by identifying responses and categorizing them into salient themes, which corresponded with the main research questions. These themes and their designated codes are financial aid (*Finaid*), participants' interactions and relationships with mentors (*Mentors*); participants' interactions and relationships with advisors (*Advisors*); participants'

interactions and relationships with peers (*Peers*); and participants' background factors and how these shape their graduate school experiences (*Background*). For each of these themes I developed codes that described a specific aspect of the theme. For instance, if a participant indicated that he or she had a fellowship for financial aid, I used the code *Finaid.fellowship*, or if a participant had received an assistantship, I used the code *Finaid.asstship*. In addition, if a participant indicated that peers helped in study groups, I assigned the code *Peers.studygroups* or if peers provided social support, the code would be *Peers.socialsupp*. Therefore, my analyses entailed using broad themes that corresponded with the research questions and adding codes that described or identified specific aspects of the overarching theme.

Following the coding of themes, I sorted out and saved similar codes in Code Families using the Family Manager feature of Atlas Ti. For instance, I assigned codes with a name starting with *Finaid* to one family and did the same with codes that shared similar themes. This process generated six main code families containing several unique but related codes. Within each code family, I identified codes that were similar and categorized them into subfamilies for further analysis. For instance, for the *Finaid* theme I separated all the codes falling under benefits of financial aid (*Finaid.benefit*) and challenges (*Finaid.disadv*) and placed them into a *Finaidimpact* family in order to examine and explore the relationships between and among the codes. Next, I developed themes around participants' experiences based on the relationships among the codes and supported them with rich, descriptive data of participants' spoken words from the original transcripts. This form of narrative analyses tells the stories of participants to lend a better understanding of their perceived experiences within their programs (Taylor and Bogdan, 1998).

Since the survey and interview items were similar in theme and substance, I analyzed the data from each method independently and then compared the data for convergence or consistency at the interpretation and reporting stages. For instance, one

open-ended item in the survey asked students to describe ways in which their faculty advisors influenced their Ph.D. success including academic performance, collaborative research, preparing for comprehensive exams, and the dissertation progress. I asked this same question to the eight interview respondents. I analyzed the responses to these questions separately, seeking common themes, which I integrated in reporting the findings. For the structured scale items on the survey, I analyzed frequencies and reported the findings to support the qualitative (open-ended survey data and interview data). For instance, where participants indicated that they agreed strongly with a statement such as "My knowledge of issues in my discipline/field increased" as a result of financial support, and at the same time the interview data showed that students learned about their discipline through their research or teaching assistants, I used the survey and interview data to converge the findings across the two methods (See Green et al, 1989; Caracelli & Greene, 1993).

The use of this mixed method strategy had one main limitation and one strength. The key advantage was the ability to find similar themes across the two methods, particularly for the survey open-ended items and interview data. This strengthened my conclusions around converging finding across the methods. The main challenge was in the survey structured response items, which lacked elaboration, and therefore, it was difficult to integrate these findings with the other findings. I incorporated these findings into the interpretation to corroborate the qualitative findings where applicable (see Caracelli & Green, 1993). The findings in Chapter IV and Chapter V, therefore, are based on the survey data from five minority students and interview data from eight minority students, altogether 13 minority doctoral students. Where relevant, I used the open-ended survey findings of 73 majority students for comparison and contrast.

Establishing Validity/Trustworthiness

Survey

Prior to collecting data, I piloted the survey with six doctoral students from a social science discipline because, like STEM doctoral students, these students had experienced some form of financial aid and interacted with peers and advisors within their college. They were therefore in a position to understand the content and requirement of the survey and provide feedback on it. I also asked for a critique of the survey by my advisors and colleagues. I sent each of these participants the URL address of the survey and asked them to take the survey and to provide a report of the time it took as well as their level of comprehension of the content. This was to accomplish three things: 1) to ensure there were no technical glitches in taking or submitting the survey online, 2) to improve the wording of the questions, scales, and formats, and 3) to establish content validity (Creswell, 2003). The feedback proved helpful in finding out the length of time it took pilot participants to fill and submit the survey (approximately thirty minutes). The pilot results also indicated that some definitions, words, and concepts were not clear and that some categories were missing in the scales. I therefore used this feedback for revisions to reflect the meaning I intended, add categories to scales, and simplify questions that were too long into a shorter, more manageable size. For instance, for the question on racial identity I had omitted the "Asian" category, which I added after receiving comments on the pilot. I also added the category "not applicable" to many of the scales for participants who may not have had specific experiences that the survey asked about. Finally, some of the participants indicated that although the survey was "not too long" it required a lot of detailed information. I did not change the length of the survey as I felt all the information was relevant to this study.

Interviews

I used two methods to ensure trustworthiness of the data, the analyses, and the interpretations of the findings. 1) Peer examinations, which entailed a critique and commentary on my analyses and interpretation by my department colleagues and my advisors and 2) triangulation, which comprised the use of mixed methods and multiple sources to confirm emergent patterns (Merriam 1998; Creswell & Miller, 2000). For the first method, my advisors not only provided a critique but also probed the meanings, interpretations, and conclusions of this study. This compelled me to constantly examine my reporting and interpretations in light of the data and to stay true to the data as much as possible. The second method that I used was facilitated by the mixed method approach that I employed. Thus, I used survey data (from both minority and majority students) to confirm the interview data; I also used the interview data to elaborate the survey data. These methods were useful in ensuring that the reporting and interpretation of the data were accurate.

Limitations

This study is limited in several ways. First, this study suffers from the inherent weaknesses of low response rates. One of the potential explanations for the low response rates is over-surveying in academic arenas, which leads to respondents' negative attitudes towards surveys because they receive large numbers of survey requests. Another reason why internet surveys get low response rates is length (Ellinger, Watkins, & Marsick, 2005). From my experience as a graduate student, I can attest to the fact that students receive numerous solicitations for research participation, which results in fatigue and negative attitudes towards internet solicitations. However, multiple contacts with respondents prior to and during the survey process can increase the response rates (Dillman, 2000). In this study, I contacted my potential participants before the survey by sending a pre-survey email notice and during the survey by following up with reminders.

Despite these inherent challenges of surveys, I decided to use a survey to provide comparison and contrast to respondent interviews where relevant.

The second limitation of this study is related to the first and involves the length of the survey. The results of my pilot survey indicated that it took respondents anywhere from 25 to 30 minutes to complete and that it required a lot of detailed information. This may have led a number of prospective respondents to click on the URL link to the survey and not submit a survey. The WebSurveyor message menu, which provided information on how many students received the survey ($n=307$), how many clicked on it ($n = 98$) and how many completed and submitted it ($n = 83$), suggested that this may have been the case. The major concern about survey non-response is that it is usually nonrandom and may bias the results (Ellinger, Watkins, & Marsick, 2005).

The third limitation is that this study relied on data from a convenience sample of eight interviewees and five survey respondents who volunteered for the study. It is possible that those who volunteered to participate are different in significant ways from those who chose not to participate, in which case the findings would not be representative of the overall minority students' views and perceptions.

The fourth limitation of this study was its reliance on volunteers and nominations of others by initial volunteers. The main drawback of this sampling technique is that it is difficult to know the extent to which the sample is representative of the population (Black, 1999). In my study, interview participants tended to introduce their friends or close acquaintances, who could share certain traits or backgrounds; therefore, the total sample may not be representative of overall minority students' perceptions.

Last, because this study is limited by the small sample of respondents, it can only serve descriptive purposes. The findings are neither generalizable to the STEM programs in this study nor to the broader minority student body. The findings should be interpreted with caution and used to generate hypotheses about theoretical issues and for future empirical study.

Summary

In this chapter, I have described the methodology of my research study including the research design, data collections strategies, the sampling procedures, the research questions and the data analysis techniques. I have also discussed a number of limitations of this study.

This study is a descriptive study of minority doctoral students' perceived experiences in STEM program at a research university in the Midwest. I employed a mixed methods approach comprising a cross-sectional survey of all doctoral students in STEM and semi-structured interviews of minority students in two specific STEM programs. The purpose of this approach was to facilitate the triangulation of findings between the two methods. The study examined the types of financial aid minority doctoral students received and how these financial support packages influenced their ability to integrate and participate in their program's academic and social activities. The study examined minority students' interactions with advisors and mentors and with peers and how these interactions shape their doctoral experiences.

The sample of volunteering students came from U.S. citizens or permanent residents enrolled in STEM doctoral programs at the institution in spring, summer, and fall 2009. I used the snowball sampling technique to recruit interview participants and email communication to invite survey participants to the study. In this study, the research questions focused on the following two factors that shape Ph.D. students' experiences: financial aid and relationships with advisors/mentors and with doctoral peers. I analyzed the survey data using simple descriptive statistics (frequencies) and the interview data using the constant comparative method facilitated by Atlas Ti. In Chapter IV and Chapter V, I present the findings of my research.

CHAPTER IV

FINANCIAL SUPPORT

Chapter IV describes findings pertaining to the forms of financial support that this sample of underrepresented minority doctoral students report and the effects of the various forms of financial aid on their doctoral progress. It is organized into two sections. The first describes the types of financial aid that students received in the course of their doctoral program. The second describes the perceived value or benefits students derived from various financial aid types. It closes with a brief summary highlighting the most common themes emerging in this topic.

Types of Financial Support

The survey and interview findings show that the most common type of financial support the underrepresented minority students who participated in this study reported receiving is fellowships, followed by teaching assistantships, then research assistantships. Specifically, 10 of the 13 participants indicated they received fellowships, eight received teaching assistantships, three received research assistantships and two supported their doctoral studies with loans and/or off-campus employment. The two students who reported utilizing loans or working off-campus to support their doctoral education both participated in the survey and, therefore, there was no further information to explain why they did not receive any form of institutional funding for their doctoral degree.

In addition to the various forms of financial support that minority students reported, they also reported having more than one form of financial support during their doctoral program. Four reported having three forms of financial support, five reported two forms, and four reported having one type of financial support. Although some students report only one or two forms of financial support, most will be likely to receive additional forms of aid before completing their doctoral degrees. Table 6 shows the forms of financial support that participants reported.

Table 6: Form of Financial Support Received by Minority Doctoral Students

	Fellowship	Teaching Assistantship	Research Assistantship	Off campus Employment	loans	Other funding*
Student 1	x	x				x
Student 2	x	x				
Student 3	x	x				
Student 4	x	x				
Student 5	x	x	x			
Student 6	x	x	x			
Student 7	x					
Student 8	x	x				x
Student 9		x				
Student 10			x			
Student 11**	x				x	
Student 12**				x	x	
Student 13	x					
Totals						
Recipients	10	8	3	1	2	2

Notes:

*This type of financial support was provided for one semester to allow students focus on a project of interest or travel to a conference.

**The two students who reported utilizing loans and off-campus employment to support their doctoral studies participated through surveys and therefore they did not provide further explanation regarding their financial support.

In the interviews, minority students reported that the fellowships they received were from federal grants that their departments had won or from the institution's Graduate College. According to these students, the fellowships typically provided them with financial support for up to five years depending on individual department's implementation of the funding policy.

Specifically, minority interview participants reported several types of fellowships including the GAANN (Graduate Assistance in Areas of National Need)⁷, AGEP (Alliance for Graduate Education and the Professoriate), VIGRE (Vertical Integration of Research and Education in the Mathematical Sciences), the Presidential Graduate Fellowship, and the Dean's Fellowship. The AGEP, GAANN, Presidential, and Dean's fellowships, according to the participants, provided funding for up to five years and offered students first and final year funding with no obligation to work as teaching or research assistants. In the second, third, and fourth years, fellowship recipients were appointed as teaching or research assistants in their respective departments or programs. This pattern, according to different participants, varied according to the number of years or semesters that the fellowship required them to engage in teaching or research assistantships.

The recipients of the Dean's and Presidential Graduate Fellowships, both of which were funded by the institution, reported that these fellowships offered four and five years of financial support respectively. Two recipients reported that the first and final years were free of departmental teaching and research obligations for the Dean's fellowship while the first, fourth and final years were free from teaching and research obligations for the Presidential fellowship. In the second and third years of both fellowships, recipients reported that they were appointed as graduate research or teaching assistants in their

⁷ The areas of national need are published each year in the federal register and the case of GAANN fellowship they include biology, chemistry, computer and information sciences, engineering, mathematics, nursing and physics (U.S. Department of Education, 2009)

respective programs. In addition, the recipients noted that both these fellowships provided support for the summer sessions for the duration of the funding term, which did not require them to work as teaching or research assistants.

The AGEP and GAANN fellowships, both of which are competitively awarded by the federal government to specific research institutions' programs, were interpreted and implemented differently by different programs, according to recipients' descriptions. Specifically, the GAANN fellowship, which was funded by the U.S. Department of Education, provided funding for graduate students with good academic records and who demonstrated financial need and pursued disciplines that fall under the "national need" categories, which included STEM fields (U.S. Department of Education, 2009). According to two minority students who received this fellowship, the GAANN fellowship offered five years of support, only requiring the recipients to work as teaching assistants for two semesters, but in these particular programs students, in consultation with their advisors, decided the length of time they want to serve as teaching assistants based on their career goals. One minority student illustrated the flexibility of the fellowship, saying:

The first semester they allow you to focus on class work and you choose the professor that you will work with. The second semester you start your research that goes towards your dissertation. And you are required to TA twice if you discuss with your professor you can teach a class if you want to be an academic Ph.D. And the other option is, depending with your professor's financial situation, you may TA only once. Some people have TA-ed once. I have TA-ed six times.

This particular student and two others explained that they had the option to teach as few or as many semesters as they chose depending on their academic and career goals as well as the availability of teaching assistantships and their advisor's funding. One of the three, however, perceived opportunities for teaching assistantships in her program to be limited, saying:

I guess I had to work [off campus] because they don't have a TA-ship position in [my department]. It seems as though in our

department they give those positions to international students because even last year when my advisor said to me 'we've got to finish this year 'cause your funding is expiring' I was like, 'I am not going to have a TA-ship position.'

Three other minority students who reported receiving the GAANN fellowship stated that they had two to three years of funding with no service requirement at the beginning of their doctoral program and during the final year. They reported having the option to choose their non-service years at any time of their program depending on their needs but, typically, all the participants took the first two years and the last year of non-service funding to focus on their transition and their dissertation respectively. Further, the students reported that the fellowship required them to serve as teaching or research assistants in the interim years. Two of the GAANN recipients reported they served as teaching assistants in their departments while one, who was still in the first year, had not received any other form of funding.

Another type of fellowship funding that one participant reported receiving is the AGEP fellowship, which is funded by the National Science Foundation and aims at increasing the number of underrepresented minority students obtaining graduate degrees in STEM fields and entering into faculty positions (NSF, 2009). This AGEP fellowship recipient reported that the fellowship provided two years of non-service funding with the interim years funded by the respective programs through teaching and research appointments. In addition, the AGEP fellowship provided summer funding that was service free for the duration of the fellowship. The AGEP recipient reported receiving a teaching assistantship appointment during her third and fourth year of the doctoral program.

The last fellowship that two minority doctoral students reported receiving was the VIGRE fellowship funded by the National Science Foundation specifically for mathematical sciences to support undergraduate, graduate, and postgraduate student traineeships (NSF, 2009). The two recipients of this fellowship indicated they received support for a semester-long individual research project. These two recipients reported

receiving three forms of funding namely, the GAANN fellowship and Presidential fellowship respectively, teaching assistantships, and the VIGRE fellowship.

The survey participants (n=5), two in their first year and three in their second year of the doctoral program, reported receiving several types of financial support. The two first year students reported receiving a teaching assistantship and a research assistantship appointment respectively. A third student reported funding the first year through student loans and the second year through a combination of student loans and a fellowship. A fourth student reported relying on a combination of student loans and off campus employment for the first and second years. The fifth student reported that she/he received a fellowship during the first and second years of the doctoral program.

One unanticipated finding from minority students' interviews is that they perceived differences in the different types of financial support. Four minority students perceived the federally funded fellowships to be the most "lucrative," followed by the institutional fellowships Departmental research and teaching assistantships, which were the least lucrative. Students described these differences as follows:

[TA-ship] is physical labor. Then you get less than any fellowship. The years that I don't have to work I get paid more. A TA gets paid \$17,000 a year and most fellowships like the Presidential give \$21,000, GAANN and AGEP are \$25,000 but the TA makes the least. Then the two middle years you have to TA but you get paid slightly more than the TA [non-fellowship TAs] 'cause we have the summer support but the [non-fellowship] TA has to apply for it. They don't get that.

I think at this point I am fine with being a TA but the fellowships do generally give you more money. I miss it. When I was on a fellowship one year and TA-ed the next one, I was like, "oh, pay cut!"

Although students perceived federally-funded fellowships to be more lucrative than teaching and research assistantships, they still perceived research and teaching assistantships as beneficial in equipping them with important skills.

Several minority students perceived their racial background to be an advantage in securing them a fellowship as the primary form of financial aid. Six of the eight minority

students reported that not only did they receive fellowships in part because of their racial background, but they also received more money per year compared to their majority counterparts who received assistantships. Minority students spoke candidly about this perceived advantage:

I would be hard pressed to name one minority student who comes into our department without a fellowship. And because of that you have this thing where minority students are always paid more than the white students, and I mean significantly more. So that could always be a little bit of an issue sometimes. But actually I have to admit that the white students in our program are really nice about it. They don't make it an issue. They don't say anything about it even though they know it. They don't treat you differently, which is admirable because there is a big pay difference between us.

I probably would not have got my fellowship had I not been an African American. I also know it will help me with jobs too. I know that a lot of departments are looking to fill a minority quota but in that sense it will probably help me.

The above comments link to one important issue raised by majority students who participated in this study. One of the minority students above noted that although minority students received fellowships and therefore more money, majority students were "nice about it" and do not seem to mind. However, another minority student reported her perception that majority students in fact minded and did get "a little angry" about the perceived advantage that minority students have vis-à-vis fellowships. This student said:

Sometimes [non-minority] students in the department think it is unfair that certain people are given certain opportunities. A lot of times non-minority students would just be given a TA and that is not as much money as a fellowship because the fellowship pays you in the summer. So that kind of ups how much we make per year and [non-minority students] don't have that so that kind of makes them a little angry. You get more financial aid. The fellowship is only for minorities.

Further, eight majority students who responded to the survey perceived their majority status as limiting their opportunities to receive fellowships, and they also stated that they found it unfair that minority students were awarded fellowships based on their racial background and not merit. Sharing minority students' perceptions that the latter are

avored by fellowships, some majority students expressed frustration with the situation in their survey responses:

It is becoming more and more difficult for people in my situation, a blue collar, White male American to get funding through a fellowship or a grant because there are specific fellowships that are only offered to people of a certain background [minority]. Is that fair or should it be open to all students and the ones that write the best proposal wins?

I was discouraged from applying for a fellowship that I was qualified for. I was told that I wouldn't get it this year anyway and found later that it was used to recruit minority students. This fellowship would have enabled me to have more study time than my [research assistantship] allows for, which would have greatly benefited me as my coursework got harder. I am convinced that if I were a minority student I would have been more likely to receive the fellowship.

The perceptions of the minority and majority students that minority students are more likely to receive fellowships compared to their majority counterparts surfaces in some STEM programs that compete for federal grants that are specifically targeted at recruiting minority students (such as the AGEP, GAANN). Therefore, these programs can only award the fellowships to minority students as stipulated in the grant. In addition, the university's Graduate College may also award some fellowships only to minorities. What was not studied in this study is the distribution of merit-based fellowships from the Graduate College among doctoral students.

In summary, minority students reported that they received a combination of fellowships and teaching and research assistantships. A few relied on student loans and off-campus employment to fund their doctoral programs. Student who participated through interviews reported that their fellowships provided four to five years of funding, including summer funding, and that their fellowships provided two to three years of funding that did not require teaching or research. In addition, they reported that their fellowships required them to work as teaching and research assistants during the middle years of their doctoral program. The survey participants individually reported receiving a teaching assistantship, research assistantships, a fellowship, student loans and utilizing

off-campus employment to fund their doctoral education. Minority and majority students shared the perception that minority students were advantaged as far as fellowship funding was concerned, which at least a few majority students perceived as unfair.

Skills/Outcomes Related to Different Forms of Financial

Support

The survey and interview findings on underrepresented minority students revealed their perceptions about the influence of various forms of financial aid on their doctoral experiences. The five minority survey participants and eight interview participants responded to questions on financial support. In their survey responses three of the five minority students indicated that they agreed with the statement, "I developed research skills" while four of the five students agreed with the statements, "my knowledge of issues in my discipline/field increased," and "my understanding of expectations about my profession increased" as a result of participating in activities related to financial aid. Further, three of the students agreed that their teaching and research responsibilities provided preparation for their professions.

Minority students responding to the survey reported that financial support aided their enrollment and subsequent re-enrollment in their doctoral programs. Four of the five students indicated that they strongly and moderately agreed that they would not have been able to enroll in their doctoral program, and four indicated that they strongly agreed that they would not have been able to re-enroll for the second year without financial aid.

Minority survey respondents also indicated they would encourage their peers to seek financial aid that required teaching or research services. In their responses, three of the five respondents agreed with the statement that they would encourage others to seek financial aid that requires teaching while four of the five students agreed that they would encourage others to seek financial aid that requires research. This may be an indication

that students perceived these kinds of financial aid to be of value to doctoral students.

Table 7 summarizes their survey responses.

Minority students responding to interview questions about the positive or negative influence of financial aid on their doctoral program experiences indicated that financial aid had many positive effects as well as presented several challenges. First, in the interview discussions, all minority students (n=8) noted that having financial aid, particularly fellowships/traineeships, facilitated enrollment into their doctoral programs. These interviewees reported that their decisions to enroll and their ability to remain enrolled were based on, among other things, the availability of financial aid. The following excerpts from the interviews illustrate this sentiment:

I don't think there's any way I would be here if I was paying myself for school. My initial thought would have been that I wouldn't. I don't know if a couple of years later I would have been like, "I think I want [graduate education]" and really tried to create the finance for it.

The [Dean's fellowship] is a four year funding where I don't have to work the first and the last year and the two middle years I have to do RA. And with that my tuition is paid and I get a stipend and I have summer support. I think that was what made me be able to stay in [my department] because it was going to be a hard time trying to figure out the tuition and all this other stuff and because I would be considered out of state 'cause I didn't get the TA-ship.

Four survey respondents who indicated in their responses that they would not have enrolled in their program if they had no financial aid shared these perceptions.

In addition to their perception that financial support facilitated their enrollment and ability to stay enrolled, minority students also perceived financial aid, specifically fellowships, as advantageous in facilitating transition during their first year into their respective doctoral STEM programs. In discussing their transition experience during their first year, for instance, the eight interview respondents reported that the availability of financial aid not only eased their financial burdens but also allowed them to focus on fulfilling their academic requirements for their first year in the doctoral program.

Table 7: Skills/Outcomes Related to Financial Support Packages: Minority Survey Respondents

Statement (Skills/Outcomes)	Strongly Agree	Moderately Agree	Moderately Disagree	Strongly Disagree	Not Applicable
I developed strong research skills	2	1			2
I developed strong teaching skills	1	1			3
I improved time managements skills	1	1	1		2
My knowledge of issues in my discipline/field increased	3	1			1
My understanding of expectations about my profession increased	3	1			1
I developed skills (teaching & research) that I would not have developed otherwise	1	1			3
I received opportunities to conduct collaborative research with faculty	1	1			3
I received opportunities to conduct research with peers	1	1			3
The amount of work required negatively impacted my academic performance		1			4

Table 7 Continued

My teaching responsibilities slowed down my progress towards Ph.D. completion	1			4
My teaching responsibilities providing training for the requirements of my profession		3		2
My research responsibilities provided training for the requirements of my profession		3		2
I would not have enrolled in my doctoral program without financial aid	3	1		1
I would not be able to re-enroll in my program semester after semester without financial aid	4			1
I would encourage all doctoral students to seek financial aid that requires teaching	1	2	1	1
I would encourage all doctoral students to seek financial aid that requires research	1	3		1

These students reported that they were able to focus on their studies and pass their qualifying examinations because they were not required to take up teaching or research responsibilities during this transition period, saying:

The [GAANN fellowship] was great, because I didn't have to worry. I could focus on studying because for the first three years I was pretty much buckled down and studied for, and passed my, qualifying exams in my department. With GAANN it was great because I could just focus on studying and not have to worry about having a second job. It was great. I would say what contributed the most to my [doctoral progress] was GAANN fellowship, that three to five year window where you just concentrate on studying. So what really made the biggest impact for me, right now I am done with classes, just focusing on research. Everything is downhill now and you got the wind at your back now and cruising to the finish line. The first five years are like an uphill battle, trying to get past qualifying exams. I don't know what I would have been able to do without that GAANN.

I am not quite convinced that if I had to teach especially that first year in particular I would have transitioned as well and, you know, even within the first few years would have been able to pass my [qualifying exams]. Because even with the [fellowship] I had to retake [qualifying exams]. I didn't pass them the first time. I passed a couple. But I did have to retake the [qualifying exams] and I was not even teaching and so imagine if I had had additional responsibilities on top of just trying to learn everything.

When I began graduate school, I took two of the undergraduate courses. I just wanted to ensure that I had the background that I needed, just to be sure. I think I was a little bit afraid of not being prepared for my grad school courses here. I think teaching would have been a horrible experience for any student at that time. I mean I was already nervous in my third year but being in the department long enough, for two years, I was like, "Ok I can do this." When I got here, I realized I needed to work harder than I usually did to have the same kind of understanding that I usually had in a course. I also usually like to work alone 'cause I am an independent worker and when I got here, I was like, "I don't really know how to do this stuff. I really need a lot of help." So I had to learn to ask people questions and go to the professor a little bit more. I guess I needed that adjustment period to do that and the time to deal with just managing studies.

Minority students also reported that fellowships provided them with a final year of funding that was free of teaching or research responsibilities, which students perceived as advantageous in allowing them to focus on their dissertation research and writing.

One student explained:

What I am happy about is that in my last year I need to focus on my research. I am going to take this fellowship and focus on that. So I think for the years in between, being a TA would be good for me. I am getting the experience that I need being in the classroom and then be able to focus on my schoolwork the last year.

According to these participants, without the support offered by the fellowship especially during the first years, it may have been more challenging for them to cope with their new environment while getting ready for their qualifying examinations.

Further, students perceived fellowship funding as helpful in facilitating their participation in professional activities such as conferences, student organization activities, and hobbies and other recreational activities. Some students reported how fellowships provided opportunities for professional and intellectual development through conference attendance as well as opportunities for recreation and relaxation. Students' comments below illustrate these other opportunities provided by fellowship funding:

Initially I was on a GAAN fellowship. The way it is structured is that they pay the tuition and so you don't have to worry about that. It is 26,000 per year for three years and then it goes to 28,000 over the last two years. In addition to that the college has a fellowship that offers 10% of the cost of that fellowship as a discretionary fund to buy books and all kind of relative aid, go to conferences, trips, and do anything that you can justify that actually adds to the value of education or increase the aptitude of your education. I was able to use my discretionary funds to go to [conferences] where I could rest, relax, and get away from it. So there I could recharge, do my business, go and give a presentation, meet people and do all things that I do at a conference before I came back. And I didn't strain financially to do it. So if you can negotiate or navigate your way in that aspect and make sure that every asset that they give you actually becomes an asset and not a liability.

I have been very fortunate. Since I have gotten here any conference I have wanted to go to I have received funding for, which is not common. It's becoming common now since we got the VIGRE grant since my third year here. When I first got here there was no money at all for traveling if you didn't have a fellowship. Now if you are TA you have to apply for the VIGRE grant or our department and they will either say yea or nay and either give you money or not depending. But before then there was none. A TA would have to pay from their pocket unless the conference itself was funding people.

Although minority students perceived fellowships as advantageous for the reasons described above, some also perceived them as presenting challenges. One of the

perceived challenges that two of the minority students reported was that having a fellowship limited their teaching opportunities. Although only two students expressed this sentiment it is important that these two students felt that they needed more teaching experience. These students explained:

I guess the only drawback is less teaching on the funded years. I mean that's the only drawback that I can think of. The [department] gave me an incentive for a summer and a semester of VIGRE [fellowship] but that was, I didn't like that because I had one less semester of teaching experience. I don't think people in [my department] see [fellowship] support as good when they have to have a resume full of teaching experience.

I did teach at [a local community college] for one semester and I didn't do it for the money but for the experience of teaching. That's the downside of having a fellowship like that because you don't get that teaching experience. I've taught at [this department] for maybe a semester but I didn't really have a course. I was a TA where I graded papers and stuff like that. [The community college] gave me the opportunity to make my own syllabus. I was in charge of my own class and I graded. I felt that I could figure out whether I wanted to go into teaching. I know that one of the stipulations of the GAANN fellowship is that you have to teach for a semester but your teaching may not be teaching. It may be a TA-ship where you are grading papers or just having office hours.

Minority students also discussed perceived benefits and challenges of teaching assistantships (TA). They identified two types of TA work requirements. In one type, a professor assumes the key role of instructor and the teaching assistants assume a supportive role by grading papers, administering tests and quizzes, and holding discussion sessions to go over homework problems with undergraduate students. In the second type, the teaching assistants assume the lead role of instructing lower level courses under the supervision of a professor. While all the interview respondents indicated that they had held the first type of teaching assistantship, only four of the eight indicated they had done the latter type of TA work.

Teaching assistantships as a form of financial support had perceived merits as well as challenges. The single most cited benefit of teaching assistantships by interview participants was the teaching skills acquired for entry into careers in academia and an

understanding of the expectation and requirements of teaching. Respondents described these experiences as follows:

The advantage of TA-ing is that it gives you an idea of what you are headed for. Because most people in our program at least, will end up being professors somewhere whether it's a liberal arts or something. [People in the other program] may go into industry or government type thing. And generally if you are going to teach high school you are going to need math education as opposed to this. So usually you are going to be a professor somewhere. How can you expect to get a job as a professor, even at a liberal arts college, if you have never stepped in front of a classroom? That's unreasonable. So you need to have [teaching] experience.

As a TA [the department] gives you your guidelines of how many hours you are supposed to spend doing what. And if you allow yourself, people will let you go on if you don't call attention to it. Like I was supposed to spend eight hours grading according to the guidelines but last week I spent six hours on one class. So I must have spent at least five hours on the other class so I must have spent at least eleven hours grading when I was only suppose to spend eight. And, as a matter of fact yesterday I had two of my office hours and I didn't look at the time and I went over by forty-five minutes on my office hours. So you can see how it creeps up on you if you let it. So if you are not used to being a TA, creating those boundaries 'cause student like to pop by but you have to let them know, "I am here physically but my time right now is dedicated to doing something else. I appreciate that you have a problem but see me during my office hours or send me an email and ask if you can make an appointment but don't think that any time you have free time you just show up and I happen to be there means it is your time." Creating those kinds of lines, which, again, is important 'cause as a professor you have be able to do the same thing. So it is learning those skills.

The above reports show that students perceived teaching assistantships as a means through which they prepared for teaching careers and through which they acquired other professional skills such as knowing how to balance the requirements of teaching and meeting their students' needs. Two students also noted that their teaching experiences allowed them to get away from their graduate work by doing something they enjoyed.

Other students noted that the benefits they perceived from their teaching assistantships served other important purposes as well. Two of the minority students perceived teaching assistantships to be helpful in facilitating learning of lower level course material that they needed for their comprehensive examinations and that they had

not taken during their undergraduate coursework. These students reported that as they taught the courses they learned the material by reading the books and consulting with professors and thereby got ready for their comprehensive examinations. Students described this perceived benefit thus:

I was a TA and sometimes I even volunteered to be a TA. The advantage was that some of the courses that I had not had and I needed to know the content in those course and to prep for my qualifying exams. So for me I used it as a means to prepare for my qualifying exam.

A lot of times I TA-ed simply because it was a class that I was interested in. So I was like, if I TA [the class], that was my way out of taking classes. Essentially you get a private tutor, so you know you read and go on as you wish and the professor comes and help to fill in the gaps. Which normally a professor would not help to fill the gaps along the way but since they are filling your gaps you are filling the gaps for the twenty or thirty students in a class. And I say you know what, that's a much better way because you get a free tutor.

While some of the minority students perceived teaching assistantships as opportunities to facilitate a deeper understanding of course content that they required for the doctoral program, others perceived teaching assistantships as facilitating acquisition of teaching skills relevant for their careers in the professoriate. Four survey respondents who indicated that their assistantships or fellowships contributed to their understanding of the expectations of their professions share this latter perception by agreeing with the statement, "My understanding of expectations about my profession increased."

Teaching assistantships came with some perceived challenges. The most cited challenge was the amount of money teaching assistants received compared to other forms of financial aid. Four of the five interview respondents perceived having a teaching assistantship as taking a "pay cut." This perceived demerit according to these participants, however, did not override the perceived benefits of teaching experience. Another drawback of teaching assistantships that one minority student cited related to the nature of the work requirement of a TA. This was unique to one student who reported that although teaching experience was one of the requirements of the GAANN

fellowship, the teaching assistantship that was available did not provide the actual classroom teaching experience that the student desired but rather focused on grading papers and maintaining office hours to answer students' questions. This particular student reported having to seek teaching experience, which involved developing syllabi, teaching, grading, and the entire spectrum of teaching responsibilities at a local community college.

Minority students also perceived research assistantships as beneficial to their doctoral progress. Two of the minority students who had received research assistantships discussed the perceived benefits of research assistantships. In their interview responses, one of the students stated that research assistantships provided hands-on research skills in preparation for doctoral research. In addition, research assistantships provided other non-academic experiences such as equipment and materials procurements that prepared participants for careers in industry. One of the minority students reported:

RA-ship is good too because it's the only reason you are in grad school anyway. That's going to help you get that degree. You need to do that research. So the RA-ship allows you to focus on your research rather than working on a second or third job making ends meet. It gives you access to your professors and research facilities. I've learned a lot on how to use a lot of research equipment and having to talk to vendor; order new materials and parts you need in the lab. So I have been gaining that experience [including] procurement of materials and new research lab skills and equipment, digging through research journal articles, and sitting around the table and having weekly meetings to discuss different things.

The student perceived a research assistantship as beneficial in providing financial support and also in providing opportunities for immersion into the dissertation research, proving skills relevant for working in a laboratory set up, and acquiring team skills in a laboratory setting.

Summary

Forms of Financial Aid

Overall, most (ten of thirteen) minority doctoral students who participated in this study reported that they received institution-based or federally funded-fellowships as they entered into their respective Ph.D. programs. Further, in the years following the first year, some received teaching assistantships while others received research assistants. Only two students reported funding their doctoral program through loans and off campus employment. In addition, students received a number of different types of financial support in the course of their doctoral program: four received three forms of financial support, five received two types, and four received one form of financial aid in the course of the doctoral program. Although some participants reported only one form of financial support, it is likely that they will receive additional forms of financial support before completing their doctoral degrees.

Further, minority students who received fellowships revealed that the fellowships facilitated their transition during their first year and their focus on their dissertation during the final year by requiring no teaching or research services in these years. Students reported being required in the second, third, or fourth years to have teaching or research responsibilities in their respective departments. The number of years or semesters requiring no teaching or research varied from student to student based on the fellowship they received.

In addition, interview findings revealed that students rank financial support types by how "lucrative" they are, basing the ranking on the amount of money they receive per year. Thus, minority students perceived fellowships from federally funded grants to be the most lucrative with the highest pay, followed by institutional fellowships, and then departmental teaching and research assistantships. Although the latter ranked last on the

scale of best to worst paying, students perceived them to be valuable in equipping them with various skills necessary for their careers.

Last, minority students' interview responses revealed that some of the students perceived their minority status as increasing their likelihood for fellowship funding. Six of the students perceived their minority status as advantageous in the award of fellowship funding compared to their majority counterparts. This perception was also expressed by eight of the 73 (11%) majority survey respondents who perceived their race (or being White) as a limiting factor in their eligibility for fellowships.

Skills/Outcomes Related to Different Forms of Financial Aid

Minority students perceived financial aid as beneficial to their doctoral progress, with some variation among the different forms of aid. Overall, minority students perceived financial support to be helpful in enrolling and remaining enrolled in their doctoral programs. Most survey and interview participants ($n = 12$) noted that without financial support, it would have been difficult to enroll in their doctoral programs.

Three of the five minority students who responded to the survey and most ($n = 5$) of the interview respondents reported that financial aid equipped them with teaching and research skills and increased their understanding of their professional expectations. Students perceived teaching assistantships as beneficial in preparing them for careers, providing a better understanding of career expectations and requirements, facilitating the acquisition of content knowledge in required courses, and equipping them with time management skills. The only perceived disadvantage of teaching assistantships was the lower pay scale they provide compared to fellowships.

Minority students who reported receiving research assistantships perceived them to be helpful in providing laboratory experience including material procurements and

equipment use as well as equipping them with research skills and experience relevant for the dissertation process.

Chapter VI discusses the findings of this chapter in the light of literature and theoretical perspectives presented in prior chapters.

CHAPTER V

RELATIONSHIPS

This chapter describes underrepresented minority students' relationships and interactions with faculty advisors and mentors and with doctoral peers and the perceived influence these relationships have on their doctoral experiences and progress. The first part this chapter discusses student-faculty relationships and interaction. The second part describes minority students' relationships and interactions with their doctoral peers. The last part describes other relationships that emerged from the findings.

Student- Faculty Relationships

In response to the question about the benefits or value of having an advisor or a mentor, participants reported several roles played by their advisors and mentors that facilitated their progress towards doctoral degree completion. Minority students' survey and interview responses suggested three perceived roles of faculty, namely, academic advising, career/professional development, and social support. Further, minority students perceived the roles of mentors to be similar to those of advisors. The main difference between mentors and advisors, according to four minority students in the interviews who had both an advisor and a mentor, is the selection process and the role each played. Hence, students selected advisors based on the extent to which their research interests matched those of advisors, while programs assigned mentors to students at the beginning of their doctoral program or students selected faculty that they perceived to be approachable and friendly as their mentors. In addition, students defined the key role of advisors to be closely linked to their dissertation research while that of their mentors was not as clearly defined.

Below I describe the roles of advisors and mentors and their perceived influence on minority students' doctoral experiences.

Faculty's Role of Academic Advising

Minority students perceived academic advising to be important to their doctoral progress. Five of the eight interview participants reported that the academic advising role involved guidance on research, advice on course loads, advice on course selection, and provision of supplemental materials to enhance learning. Survey respondents reported similar perceptions of the roles of faculty members. Four of the five survey respondents reported that their advisors provided guidance with coursework as well as in the general planning of courses and deadlines pertaining to academic requirements. Below are a few illustrative comments about the perceived academic role of advisors:

I am taking one course and it's one seminar broken down into three topics and so I have had a lot of readings. My [advisor] has given suggestions for the class, he just wants me to learn the overview and so he is like, "Try to work the exercises but don't let it take all your time. It's fine if you do it but if not just get the overview." And if maybe there is one area that I need to review, he's given me a book and many references on where I can go to review that information. So I think he's given me advice on how to manage all the readings. And the other students who work under him are good to talk to as well.

My faculty advisor has helped with advising in the classes that I am taking.

I have had positive interactions with my academic advisor. She has generally provided good feedback on my handling of my schoolwork and other professional issues. My faculty advisor has had a very positive impact on my academic success.

Further, students reported that their advisors provided guidance on dissertation and research activities, saying the following about their perceived value of this kind of academic advice:

For right now just advice on the writing aspect. For my dissertation [my advisors] were hands off so they just told me to go write everything I needed and then we sat and painstakingly corrected page by page to try and make sure everything was in place. That aspect of it has been helpful

[My advisor] is definitely more supportive and gives more guidance. We are basically solving real [applied research] problems doing real research and development. I feel like I am doing real work. And he's just not saying, "Here chase this for a

while," or when this doesn't take you anywhere he says, "Alright let me yank you over here." He is not doing that. Everything is really driving towards a common point. Everything is being connected.

In addition, students reported other types of academic advice that they perceived to be of value to their doctoral success. Two students reported that their academic advisors helped them with planning their coursework:

Time management is a problem for me. Having my advisor setting clear deadlines helped

My advisor has a meeting with me at the beginning of the new semester to tell me what to expect during the semester.

Overall, minority students perceived their advisors' role of academic advising to consist of guidance on research, advice on course loads, advice on course selection, supplemental resources to enhance learning, course planning, and meeting required deadlines.

Faculty's Role of Professional/Career Advice

In addition to providing academic and research advice and assistance with planning of coursework, four interview respondents reported that advisors also socialized them into the science disciplines and professions. Some examples of the kinds of interactions or training that students reported include guidance on how to navigate professional meetings and conferences, guidance on career expectations and requirements including writing employment applications, navigating the career world, preparing for the tenure process through research, and preparing manuscripts for publication. In the interview excerpts below, minority students explained the role of faculty in preparing them for careers in science:

Whenever I go to conferences [my advisor] says, "Here is what I want you to get out of this person. So here is how I coax a person out to a comfort level so that they can give me the information that I want." As far as information gathering, one of them has taught me that. The other [advisor] has taught me how to navigate the business aspect and to figure out what is the next big product and where would you like to take science. How I can intervene to get a niche research area. So between the two of them I have learned

how to gather information so that it helps me in the long term with the project and to figure out how that project fits the company business focus. So it's a dichotomy

My advisor said to me, "As of now, all your work has been collaborative which is expected because you are a student. But eventually you want to get tenure and a lot of times if all you have done is collaborative, people start to ask questions like "How do we know if this person has really done any work? So some point in time you want to make sure that you do something that has only your name on it so those kinds of things don't come up." It is a good thing to think about. It probably wouldn't occur to me at this stage but it needs to be in my head just so that I know. So he is thinking about my career in that way.

Actually with my second advisor everything down to deadlines is valuable. I have a paper that I must write by the end of September and be submitted so that it can possibly be accepted by the time they read my first job application in November. I mean I don't know these deadlines but [my advisor] does. So [my advisor] is invaluable because [she] tells me deadlines that I cannot look up anywhere. [My advisor] teaches me things that are not in the class like what is a teaching statement? What is a research statement? How long are they? There is no class for that and she connects me to her friends who are experts, networks.

Now that I am writing manuscripts, it is easier 'cause one advisor is more adept at writing manuscripts. He was an editor of multiple [journals] so I can just sit down with him and figure out where to put stuff in. And since he's been editor for four of them, I can figure out why I would put something in one journal as opposed to the other and how the act of putting it in one journal will affect my career long-term or short term. Is there any better way to put it in a journal, like if I were to put it in a review book is it better than a journal? So all of these interpersonal career growth type things I am able to figure out on a one-on-one basis.

Minority students who responded to the survey shared similar perceptions that faculty advice relating to professional or career development was important for their doctoral success. Three students indicated that career advising by faculty advisors was very important and two indicated it was moderately important to their doctoral success. Further, four students indicated in their survey response that their advisors' willingness to share opportunities for professional development was very important and one indicated it was moderately important for their doctoral success (See Table 8).

Faculty-Student Social Interactions/Support

In addition to the perception that faculty members' relationships with students involved academic advising, assisting with course planning, and socializing students into the science disciplines and professions, minority students also reported that advisors provided social support. The survey responses indicate that four of five minority students perceived their advisor's interest in their personal welfare to be "very important" and one indicated that it was "moderately important."

Further, in their survey response to a statement about the level of importance of social interactions with advisors, one student indicated it was very important, while three perceived it to be moderately important to their doctoral success. One indicated it was "not at all important" (See Table 8). Three interview respondents who reported this kind of interaction or relationship with their advisors said that it built rapport and built encouragement and confidence:

Basically [my advisor] gave me a support system because there are things that I was uncomfortable with. It was almost like counseling. I could talk to him about anything that was going on in the department and be honest with him. And sometimes things got really stressful, if I needed to I could always talk to him. I did not have to front as is everything was going good all the time. A lot of time you just need to vent and so he provided that ear for me to vent and of course, with his experience as a graduate student himself and working with a lot of grad students, he was able to provide me with valuable insight and to let me know that a lot of people who are successful now struggled when they were in grad school or they struggled when they were where I am. And so that kind of helped me with my confidence and knowing that it was going to be ok. Had I not had that I would have been done with it.

Occasionally my advisor invites me to go [for recreational activities]. And we bring family in for family get-together and things like that. But when we do actually get to work, we are able to agree to disagree. And I think it is mutually beneficial because we have to step back and figure out where the other person is coming from.

By showing understanding of some of my limitations, [my advisor] helped me overcome self-doubt.

Table 8: Minority Students' Perceptions of Faculty-Student Relationships

Faculty/Student Relationships or Interactions	How Important are the following advisor characteristics for your Ph.D. success?				To what extent have you experience these attributes in your Ph.D. program?		
	Very Important	Moderately Important	Moderately Unimportant	Not at all important	Always	Sometimes	Never
Faculty Accessibility	5				3		
Open and honest communication with faculty	5				3		
Trust between student and advisor	5				3		
Advisor approachability	5				3		
Advisor's interest in students' personal welfare	4	1			2	1	
Advisor's willingness to share opportunities for professional development	4	1			2	1	
Career advising by advisor	3	2			2	1	
Informal (social) interactions with advisor	1	2	1			3	
Advisor treats students as a junior colleague	2	2	1		1	2	

Overall, minority students identified three roles that their advisors play in their doctoral studies, namely, providing academic advice, providing career and professional guidance, and providing social support.

The Role of Mentors

Minority students who reported having a mentor ($n=4$), identified two perceived roles of mentors: one, facilitating a smooth academic transition from undergraduate to the doctoral program and two, providing career advice and training to students at the more advanced level of their doctoral program. In facilitating students' transitions, mentors for instance, recommended courses and gave students tips on how to understand the discipline. Below minority students describe the role of their mentors:

The first year I am sure I was like every other mentee that [my mentor] had. What he does is he calls you into the office and he talks about [the discipline] for a while. He helps you figure out what classes to take if you need to take undergrad classes to supplement what you don't know. His strong suit is that he helps you to really understand what it means to learn [the subject]. A lot of the problems when people transition is that they think they know something and they will say they know it and they don't really understand what it means to know it. And that's the thing he helps to break down. He says, "You say you know it, prove it to me. Define it. If you can't do these things from off the top of your head when I am asking you, then you don't really know it." And getting to that point when you can understand these ideas and not feel broken, 'cause a lot of people feel broken at that point and want to quit, you have to realize it and figure out if you want to put the time and dedication in to getting past that and truly learning it and then moving forward. And so that's what really the first year with him is like.

My first few years I would see [my mentor] around the department and he would always remind me to come to his office and speak with him. I even talked to him about how to go about finding an advisor, like going through the process and telling me what I should do and just sent emails to people and ask them about their research. I did that with him first and then I did that with somebody else. Also I talk about my progress in the program. So he's always been encouraging. Sometimes I feel that I am not as far as the other students in my class because a lot of the classes that I take, I took them one year after [other students in my cohort] since I started off with two undergrad courses. I actually feel like I am more on the level of the class after me because those are the people I actually took a lot of my graduate courses with. So

whenever I would talk to [my mentor] he would say, "That is fine, you can still get done in enough time." And it's not a problem so I am encouraged that I can do that and I can still finish the program in good time. He is somebody that I would see just like in the department and he would always remind me to come to his office and to speak with him about anything.

In the interviews, some minority students reported that they perceived some interactions with their mentors as having negative outcomes. In one case, for instance, one student perceived his/her mentor to be discouraging and in another, the student reported disagreeing with the mentor's advice about coursework. These two students described their experiences below:

When I first got here after I got my first master's degree [my mentor] said, "Maybe that's enough. Maybe you should go back where you came from and just teach there." Or he would say, "I see you are hanging out with such and such you are not serious enough about your education." I think he has been the most discouraging, like the worst. I don't think anybody has really been as bad as him. It got really bad at one point where I would leave his office in tears because I would be so discouraged and I was like, "I can't make it. There's no way in the world." At one point I was like, "Maybe I need to go to a therapist." It was just crazy. I stopped interacting with him. He's my mentor on paper.

When I came to [this university] my mentor had me do one year of undergrad classes that I have already taken and I am thinking, "Is he not thinking that my undergrad was good enough, that's why he had me take those classes?" I was so frustrated because these were all undergrad. My second year I started doing graduate work and then my third year they started yelling at me, saying, "Why haven't you done your comps?" And I was like, "Because my first year wasn't useful, hello!"

The above students, both of whom had advisors, perceived their interactions with their mentors to have a negative effect on their doctoral experiences. The first student reported that she experienced emotional stress due to her perceived negative interaction with her mentor, and therefore limited her interactions with the mentor, while the second student reported feeling frustrated because her mentor required her to take remedial courses, which she perceived as unnecessary. There was insufficient data in this study to determine the extent to which advisors and mentors collaborated in the advising of minority students.

Overall, the four students who had mentors reported several roles of mentors that they perceived to be important including academic support in the initial years as well as providing career related advice during the more advanced years of graduate school. Two students reported some negative interactions with their mentors. Overall, however, students perceived their mentoring interactions to be beneficial to their doctoral experiences.

The Nature of Student-Faculty Relationships

In addition to the perceived roles of faculty advisors and mentors described above, minority students' interview and survey responses reveal that students perceived other aspects of their relationships with their advisors as both positive and negative. In the survey responses, all five minority respondents perceived faculty accessibility, open and honest communication with advisors, trust in the relationships, and advisor approachability to be very important to their doctoral success. Similarly, in interviews, minority students identified several characteristics or traits that they perceived to be positive and desirable in their interactions with advisors/mentors and that made them feel at ease to discuss their concerns. The traits include approachability, availing time to students or being there to answer students' questions, and understanding students' academic and professional needs. Interview excerpts below illustrate these qualities:

[My advisor] is great. He is around, he is approachable, and if you have any question about anything, he is always there to answer them. He is just a good guy to talk to and have around. He is not like other experimental ones that leave their students to their own devices in the lab. He is actually in there.

With my advisor, we understand each other. He understands me probably a little better than I understand myself [academically]. He knows how to talk to me. He knows exactly when I am confused I get a certain look on my face. He knows what I am thinking, what my questions is and where I am confused and can explain to me what the problem is. He understands how my brain works which is amazing because half the time I can't verbalize what is wrong but he understands literally how I think. The other thing about him that I absolutely love is that he holds [all his advisees] to the level that we want to be held to. What I mean by that is I made it very

clear to him early on that I want to be trained to work at a research institution. There was another student who started at the same time as me, who explained to him that he wants to teach at a liberal arts school. So he doesn't treat us the same. He holds him to the expectations of what he needs to accomplish in order to work at that type of school and he holds me to the expectations of what I need to do in order to be able to get a post-doc so that I can work at a research institution. So the way he treats us is completely dependent on what we have expressed to him that our goals and desires are.

Other qualities of advisors that students perceived as positive and desirable relate to being knowledgeable or an expert in one's field and having a good track record in research and in graduating doctoral students. In response to a question about desirable traits of an advisor, two students said:

I guess being knowledgeable and an expert in his field like on his papers that he has written and his previous students and how successful they are. He speaks of them as though they were very shy and reserved people when they were in grad school and I am like, "Ok I have hope." But I think I like people who know what they are doing and what they are about and not necessarily trying to figure out what they are doing while they are doing it because then you get lost with that person.

[My advisor] has a better track record as far as graduate [students in the discipline] and as far as doing research. When dealing with advisors here's the first thing you want to know. You want to know his or her track record, how long they have been in the university and how many students have they graduated.

The interviews further reveal that minority students perceived some advisor-advisee interactions as negative and detrimental to students' degree progress. For instance, one minority student perceived his advisor as not interested in the students' research development. This student shared his story about his interactions with his advisor and the perceived negative effects it had on his progress:

When I joined my [first advisor's] group he never made any time to talk about his project any kind of research topics or anything that I could work on. He pretty much saw himself more as academic advisor but he said, "Take more of these classes, take these, take that." And outside of research group meetings, whenever I scheduled time to go and talk to him he always seemed like he was kind of rushing and rushed me out the door. So I hang around that guy for almost two years and the summer of 2008 I decided that this is going nowhere, the guy is showing no interest in helping to develop me into a Ph.D. I've seen him take in new students and

give them projects right away and they are off to the races doing projects and me on the other hand, he would give me a thousand page book on [topic] and he would say, "Go and read that and we will talk about it." He wasn't a guy who had my best interest at heart at all. Had I been able to read people I would have been able to quickly come to a conclusion by summer of 2007 and would have switched the guy to the one I have now.

This student perceived his slow progress and the loss of two years of his doctoral progress to be due to a lack of interest by his advisor. Another student, under slightly different circumstances, described his experience with his advisor as follows:

My [advisor] left in the middle of my research, towards the middle. I had to throw away everything that I had done basically and start from scratch with someone else. I mean I think that is no big deal, you kind of have to do what you have to do you know. I am glad that I didn't complain. 'Cause what can you do by complaining about it anyway? You kind of feel bad for a while or attribute everything you haven't done to that one event.

Although this student could do nothing about his advisor's departure to a different college and although he reported that he took it in stride and did not "complain," he also reported that he had to play "catch up" to compensate for his perceived setback.

In the discussion of desirable and positive advisor or mentor qualities and traits, no minority student brought up the issue of faculty of color. This topic was not explicitly addressed by an interview question. It is impossible to know whether being mentored and advised by majority rather than minority faculty was not an issue for this group of minority students or whether it was an issue that needed to be prompted by a specific question before students discussed it. Because this study did not establish how many minority students were mentored or advised by minority or majority faculty or the extent to which having a majority or minority faculty mentor or advisor mattered to minority students, there is need for further research.

The Evolving Nature of Student-Faculty Relationships

One observation that minority students made in their interview responses is that they perceived their relationships with their advisors and mentors as evolving over time. Four of the interviewees who were in their final years of their doctoral programs,

reported that at the start of their relationship, mentors and advisors treated them as "students" who needed training and guidance. With time, students noted that this relationship changed to a point where the advisor or mentor treated them as junior colleagues, gave them more responsibilities and encouraged them to be independent researchers. Students mostly in their last years of the doctoral programs describe this perceived relationship as follows:

What has changed is just that at [beginning of the program] I was a student trying to learn the material. Now my [advisor] is training me to be his equal. So as time passes on, the level of expectation of course rises but now he's trying to give me more confidence in what I do. He calls it ownership. When you are studying material written in a book it's not yours and you are not discovering anything new. But now he is trying to really push for me, when I do research, to say it's mine, to own it 'cause I am not big on that. It doesn't occur to me to think of something as mine and so he is trying to get me far more into the research community I guess. 'Cause you can't get noticed without promoting yourself. I have never really been an advocate of self and he is really trying to help me into that 'cause he knows that's what I want, he knows that's what I need to do and it doesn't come naturally for me. So that is the way our relationship has changed.

[My advisor] was scheduled to speak but she was [unavailable] and so I didn't know when I was going [to the conference] that I was speaking with the experts and I took her slot. There were no graduate students. So that was a good thing. She just sent me to take her place and I got to speak about our joint work so that would never have been able to happen yet. That's what happens during my post-doc afterwards, as a colleague actually as a post-doc.

When I started off it was [my advisor] being right most of the time and now it is kind of come to the point where I am starting to get a little bit.

One student noted that this treatment by faculty helped build self-confidence as she moved from candidacy into the research phase of the doctoral process.

In summary, minority students reported three roles played by their advisors namely academic advising, career and professional development, and social support. Further, minority students perceived interactions characterized by approachability, availability, and open and honest communication as desirable and beneficial to their progress while they viewed an advisor's perceived lack of interest and perceived

discouragement of students as detrimental to a student's doctoral progress. In addition, minority students in their final year(s) of their doctoral program reported that their relationship with their advisors had evolved to one of mutual respect.

Peer to Peer Relationships and Interactions

Several themes relating to minority students' interactions with their doctoral peers emerged from their interview and survey responses. These are academic interactions, social interactions, interactions among minority students, and gender relations.

Peer to Peer Academic Interactions

In their survey and interview responses, minority students reported that they had numerous academic interactions with their doctoral peers. All five of the survey respondents and five of the eight interview respondents reported that they perceived academic support from peers to be important. Specifically, in their response to survey questions that asked them to rate the importance of several types of peer interactions, the five minority respondents indicated that peer academic support (including study groups) and academic advice on coursework and feedback on academic work by peers were important for their doctoral success (see Table 9).

Further, five of the eight minority interviewees and four of the five minority students who responded to the survey's open-ended question reported that they perceived academic advice and support from their peers to have a positive impact on their academic success. These nine students reported peer study groups as the most common form of academic support that they got from their peers. These students gave examples of academic related activities in which they participated within their peer groups, which include studying for examinations, discussing assignments and projects, discussing journal articles, and sharing resources like books and journal articles. Excerpts from the interview and survey responses illustrate this aspect of peer interactions:

This is going to sound probably like a dream but our year was really a dream. It was harmonious. Every one studied together in the first year, which is the hardest year 'cause we had to prepare for the master's qualifying exams after the first summer. So the first year we had to study together and most of us did it till midnight together in the [department] offices and collectively, and every one would go to a bar a couple of nights a week. There was no competition between any two people in our year. I heard that it's not often the case in math. But our year also did better than most other years collectively.

In [my department] we did have some Asian folk whom we worked with. We pretty much worked as a team in [the department] because sometimes the class breaks out and they would break themselves into groups and have a group project so that kind of encourages you to work together even if you don't know each other. I guess that was some part that was good. For the most part the [peers] in [the department] have been very supportive and I don't know if it is necessarily supportive in the sense of encouraging but focused; focused on getting it done.

The social interactions with peers as well as academic interactions have created a positive atmosphere to enjoy my research work. The peer groups allowed us to interact in reading and understanding science research publications.

In the above excerpts minority students reported some positive outcomes of their academic interactions including a positive learning environment, better academic performance, and learning from each other.

Social Interactions

In addition to academic interactions, minority students also reported social interactions with and support from their doctoral peers. In their response to the survey question about the importance of peer social support, two minority students indicated that social support was very important while two indicated that it was moderately important for their doctoral success. One student indicated that social support was not at all important for his/her doctoral success (See Table 9).

Further, five of the eight minority interviewees and one of the five minority students who responded to the survey's open-ended question reported that they perceived social support from their peers to have a positive impact on their academic success.

Table 9: Minority Students' Perceptions of Peer to Peer Relationships

Peer Interactions	How Important are the following peer characteristics for your Ph.D. success?				To what extent have you experience these attributes in your Ph.D. program?		
	Very Important	Moderately Important	Moderately Unimportant	Not at all important	Always	Sometimes	Never
Peer academic support (e.g., study groups)	3	2			1	2	
Peer social support	2	2	1		1	1	1
Peer academic advise (e.g. coursework, critique of work)	3	2			1	2	
Peer advice on departmental policies/practices	2	3			1	1	1

Students who reported receiving social support from their peers gave examples of support in the form of friendships, encouragement, and participating in social activities with their peers. Some descriptions of their experiences with peers are included in the following quotes.

I know my [peers] have been a big help 'cause usually when people ask me about [this university] I say, "Well school is kind of hard and everything but I have a good group of friends that I can hang out with." We just don't do [academic work] all day; we do things in the social setting where we get to relax and have fun. It's a very good group of friends. We sometimes get together and watch a movie or go to an event on campus. Go out to eat or hanging out. It helped me feel like I had a life here. That it wasn't just about school, that I wasn't doing school all day, that I was still trying to have a balance and have fun every once in a while. I can't go too long without doing something to relieve my mind from academic pressures.

By far our department is interesting. It seems everyone invites everyone into his or her personal things. Like some of the guys were going [for a recreational activity]. They are like, "you should come." I said, "I don't feel like going." There's always someone willing to do it. It is very inclusive and I guess the more the merrier type of attitude. Then there are departmental picnics and we have our own unofficial picnics, where we go tailgating and essentially most of the department is there so it turns into a departmental thing but the university is not paying for it. But we will have our [team] shirts on and we go to the games together. However much you choose to be involved in you can. Once you get from the social events to the class, you find that you end up grouping with the same people you were in social events in. You find that everyone leaves class and goes to study together and read together.

In the department, as we started doing homework together, we started becoming friends. And every Friday after seminar we would go out together. So then it became like a tradition. We would go out on Friday and the older students would start to come and we'd get to know everybody. It became this thing that every year the first Friday of each semester we take the first years out. And now it's the tradition. And then we formed a first year buddy program. So in addition to having a mentor, every first year has a buddy, an older graduate student, so that if you have things you want to go to them about, you know you have somebody who is going to listen off the bat when you come.

The above excerpts reveal that students' perceived interactions with peers to not only provide friendships and relief from academic work through social activities but they also

created rapport among students, allowing for the formation of study groups. Further, as one student reported, a "buddy" program emerged from student social and academic groups whereby students who had been in the program longer mentored incoming students.

Minority students also described the importance of department or program-initiated social activities. Two minority students who talked about this aspect of peer social support reported that fellowships such as GAANN and the institution's minority office organized social events for all minority students. Both students perceived these organized social activities as useful in providing minority students with a forum where they could meet and interact with other minority students. The two described their experiences as follows:

I think the other thing was a lot of the GAANN peer support. We had other people that weren't from [this state], a group of other people that kind of understand where you are coming from. Someone you can talk to and kind of go haywire and crazy with them.

I felt like the ethnic inclusion program and the other program was useful in giving me that social part of being in school.

In general, these students perceived program- or fellowship-organized social activities as useful providing support.

Other Important Interactions

Minority students' interview responses revealed that their interactions and relationships with faculty members and with peers were influenced by their educational backgrounds and by their gender. Below I discuss two emerging findings from minority students' interview responses, namely interactions among minority students and gender relationships.

Interactions among Minority Students

One aspect of minority students' interactions that emerged from interview responses pertains to the type of undergraduate institution they attended and the effects of this background on their transition into and experiences within their doctoral programs. Specifically, four of the minority students who reported attending Historically Black Colleges and Universities (HBCUs) discussed the issue of undergraduate-doctoral transition. While two of them perceived the transition from a HBCU to a Predominantly White Institution (PWI) to be challenging, two others found the transition process to be easy. For example, one student described her transition from a HBCU to a PWI as being challenging because she perceived the PWI as a bigger department and less diverse than what she was used to. This student also perceived people at the PWI to be less friendly and more competitive compared to those in her masters' program. An excerpt of the interview discussion illustrates this student's perceptions and comparisons of the two types of institutions:

Well, [my undergraduate university] is a historically black college so my transition wasn't as big from [undergraduate university] to [PWI master's university] 'cause I guess [PWI master's university] is a smaller school, a smaller department. It is a lot more diverse. And my transition from [PWI master's university] to [this university] was actually harder because it was a bigger department; it's not very diverse, well I guess it's diverse compared to other departments but not anywhere near what I am used to so that was a bigger transition.

[What made it difficult to transition?]

People weren't as friendly. People were a lot more guarded. People think people are competing against each other, which at my masters' program wasn't the case at all. In my department, I hate to say but, there's two sets of minorities. There's minorities that went to HBCUs so we are not used to communicating with non-minorities as much. And then there's minorities that went to majority schools. So [for] minorities that went to majority schools it's an easier transition for them so they do a lot better. Whereas the minorities that went to HBCUs, most of them are gone and maybe one or two leave every year.

[What specific things make them leave?]

You are not invited to any of the study groups because they don't think you are as smart as they are. And you know what I think is funny is the black people that went to majority schools are the ones who think that you are not as smart as them. It's not the non-minorities. So I think they kind of get the ball rolling.

This student not only perceived her transition from an undergraduate HBCU to a doctoral program at a PWI to be challenging but she also distinguished between minority students from HBCU and those from PWI origins. She explained that while the HBCU minority students experienced difficulties fitting into the current institution's majority culture, those from PWIs transitioned easily. Further, the student reported that part of what made the transition challenging was being excluded from study groups, by majority students as well as by fellow minority peers from PWIs because the latter perceived minority students from HBCUs to be less qualified academically than them.

This same student continued on to draw comparisons between her interactions with peers at her HBCU institution and the current doctoral program, observing that her interactions with majority and minority peers from PWI backgrounds were discouraging while those with peers in HBCUs were supportive and affirming:

I think part of what makes me feel a little uncomfortable is that I am not as used to people being so full of themselves and I am not used to dealing with people like that. I am used to people trying to uplift you instead of people trying to pull you down and I think that is kind of an HBCU experience because the black students that aren't a part of that culture, they are not used to that and they are just as boastful as the white people. I guess in my environment I am used to people always trying to lift you up and they are not like "Look at what you got wrong." They are like, "Look at what you did right" and "let me help you work on what you got wrong."

Another challenge related to transitioning from an HBCU to a PWI doctoral program relates to perceived inadequate preparation for graduate level courses. Four minority students reported that their mentor or advisor required them to enroll in undergraduate mathematics courses after admission to graduate school to enable them to meet graduate school performance expectations. Two of these students acknowledged it was useful while two others reported that it resulted in some unanticipated consequences

such as alienation, and therefore isolation, from their cohort and slowing the doctoral progress. One interview respondent explained:

In [my department] you take a class with the same people. As a result if you are with these people all day, you develop camaraderie but I just never developed any kind of camaraderie with any of the people. I had one person in my class but she wasn't even in grad school. She was in undergrad. I have to make this point. My experience was very different. This is what they do with black students. This is going back to my advisor and I won't say it is his fault and it is good he does this. In the department, the first year [doctoral] courses are very rigorous. And if you come from a black school, they typically don't make you, but they highly encourage you to take undergrad classes. And so the department at black schools taught [the subject] a little bit differently. So, my experience is different in that my first year I was not taking classes with my [cohort] so when I started taking first year classes, I was considered a second year. So I was separated from my class and I really didn't build a relationship with the [current first year] class because I was second year and they were first years and they had done orientation and everything together and I have already been at [current university] for a year.

Two students reported that because of the requirement by their advisor to take undergraduate mathematics courses during their first year to fortify their HBCU mathematics preparation, they lost touch with their doctoral cohorts. One of the students reported that she did not interact or build relationships with her peers during the first year of graduate school as a result of taking undergraduate courses. The student said the following during the interview.

I think a lot of times especially coming from HBCU you need some kind of transition classes. I think if I had been thrown into those [graduate] classes I probably wouldn't have survived. I would have been like "This is too much." I think it was good that they gave me a chance to transition but at the same time if they are going to have somebody transition, and this is something I talked [about] with my advisor, if they were going to have students transition let it be a group of students, not just one student doing this all by herself. In previous years, it was a bigger pool of minority students so they had a little clique within their graduate class where they took their undergrad class together. They did not worry about the other students that they didn't bond with because they had their own little clique, but me I was the only one, alone.

This student's comments illustrate that separation from her doctoral cohort resulted in isolation because she did not have an opportunity to interact with her peers.

Although this was not widely reported among the participants, it suggests that belonging to a peer group is important for doctoral students' social wellbeing.

The second student reported that although she only took one graduate class during her first semester in graduate school, and as a result did not interact or develop relationships with members of her cohort, she still actively sought support from her cohort members. She explained:

When I first got here, the white students in particular came in and took three graduate level courses their first year. Usually that's because no one really talks to them about what they should or should not take. They do what everybody else has always done. [Minority students] had mentors so our mentors helped us figure out what was a good fit for us and what we knew enough to take or not. So my first semester as a graduate student I was only taking one graduate course. So the peers in my class, I really didn't know many of them, they had three classes together they knew each other. So that was hard because they knew I was a graduate student but they didn't really know me [because] I only had one class with them but there are four classes you can choose but the ones who didn't take that one I had no interaction with at all with. So it could easily become a situation where they didn't know who I was. It could become whatever I let it become. What happened was I talked to a few of them in the class that I was taking, and I was very upfront with them. I said to them, "Hey, it's my first semester in grad school. I don't feel that comfortable writing proofs. I have never had to. Could you and me work together or could you look at my stuff before I turn it in if you could give it a look and see if there's anything you can see that I can be doing better." Just off the bat. And they were more than willing to help. So we studied together and they helped me with my homework but I contributed too once I started learning, I contributed, it wasn't like charity.

Although two of the students perceived a HBCU background to be a hindrance to their transition, one of the students reported that she overcame the challenges because of her knowledge and experience with expectations and culture of the PWI educational systems. This particular student reported that her familiarity with a majority culture facilitated an easier transition. She explained this as follows:

I already understood this system and knew what I was supposed to do and knew what was expected of me. It was really just a matter of doing it. In the HBCU system the expectations were different. There's a matter of doing exactly what is required of you to get the result you want and there's a matter of going above and beyond because it is something you care about not expecting a reward for

it. You do it because it's what you wanted to do. If you get rewarded and praise for it, great. If you don't, fine. But at HBCUs, it's more of a system where if you do something no matter how miniscule you expect to get some kind of acknowledgment, reward. It's an expectation that something is appreciated because you did it. You don't go above and beyond but you do the minimal amount of work and that's all you ever really do.

In summary, some minority students perceived their HBCU academic background as challenge to their transition process. On the one hand, it appears that the students who reported challenges of transitioning from a HBCU to a PWI perceived the new environment as unfriendly and unsupportive partially because they lacked an understanding of and familiarity with majority social expectations and behaviors. On the other hand, students who reported that they were more familiar with the majority social and academic expectations and behaviors perceived their transition into their doctoral programs at the PWI to be easy. Specifically, the one student who reported that she understood the PWI "system" perceived herself and her colleague's transition as more successful than those who did not. Further, the perception by their mentors that their academic preparedness at undergraduate HBCUs was inadequate and the requirement to take undergraduate courses compounded the challenges of transitioning because minority students perceived their loss of rapport with peers in their cohort to be precipitated by this requirement.

Gender Relations

Another issue that minority students discussed is gender. The discussion on gender took on two dimensions: one, the impact of the high number of women in one STEM program, and two, the "chilly" environment perceived by a few women in their programs. Four women students from one STEM program reported their program had a high number of women and as such, they did not feel out of place in what one student referred to as "a male dominated area." In the interview excerpts below, students describe their perceptions of having "many" women in a predominantly male discipline.

As far as being a woman in [my department], the good thing about our department is we actually have a really good number of females. So for the most part if I look around in my classes there are other females there. I had one class that I was the only female there but I knew some of the guys too. So it wasn't that isolated 'cause I would do work with them too. So we had enough females to where I feel pretty comfortable with them.

I don't notice any disadvantages from being a female just because there are so many females in our department. I don't look at being a female as being underrepresented. I see more African American as being underrepresented.

I have to admit before I came here I never once thought of gender when it came to [my academic major]. And part of that is probably because I was in a HBCU. Those schools are typically above 80% female, so of course everybody in [my academic program] is a girl because everybody in the school is a girl. So even though I know [academic major] is a male dominated area since it's not something I see day to day, it doesn't ever really occur in my brain. Then I got here. And it was funny because I still didn't notice anything because we have the most women in [my major] in the county. So again I am in a pretty sheltered environment. We have a [academic major] female organization we call the [academic major] chicks. We do things together.

Although these students did not reveal how many women were in their program, their perception that the program had "many" women seemed to elicit a feeling of being "sheltered" or protected in a "male dominated area." This study, however, lacks the data to fully explore this issue.

The second perspective of gender is the perceived "chilly" climate. Three women students (two minorities and one majority) reported subtle perceptions of differential treatment as women with family commitments. One of them reported that women who had children during the doctoral program were likely to be perceived by faculty as not being focused. This student said:

In our department if a female was to get pregnant [faculty] would be like, "Why you are not focused on your work?" That is one of the main reasons we haven't had any kids yet 'cause we're like if we are to do this it's going to be like, "You can't get it done because you have this to do and all this other stuff to do."

Another minority student reported that women students who brought children to the department were not as well received by peers compared to their male counterparts who did the same:

Married male students will bring their kids and it's like "Oh that's cute." But if a woman brings their kids [peers] are like, "Why are such and such kids here?"

Further, a majority student also perceived her relationship with her advisor, and that of her two women colleagues with whom she shared an advisor, to be strained because of their advisor's perceived lack of understanding of the fact that married women had other responsibilities outside academics. This student wrote in response to the survey:

In my particular lab there seems to be some problems with being female. Myself and two other grad students (all of whom are female) have had some disconnects with our advisor, which appears to only be a problem with females. Not an outward sexist attitude, but more of an inability to deal with the fact that women have more responsibilities outside at work at this stage in life, especially married people.

These three female students share a similar perception that their peers or advisor(s) might treat women students differently, especially if they have family commitments or have children. The small number of women who reported this differential treatment of women who have family commitments makes it difficult to determine the extent to which this phenomenon occurs in their programs, calling for more research on this topic.

In summary, minority students reported having academic support from their peers, which consisted of studying for examinations, working collaboratively on assignments and projects, and obtaining feedback on academic work. They also reported having social interactions, which consisted of attending student-organized or program-organized social functions as well as social support build upon friendships and encouragement. Further, a few minority students perceived their HBCU backgrounds as a hindrance to their transition, while others perceived it as a source of tension between minority students from HBCU and non-HBCU backgrounds. Finally, minority students discussed gender

relationships from two perspectives. First, some women students who perceived women as well represented in their program described the environment as "sheltered" and comfortable. Second, two minority students and one majority student viewed their status as women with family commitments/children as a source of differential treatment by some faculty and peers.

Summary

Student-Faculty Relationships

Overall, both survey and interview respondents shared the perception that their advisors play an important role in providing academic and research related advice, in facilitating students' professional and career development, and in providing psychosocial support. The five minority students who responded to open-ended survey questions and the eight that responded to interview questions reported academic advising from faculty as involving guidance on research, course loads, selection of courses, and dissertation writing. Similarly, four of the five survey respondents reported that their advisors provided academic advice on issues including coursework, course selection, and academic planning. Therefore, more than half of the participants ($n = 9$) reported that they received some form of academic support, including topics ranging from coursework to dissertation writing.

Minority students also perceived their advisors' role in professional and career development to be important to their doctoral progress. Five minority students who responded to the survey indicated that they perceived their advisors' willingness to provide professional development opportunities as important to their doctoral success. Further, all five students indicated that career advice by advisors was very important or moderately important to their success as doctoral students. In addition, four minority students who participated in interviews reported that their advisors facilitated their professional development by providing advice on how to navigate professional meetings,

how to become independent researchers, and how to prepare manuscripts for publication and meet deadlines and requirements for job applications. The students who reported this kind of interaction with their advisor or mentor were all in their final year of the doctoral program. Overall, the nine minority students who responded reported that they perceived their advisors' role of career advice and opportunities for professional development to be important or beneficial to their doctoral success.

Minority students who spoke or wrote about their social interactions with advisors perceived them to be valuable. The two interview respondents who spoke about social interactions or social support from their advisors perceived these interactions to be valuable. One student in particular reported that her advisor provided a support system in the form of counseling and encouragement. Another student reported that he participated in social activities with his advisor while, yet another reported having an advisor who helped him/her get over self-doubt by understanding and addressing his/her limitations. Although students' reports of social interactions with advisors were few ($n=5$), these students perceived the interactions to be valuable to them.

Mentors played similar roles. The four students who reported having mentors identified two key roles of mentors: one, mentors as facilitators of student transition during their first year; and two, mentors as facilitators of students' career and professional development. Two students reported negative interactions with their mentors including perceived discouragement.

Both interviews and surveys show that minority students perceived certain types of relationships or interactions with faculty to be positive and others to be negative. Five survey respondents indicated they perceived open and honest communication with faculty, faculty accessibility, trust in their relationship with faculty, and faculty approachability to be very important to their doctoral success. Similarly, five interviewees reported that having advisors who were available to answer their questions, friendly, and approachable was important for positive interactions and relationships.

They perceived advisors who have a good record of accomplishment in research and in graduating doctoral students to be desirable for advancing their own careers. However, not all were happy with their advisors. One student perceived a lack of advisor interest in developing the student as a researcher. In the discussion pertaining to advisor/mentor traits that students perceived to be desirable, no minority student brought up the issue of mentoring or advising by faculty of color.

One of the emergent issues that minority students' interviews revealed was the perceived evolving nature of their relationships with mentors and advisors. Specifically, four students in their final doctoral year reported that their relationships had evolved from mentor-mentee or advisor-advisee to faculty treating them as junior colleagues. One of these four students reported that this important change in the relationship gave them confidence as emerging researchers and scholars.

Peer to Peer Relationships

In their responses to survey and interview questions, minority students reported important academic and social interactions with their peers. Specifically, all five survey respondents reported they perceived peer academic support such as study groups and peer academic advice including feedback on their work to be very important to their doctoral success. Further, five of the minority students who interviewed and four the minority students who responded to the survey's open-ended questions indicated that peer academic support, especially study groups, was important to their academic success. Students reported several important study group activities including studying for examinations, collaborative work on assignments and projects, discussing journal articles, and helping each other with areas of academic difficulties.

Minority students also reported having social interactions with their doctoral peers. First, four of the five minority students who responded to the survey indicated peer social support was important for their doctoral success. Further, five of the students

who participated through interviews and one who responded to the survey's open-ended question perceived social support from their peers in the form of friendships, encouragement, as well as relief from academics through social activities to be valuable to their progress.

Four minority interview respondents who came from Historically Black Colleges and Universities (HBCUs) discussed effects of this background on their interactions with non-HBCU minority students and on their transition into their doctoral program at a Predominantly White Institution (PWI). Two of these four students perceived their transition from HBCUs to a PWI to be challenging while two reported a less challenging transition. One student perceived challenges in the transition process as arising from less friendly and more competitive environment at the doctoral institution as well as difficulties interacting with majority and minority students from non-HBCU backgrounds. Another student who perceived challenges in her transition process cited isolation from her cohorts because of the requirement to take undergraduate courses to supplement her perceived lack of preparedness for graduate level classes. One other student saw her transition as less challenging due to her upbringing in a majority culture and her attendance of majority elementary schools.

Four minority women and one majority woman in this sample discussed gender relations in their respective departments. Two perspectives on gender relations emerged from the interview responses. First, four of the minority respondents who were from one department perceived their department as having a good representation of women, and reported this environment to be "sheltered" and "comfortable." Second, two minority students and one majority student perceived subtle differential treatment by faculty and peers because they were mothers or had families.

Chapter VI discusses these findings in the light of literature and theoretical perspectives presented in prior chapters.

CHAPTER VI

DISCUSSION

Although the sample of participants in this study consisted of a small number of volunteering students, the perceived and reported experiences of any minority doctoral students in science, technology, engineering, and mathematics (STEM) programs may contribute to a fuller understanding of the issues that shape and influence individual progress towards degree completion. Minority students' experiences in STEM programs are not only shaped by financial policies and practices but also by the kinds of relationships and interactions they have with peers and with faculty members within their programs. Understanding their unique experiences could sensitize those who craft policies that guide doctoral degree programs, which in turn could enrich students' experiences during the course of their doctoral programs and enable them to navigate various stages of their doctoral program successfully.

Data for this research were obtained from 13 minority students enrolled in STEM doctoral programs during spring, summer, and fall 2009 and 73 majority respondents who provided some comparisons and contrasts. Five of the minority students participated in the study by responding to a survey while eight participated through interviews. The 73 majority students participated through a survey. The participants were all Ph.D. students from several STEM programs at a research institution in the Midwest.

Financial Support

The data obtained in this study pertaining to the forms of financial support that minority students reported receiving during the course of their doctoral program are important in the discussion of minority students' graduate school outcomes such as socialization and integration into their program's social and academic systems. While limited numbers and unknown representativeness preclude comparisons of financial patterns by discipline or by race, the findings suggest intriguing dynamics of financial

support that have implications for students' successful navigation of various stages of the doctoral process and that warrant additional attention and research.

Scholarly literature pertaining to forms of financial support that graduate students receive during the course of their graduate program is limited, with existing studies showing that a majority of doctoral students nationally rely on teaching and research assistantships and fellowships as the primary forms of doctoral funding. In science and engineering disciplines, more than two thirds of the doctoral students receive institutional funding and fellowships (Hoffer et al, 2007). Such funding, however, varies by field of study and by students' ethnic/racial background, with minority students receiving more fellowships in both science and non-science fields and at the same time utilizing more of their own resources compared to non-minority students (NSF, 2000; Hoffer, et al., 2007; Millet & Nettles, 2006a). In addition, some studies show that combining several forms of financial support such as fellowships and assistantships or loans increases the likelihood of graduate student persistence (St. John & Andrieu, 1995; Bair & Haworth, 1999; Nerad & Cerny, 1993; Girves & Wemmerus, 1988).

My own findings agree with this literature that minority doctoral students report having received more than one form of financial support during the course of their doctoral program. Indeed 11 of the 13 participating minority students in my study reported that they received fellowships combined with teaching and research assistantships and loans. Two students who reported working off campus and/or taking out college loans participated in this study through survey responses, providing limited information on the effects of these forms of financial aid on their doctoral degree progress. The lack of institutional financial aid to finance doctoral studies is important, particularly in STEM disciplines, which typically provide funding to a majority of doctoral students (Hoffer et al., 2007). This issue merits further examination to provide a clearer picture of the distribution of financial aid among minority students in STEM

doctoral programs and to examine why some doctoral students do not receive institutional financial aid.

The literature does not address the specific outcomes of different forms of financial support. For the respondents in this study, different forms of financial support brought complex benefits and challenges. This study goes beyond reporting forms of financial support available to minority students and provides nuanced accounts of how such funding is structured over the course of students' doctoral study and how these structures or patterns exemplify the three stages of graduate school identified by Tinto's (1993) model of doctoral persistence. Data on the types and sequencing of financial support from eight interview students corresponds with Tinto's three stages as follows:

1) *Transition stage* encompassing the period in which students join the doctoral program to when they start to teach or work in the laboratories, which varies, among my participants, from one semester to three years. During this stage, my research shows that financial support is important in facilitating students' enrollment into their Ph.D. programs. All the minority participants in this study perceived having financial support as a prerequisite for their enrollment into graduate school. This finding is not a surprise as the literature highlights this common experience (Curtis & Hunley, 1994; Border & Barba, 1998; Munoz-Dunbar & Stanton, 1999).

Further, this study shows that financial support, especially fellowship funding, is important especially during this stage in facilitating minority students' transition into their doctoral programs. Eight interview respondents reported having fellowships during this stage without teaching or research responsibilities. These students perceived this arrangement as beneficial in facilitating their transition into the doctoral program. One student's comments exemplify these perceptions: "I am not quite convinced that if I had to teach especially that first year in particular, I would have transitioned as well and, you know, even within the first few years would have been able to pass my [qualifying exams]." All the interview respondents talked about their ability to focus on their studies

during this transition period and, as the one above reports, pass their comprehensive or qualifying exams.

2) *Intermediate stage* encompasses the period when students work as teaching or research assistants for a period ranging from two and six semesters. Although they do not consider financial support in terms of the stages of graduate studies, previous studies agree that teaching and research assistantships provide opportunities for graduate students' involvement in their programs and apprenticeship, which ultimately lead to persistence (Herzig, 2004; Girves & Wemmerus, 1988; Bowen & Rudenstine, 1992; Border & Barba, 1998). These studies, however, do not recognize the impact of different forms of financial support at different stages of doctoral studies. Some, however, suggest that fellowships that do not require teaching or research obligations may limit graduate students' opportunities for apprenticeship and for involvement and integration into the intellectual and social life of their programs (Tinto, 1993; Millet & Nettles, 2006a; Bowen & Rudenstine, 1992).

My findings are consistent with this literature, but my study also provides nuanced data on the specific ways in which teaching and research assistantships not only facilitate these students' involvement in the intellectual system of their respective departments but also their acquisition of specific skills and knowledge related to their careers. Indeed, eight interview and all five survey participants in this study perceived fellowships, teaching assistantships, and research assistantships as beneficial in not only developing skills and competencies but also in providing opportunities for professional development. Specifically, four minority students reported in their surveys that their knowledge and understanding of their discipline and professional expectations increased as a result of their financial aid. The three who reported having research assistantships, perceived their assignments as beneficial in facilitating immersion into their doctoral research and skill acquisition such as procurement of laboratory materials and use of laboratory equipment as well as learning how to work collaboratively with their

colleagues in a laboratory setting. Similarly, six minority students who reported having teaching assistantships reported acquiring teaching experience that prepared them for their careers and provided insights into the expectations of careers in teaching, as exemplified by one who said, "The advantage[s] of TA-ing is [are] it gives you an idea of what you are headed for. Because most people in our program will end up being professors somewhere." Others ($n = 2$) noted that teaching assistantship appointments gave them opportunities to learn undergraduate course material that they needed for graduate school by interacting closely with and learning from faculty members.

As demonstrated in this study, minority students perceive teaching and research assistantships as useful in facilitating involvement in their departmental academic activities and in learning professional and career skills. By providing these nuanced accounts of the role students perceive teaching and research assistantships and fellowships to play, this study generally supports the literature that suggests that teaching and research provide opportunities for students' integration into the intellectual life of their programs. Further, this study's findings serve to refute some theoretical assumptions in the literature that students who receive fellowships that do not require research or teaching responsibilities may not get opportunities for involvement in their departmental intellectual life (see Tinto, 1993; Millet & Nettles, 2006a; Bowen & Rudenstine, 1992). Fellowships alone, as noted by some participants, provide opportunities for professional development through conference attendance where students meet members of their profession and learn about their professions. Further, fellowships provide opportunities for students' involvement in student organizations, which enriches their overall doctoral experience. This study demonstrates how students get involved in their departmental activities through their research and teaching appointments and how this involvement might lead to persistence.

3) *Dissertation stage* encompasses the final year(s) when graduate students exclusively focus on completing their doctoral research. Consistent with Tinto's (1993)

theory, this study reveals that minority students perceived having a fellowship that requires no teaching or research responsibilities during the dissertation year to be beneficial in allowing them to focus on their dissertation research. One student said, "What I am happy about is that my last year I need to focus on my research. I am going to take this fellowship and focus on that." This finding does not support the arguments of scholars such as Girves and Wemmerus (1988), who suggest that fellowships without teaching or research obligations limit students' opportunities for involvement. During this stage, fellowships offer students dedicated time for the dissertation process in which students typically interact closely with one or several faculty members who direct their research.

The structure of funding that emerges and the attendant perceived benefits at different stages of students' doctoral progress, therefore, not only support but also advance theory and literature on financial support that graduate students receive. The structure of funding has a perceived positive influence on students' ability to transition into the doctoral program during their initial year(s), to acquire skills in teaching or research in the middle years, and to focus on their dissertation project in the final year. The findings in this section provide nuanced data to support Tinto's (1993) theory, which suggests that different forms of financial support work effectively at different stages of the doctoral process.

Relationships

Faculty-Student Relationships

Academic and Professional Relationship

In his longitudinal model of doctoral persistence, Tinto (1993) places faculty and peer relations at the center of graduate students' institutional experiences that influence their ability to integrate academically and socially. Tinto posits that social experiences of

doctoral students "within the local communities of the department, peer and faculty, are likely to play a more important role in the development and determination of academic competencies" (p. 236). Similarly, Weidman et al. (2001) regard graduate school as a socializing agent that provides students with knowledge, skills, and values necessary for integration and success in their disciplines and professions through interactions with faculty and with doctoral peers. In this model, socialization occurs through students becoming aware of behaviors and attitudes of the discipline and profession, learning by observing mentors/advisors and other faculty through apprenticeship, and learning from their peers. This culminates in students' behavior reflecting habits and orientations of their discipline and professions. Girves and Wemmerus (1988) concur but add that it is primarily through financial support (teaching and research assistantships) that students get opportunities for increased formal and informal contact with faculty and with peers within the department, making financial support the primary avenue through which such interactions are possible.

This study aligns with Tinto's (1993) and Weidman, Twale, and Stein's (2001) theories regarding the role of advisors and mentors in socializing and integrating students into their disciplines and professions. In addition, it elaborates on the key roles of advisors and mentors in shaping these two processes at various stages of students' doctoral progress. The findings show that students' socialization takes place at two main levels, namely:

- 1) The academic (cognitive) level: This level of advising coincides with Weidman's et al.'s (2001) stage of socialization which suggests that, by watching and learning from their advisors and mentors in the classroom or laboratory, students learn about the expectations of their disciplines. This study reveals that student-faculty interactions at the academic level mainly focus on developing competence in coursework, managing coursework requirements and course loads, acquiring skills that facilitate successful navigation of the academic terrain such as time management, and learning to

conduct research. Minority students who reported this aspect of advising (n=9) used the following phrases in describing their advisors' role in academic advising: "manage readings," "good feedback on handling my school work," "time management and setting deadlines," and "solving real problems and doing real research and development." Thus, in these ways advisors and mentors at the academic level socialize students into their discipline.

2) The professional level: This aspect of socialization coincides with Weidman's apprenticeship stage whereby doctoral students learn from their advisors as well as the final stage when they begin to reflect the habits and orientations of their professions (Weidman et al., 2001). This level also coincides with Tinto's (1993) final doctoral stage. Tinto suggests that during this stage, "an informed and influential advisor may be invaluable to the early occupational success of the candidate" (p. 237) suggesting the important role of the advisor vis-à-vis aiding students to transition successfully into their professions or fields.

At this level of socialization, student-faculty interactions focused mainly on navigating and networking at professional meetings, learning strategies that facilitate success in their professions, writing and submitting manuscripts for publication, and preparing for the interview processes. One student exemplified this socialization by citing tenure-related advice she received from her advisor, who said, "To get tenure you want to make sure that you do something that has only your name on it." Another student talked about training related to publications where the advisor provided guidance not only on the writing process but also on the publication process. This student noted, "I sit down with [my advisor] and figure out where to put [manuscripts] in. And since he's been editor for four [journals], I can figure out why would I put something in one journal as opposed to the other." Another student talked about going to professional meetings with an advisor and learning how to talk "with people of distinction." Overall, it is doctoral students in their final year who discussed this concept of professional socialization. As

one pointed out, this kind of learning did not occur in the classroom, but rather by observing and learning from one's mentor or advisor.

One finding that further expands the concept of the student socialization process, particularly during the final year(s), is the notion of an evolving relationship between students and their advisors/mentors to culminate in a relationship in which advisors view students as "junior colleagues." Four of the minority students in their final year of the doctoral program reported that their advisors or mentors focused on academic development at the beginning of their advisor-advisee relationship and that, with time, this relationship evolved into one of mutual respect or the student becoming a "junior colleague" as she or he approached final doctoral years. One said, "What has changed is just that at that point I was a student trying to learn the material. Now my [advisor] is training me to be his equal. He is trying to push me to when I do research to say it's mine" and to take "ownership." According to these students, becoming a junior colleague means gaining autonomy in research and gaining respect from an advisor to the point where one is able to represent an advisor at a professional meeting. Graduate persistence literature (Girves & Wemmerus, 1988; Nerad & Cerny, 1993; Herzig, 2004) notes that treatment as junior colleagues facilitates graduate student integration and persistence. This study illustrates how this relationship develops over time and provides specific examples of what it means to be "junior colleague" from a student's perspective. This description of an evolving advisor-student relationship shows doctoral students' growth and development through the stages of their doctoral process and the central role of faculty and advisors in this process. As exemplified by the four final year students, students not only perceive faculty as beneficial in facilitating their successful completion of the dissertation but also in preparing them to be independent researchers and scholars in their own right as they transition into the work force.

The Nature of Faculty-Student Relationships

Several studies state that the way in which majority students (Millet & Nettles, 2006a; Golde, 2005) and minority students (Herzig, 2004) perceive their interactions and relationships with advisors or mentors affects the process of academic and professional socialization and their ability to gain membership into their programs or departments. This literature suggests that successful faculty-student relationships that are characterized by faculty availability, faculty feedback on projects, faculty interest in students' research and intellectual development, nurturing of students through consistent, wise, fair, and firm mentoring, providing moral support and encouragement, and having trust in the relationship are important in increasing the likelihood of graduate students' persistence.

The findings in my study are consistent with the above conclusions concerning the relationships and interactions with between students and faculty. Indeed all 13 students noted that faculty-student relationships that are characterized by honest and open communication, trust, approachability, faculty availability to answer students' questions no matter how trivial, faculty support and encouragement, advisors' interest in developing students as researchers, and treatment as a junior colleague were important to their doctoral success. This study highlights the qualities that minority students desire in their relationships and interactions with advisors and mentors. Surprisingly, in the interview discussions on the qualities minority students seek in mentors or advisors, no student talked about his/her desire to have mentors/advisors of color while others emphasized the desired qualities described above without referring to personal characteristics such as race. The fact that this issue did not come up in the discussion may suggest that the participants can be successfully mentored/advised by majority faculty who possess the qualities described above. The findings may also be due to the fact that the research questions were not focused enough to lead to a discussion on the importance of faculty of color. Whatever the case, some studies have suggested that the presence of faculty and students of color in an institution not only aids the recruitment of minority students

(Curtis & Hunley, 1994; Munoz-Dunbar & Stanton, 1999; Hill et al, 1999) but also increases their likelihood of integration into the social and academic aspects of the institution and, consequently, lead to persistence (Vaquera, 2007; Gonzalez, 2006). Other scholars (Oden, 2003; Sedlacek, 1987) have argued that the lack of faculty of color or the limited number of faculty of color as role models is likely to increase feelings of loneliness and isolation for students of color. Sedlacek further suggests that a lack of faculty of color can limit viewpoints or cultural perspectives relevant to Black students and consequently negatively affect their "learning, development, and identification within universities" (p. 541). If, as suggested by my findings, minority students seek faculty of any racial background with these qualities, this finding may contradict some of the studies that suggest faculty of color are important in minority students' successful mentoring. My study suggests, contrary to the literature, that in the absence of advisors or mentors of color qualities of mentors/advisors such as the ones identified above by minority students may lead to the successful mentoring of minority students. This study lacks sufficient information to make concrete assertions about mentoring of minority students by majority faculty. Therefore, further examination of successful mentoring of minority students by majority faculty would be necessary to understand factors that render such relationships successful.

Overall, the reports and perceptions of minority students show that not only do faculty facilitate their academic development but they also play a role in socializing students into their career or profession as they approach the latter stage of their doctoral program. Further, treatment by faculty as "junior colleagues" during advanced stages of the doctoral program is important in facilitating students' transition into their professions. Last, faculty-student relationships and interactions characterized by encouragement, moral support, availability, approachability, and honest and open communication are essential for successful mentoring.

Peer to Peer Interactions

Peer support is often cited in scholarly literature (Girves & Wemmerus, 1988; Tinto, 1993; Bair & Haworth, 1999; Vaquera, 2007) as secondary to faculty support in facilitating graduate students' persistence. Although this literature is consistent in its argument that graduate students' relationships with peers and membership in peer groups play a weaker role in students' integration than relationships and interactions with faculty, it also suggests that students' peer groups at the doctoral level, compared to the undergraduate level, play an important role in the development and determination of students' academic competencies. These competencies develop as a result of graduate peer group interactions and relationships which occur outside the classroom (Tinto, 1993; Gardner, 2008). This study confirms some aspects of the literature on the influence of peer groups as well as contributes additional detail about peer interactions among minority students in graduate school. Students in this study identified two overlapping domains of peer interaction important for their success: the academic level and the social level.

At the academic level of interactions, minority students report support in study groups, collaborative work on assignments, sharing academic resources and preparation for qualifying examinations to be important to their academic success. One student, for instance, described his/her peer group support as follows: "everyone studied together in the first year, which is the hardest year 'cause we had to prepare for the master's qualifying exams after the first summer. Our year also did better than most other years collectively." Thus, minority students view their peer groups as instrumental in the development of their academic competencies as they prepare for the candidacy stage as well as during the dissertation stage.

At the social level of interactions, minority students perceive peers as essential in providing support through graduate school. In their survey and interview responses, eight minority students indicated that peer social support and interactions in the form of

friendships, moral support, encouragement, and participation in recreational and social events were important for their overall doctoral success.

The results of this study further indicate that social and academic interactions between minority students and their doctoral peers, in some instances, are not mutually exclusive interactions. For instance, two students reported that social peer groups and academic peer groups often were interchangeable. Some students reported that they studied together and then went out for food or drinks or they met during social activities and formed study groups with the same peers. Based on students' reports of peer group activities, there was often no clear distinction on their part between social and academic peer groups, but rather the social and academic roles became intertwined over time, and, as Tinto (1993) suggests, students' social experiences become a part of academic experiences and vice versa. This study, therefore, confirms Tinto's (1993) theory by illustrating how the two domains of peer activity are not discrete but rather overlap and ultimately facilitate the development of academic competence among students.

This study contributes a new perspective on doctoral peer interactions among minority students and issues of transition stemming from their historically Black Colleges and Universities (HBCUs) backgrounds. Three key issues emerged from the findings. The first relates to isolation of minority students by both White and minority peers. The literature on minority students' peer interactions and relationships suggests that minority graduate students' integration with their peers particularly in predominantly white institutions (PWIs) is limited owing to few minority peers and faculty and a lack of acceptance by their White peers, as well as hostile racial attitudes regarding social, academic and personal work and study groups (Oden, 2003; Gonzalez 2005). Gonzalez notes that Hispanic students face integration challenges but those who integrate into their departments' social and academic systems successfully are those who seek strong support from like peers, faculty, and communities. These studies reveal the importance of

minority peers and faculty in the socialization and integration of minority students into their disciplines and departments.

My study is consistent with the literature that suggests that some minority students face exclusion by majority students. Specifically, two participants in this study reported being excluded from majority peers' study groups and tended to perceive PWI peers as less friendly and less supportive, as illustrated by the perceptions of two minority student who reported feeling isolated by their White peers. What is also noteworthy is the perception by some minority students that their relationships with fellow minority students were characterized by tension and exclusion. One student reported that some peers, particularly those from non-HBCU backgrounds, often failed to include minorities from HBCU backgrounds in their study groups because they perceived them to be less academically qualified. This student noted that, "The Black [students] that went to majority schools are the ones who think that you are not smart enough." Another minority student from a HBCU background shared the perception that indeed some minority students, not necessarily those from HBCUs, were not welcome in the study groups based on the perception that they lacked a work ethic that was conducive to success, such as spending long hours at study. Although this was not widely reported in interview or survey responses, it provides a glimpse into minority students' group dynamics that exist due to differences in backgrounds. These reports by minority students suggest that their educational or social backgrounds may influence the perceptions that other minority students have of them and, as is the case in this study, negatively affect interactions with their minority peers. Therefore, fellow minority students' perceptions of others from HBCUs and their exclusion from study groups, may contribute to minority students' negative experiences.

The second issue relates to minority students' transition from HBCUs to PWIs. Specifically, this study shows that while some minority students are able to transition easily from HBCUs to PWIs, and to integrate into majority study groups due to their

knowledge of the majority graduate school "system" and "expectation," others from HBCUs find it difficult to fit in and to communicate with people in PWIs. One student noted that, "minorities that went to HBCUs are not used to communicating with non-minorities. [For] the minorities that [attended] majority schools, it is an easier transition so they do a lot better. Minorities that went to HBCUs, most of them are gone and maybe one or two leave every year." This finding is consistent with other studies (Oden, 2003; Gonzalez, 2006) in pointing out that some minority students' graduate school integration is indeed limited or hindered by their lack of support from peers and faculty, leading to attrition. However, this study does not address whether the sense of isolation led to attrition. Further, while the literature suggests that minority students may not be accepted by White peers, my study shows some minority students, as exemplified by those who integrate into majority groups, interact with and are accepted by majority students. This finding suggests that students' prior experiences with majority cultures and expectations may ease their transition and integration into PWI doctoral programs.

The third issue relates to minority students' requirement by advisors/mentors to take undergraduate remediation courses after enrolling in graduate school. Four students who reported coming from HBCU undergraduate backgrounds reported this requirement. The requirement to take undergraduate remediation courses elicited mixed responses from students. Two of the students perceived this requirement to be necessary and one noted, "I think a lot of times especially coming from HBCUs, you need some kind of transition classes. I think if I had been thrown into [graduate] classes, I probably wouldn't have survived." By contrast, this requirement elicited reports of two unintended and potentially harmful consequences for students' doctoral progress. One, the requirement to take undergraduate remediation courses was reportedly frustrating to one student who said, "My mentor had me do one year of undergraduate work. Classes that I have already taken and I am thinking 'is he not thinking my undergrad was good enough?' I was so frustrated because these were all undergrad." This requirement for

some minority students has the potential to be construed as discriminatory or stereotyping of minority students, as noted by the above example in which the student implies that her undergraduate was perceived as "not good enough." Studies suggest that minority students are more susceptible to stereotyping which portrays them as having lower academic abilities than White and Asian students (see Steele, 1997; Fries-Britt & Griffin, 2007). According to Fries-Britt and Griffin, racial stereotyping has the potential to cause students to doubt their academic abilities and to damage their achievement and self-esteem. Although this was not reported in this study, there is evidence to suggest that one student questioned the requirement for remediation and was indeed frustrated because she felt her undergraduate credentials were being questioned. The second consequence of taking undergraduate courses was that it separated, and consequently isolated, students from their doctoral cohorts. For one student, it was difficult to make connections or develop "camaraderie" with her cohort members because her opportunities to interact with them were limited. This isolation has the potential to lead to attrition. Overall, the above three issues emerging from minority students' HBCU backgrounds are important for the transition of minority students into PWIs. The findings, however, are based on a very small sample of volunteering minority students, warranting further exploration of the issues. For instance, it is not clear whether only minority students from HBCUs are required to take undergraduate courses or whether other students, including minority students from non-HBCU backgrounds and majority students, are required to do this.

Last, the findings on gender issues in STEM programs in some respects are not surprising and to some extent find support in the literature, while other findings are a little more surprising but still also serve to confirm what the literature observes about gender. First, some women with children/family commitments report a "chilly" climate in some programs. According to the literature, a chilly climate is characterized by differential treatment of women students by faculty or peers ranging from overt discouragement of their participation in class to more subtle implications that women

lack commitment due to family commitments (Hall & Sandler, 1982; Brus, 2006). Although none of the participants in my study reported overt discouragement from faculty or peers, two students spoke about their personal experiences with faculty and peers: one reported that her peers viewed her as not making "sense" while another perceived a "disconnect" with her advisor because of her family commitments. Further, one student expressed her reluctance to start a family for fear of being perceived as not "focused" by faculty in her department. This perception of a "chilly" climate was not widely reported among minority or majority Ph.D. students in this study. The three participants who raised the issue discussed it regarding women with family commitments or with children.

A second issue related to gender emerged from this study suggesting that with an increased proportion of women Ph.D. students in a program, respondents feel less isolation and the perception that they are out of place seems to diminish. This was reported by four women in one STEM program who reported feeling comfortable and "sheltered" because they perceived women to be relatively well represented in what one student described as a "male dominated area." One woman made an illustrative comment that summarizes what others perceived about being a woman in such a gender balanced STEM program saying: "I don't notice any disadvantages from being a female just because there are so many females in our department. I don't look at being a female as being underrepresented." The perceptions of these women in this particular program are unique to this program, which is nationally renowned for its success in recruiting and retaining underrepresented groups including women and minorities. Although this finding is inadequately supported by data due to the small sample and warrants further investigation, it may suggest that having a balanced representation of men and women in STEM programs may mitigate the effects of isolation for women in "male dominated" disciplines.

Overall, this study illustrates how faculty advisors are crucial to the development and determination of students' academic competence at all stages and professional development especially towards more advanced stages of the doctoral progress. Faculty advisors' roles typically revolve around students' coursework and preparation for qualifying examinations and candidacy while at the dissertation stage advisors focus more on research and the dissertation process. During the final year(s), faculty advisors and mentors focus on equipping students with skills and knowledge to be independent researchers and scholars as they transition into their careers. Students' perceptions of faculty as encouraging, trustworthy, and having genuine interest in students' academic development are important in fostering successful mentoring and advising relationships.

Doctoral students' peers play an important role in their integration into the intellectual life of the department through academic support activities such as study groups, collaboration on projects and assignments, and providing a critique of each other's work. In addition, doctoral students' peers also provide social support through social activities that provide much needed relief from academics. They also provide encouragement and moral support. Peer academic and social roles are not mutually exclusive but rather they overlap and ultimately they lead to the development of academic competence membership in the learning community. Further, the findings suggest that minority students' educational backgrounds may affect the relationships they form with their minority doctoral peers.

Implications

The findings from this study suggest implications for practice and additional research. There is no doubt that financial support in the form of teaching and research assistantships and fellowships is important in facilitating minority students' access to doctoral STEM programs. However, the way in which this financial support is structured can enhance minority students' experiences in doctoral studies. Specifically, offering

fellowships during the first year(s), teaching and research assistantships during the intermediate years, and fellowships during the final year(s) of the doctoral program facilitates transition of students into doctoral programs, integration/involvement and development of skills relevant for the discipline and for careers during the intermediate years, and completion of the dissertation during the final year(s). Thus, programs should consider this pattern of funding when offering minority students financial support.

Financial support is also the primary avenue through which students get opportunities for frequent interactions with their faculty and with peers. These interactions aid their integration into the departmental academic and social community and thereby socialize them into the discipline and the profession. Entering graduate school without financial support and relying on personal resources or off-campus work diminishes their likelihood of having frequent interactions with faculty and with peers and in turn limits their integration and socialization by peers and faculty. Therefore, when and where possible, programs should consider offering at least a quarter-time financial support package to incoming minority doctoral students to provide opportunities for interaction with faculty members in their department(s).

In addition, faculty-student interactions and relationships are important in minority students' academic and professional development. Faculty-student relationships and interactions which minority students perceived to be positive -- including faculty availability, faculty feedback on projects, faculty interest in students' research and intellectual development, faculty provision of moral support and encouragement, and trust in the relationship -- are useful in fostering successful relationships. This study suggests that such interactions, coupled with faculty efforts to develop minority students academically and professionally, enhance the likelihood that minority students will successfully navigate the various stages of the doctoral process and ultimately succeed. Combining these two aspects of interactions -- academic and professional development -- can enhance students' overall doctoral success.

Another implication relates to the process of minority students' transition from HBCUs to PWIs. One of the issues that emerged from this study is that minority students from HBCUs were required or encouraged to take undergraduate remediation courses during the first year of their doctoral program, to make up for perceived inadequate preparation, which resulted in two outcomes. First, some of the minority students felt separated and isolated from their first year cohort throughout their studies while others were able to re-integrate into their cohorts. Minority student membership in cohorts is important in facilitating relationship and interactions with peers, such as those described earlier in this study. Therefore, where possible, programs could consider finding ways of scheduling to allow minority students to take the necessary undergraduate courses and, at the same time, remain an integral part of their doctoral cohort. Alternatively, intensive tutoring and intensive summer preparatory classes might be sufficient for students to continue with their cohorts. In addition, programs that have such requirements could consider organizing events where doctoral students interact in their cohorts. Second and more importantly, minority students may perceive the requirement to take undergraduate remedial courses as a form of discrimination or stereotyping. As such, programs that require minority students to take undergraduate remediation courses must carefully consider, through focused mentoring of students, which students (both majority and minority) need remediation. Programs must carefully implement such a requirement to eliminate the potential harm to students who might view it as discriminatory.

The study also suggests several areas for further research. One of the emergent issues in this study regarding underrepresented minority students' transition is the perceived influence of their educational background on their transition. A few minority students discussed difficulties adjusting to a PWI due to their HBCU backgrounds. Further, some perceived their minority counterparts from non-HBCU backgrounds to fare better in graduate school at a PWI. Although this was an emergent issue and not directly related to the research questions, it warrants further investigation because it affects

minority students' transition processes into doctoral programs. Few, if any studies, address the issue of minority doctoral students' transition from HBCUs to PWIs. Therefore, more research could compare how underrepresented minority students from HBCU and non-HBCU backgrounds transitions into doctoral programs.

Last, the issue of minority students taking undergraduate remediation courses requires further exploration to increase the understanding of this issue. For instance, it would be useful to explore whether the requirement for remediation varies by minority students' educational background (e.g., HBCU versus non-HBCU) or whether some majority students are required to take remediation courses. It would also be useful to explore, using a larger sample, the extent to which remediation is a common practice in some programs, the criteria that programs employ in recommending it to students, and the effects of such requirements on minority students' overall experiences.

Related to the above is the group dynamics of minority students from HBCU and non-HBCU backgrounds. This study reveals perceived tension and exclusion between these two groups of minority students. The literature has previously shown that minority students can experience negative stereotypes (e.g., Steel, 1997; Fries-Britt & Griffin, 2007) from their majority counterparts. In this case, however, it seems like perceived stereotyping is an issue among minority students based on their educational background. Research on this issue would be useful in documenting how minority students interact with their fellow minority students from different backgrounds and the effect this has on their doctoral degree progress and success.

Another issue for further investigation concerns the experiences of women in STEM programs. The findings in this research show that a few women with family commitments or children perceived an unwelcoming or "chilly" climate in their departments. While some women perceive differential treatment in their departments, others report other women's experiences. From my study, therefore, there is some evidence that biases against women with children/family commitments may exist and

have a negative impact on their progress. Although this topic has been studied extensively (e.g. Hall & Sandler, 1982; Brus, 2006; Morris & Daniel, 2008), further research on this issue may establish whether the perception of a "chilly" climate varies by discipline or by the number of women enrolled in programs, and whether it is different for minority students. It is also important to address the extent to which it is related to women's roles as mothers.

Last, this study relied on a small sample of minority students as the primary source and qualitative methods as the primary means of investigation. Rich interview and survey data from small numbers of students can provide nuanced reports of students' experiences. However, this study may not have sampled equally powerful perceptions from those who for whatever reasons did not participate in this study. Similarly, studies of mentoring relationships increasingly collect the perceptions of both faculty and graduate students. Increasing the sample of participants and expanding the research to include the perspectives of faculty and staff would provide a greater depth and breadth of understanding of minority students' experiences in STEM programs.

Concluding Remarks

This study was a descriptive exploration of selected doctoral students' experiences in STEM programs. It began with the understanding that minority students are often underrepresented in STEM doctoral programs and that their perceived and reported experiences in doctoral programs were understudied compared to those of minority undergraduates. Using a framework of doctoral students' persistence (Tinto, 1993; Weidman et al, 2001), this study examined the influence of doctoral students' financial support and relationships with faculty advisors and with doctoral peers on their doctoral experiences and progress, particularly integration and socialization.

The study suggested that financial support of doctoral students through fellowships and research and teaching assistantships provided opportunities for students

to interact closely with their faculty and their peers and thereby experience socialization into the discipline and the profession. In the process of teaching and research, minority students reported acquiring skills and competencies useful not only for graduate school success (e.g. time management; course reading; dissertation writing) but also for successful transition into their respective professions and careers. In addition, minority students reported that the structure or pattern of funding affected their progress through the doctoral program. Students reported that receiving fellowships during their transition, teaching or research assistantships during the mid years and fellowships during the final year(s) supported successful transition into the doctoral program, development of academic and professional competencies during the middle years, and successful doctoral completion during the final year.

Faculty-student and peer-peer relationships reportedly played an important role in socializing minority doctoral students into their disciplines and professions. Faculty advisors/mentors were especially important in developing students' academic competencies as well as in preparing them for their professions, while peers primarily offered academic combined with social support. In addition, faculty-student relationships characterized by faculty availability, approachability, interest in developing students' academic and professional competence, and support and encouragement are important, perhaps especially so in the absence of mentoring by faculty of color.

Findings from this study could provide graduate programs and departments with an opportunity to begin a dialogue on aspects of doctoral program practices that can be targeted to enrich doctoral students' experiences, to add value to their education, and to assist them to successfully navigate through the various stages of their doctoral programs. Key questions raised by responses in this study could guide departments and programs wanting to investigate their own financial support systems, mentoring and advising of minority students.

Future research should continue this line of questioning to determine whether these issues are typical and recurring. Additional research on doctoral students' experiences will create a more complete picture and add to the limited research. One serious limitation on future research is the difficulty of getting students to participate in these studies. The present study tried various modes for getting students to respond, including mass emailing, student recommendations and introductions, and relying on social introductions and events. The time available for the survey and the interviews was extended over weeks during the semesters and over several semesters.

This researcher proposes to continue this line of inquiry with shorter and more targeted “quick” surveys and brief telephone interviews, each addressing one single point and directed at representative samples from available populations. Individuals would only need to answer five short survey items on one facet of the findings or two quick interview questions. If proportionally more students from the available population responded, a fuller picture would emerge over time. In this way, for example, it would be possible to see how women and men, majority and minority, with and without children, conceptualize the issue of a “chilly” climate for women and/or mothers compared to fathers. Similarly, it would be possible to explore the alignment of mentors, peers, and identified students' perceptions of the entering skill level and ability of students from HBCU backgrounds. This present study raises intriguing questions that can only be fully addressed with additional targeted research.

APPENDIX A

LETTERS OF RECRUITMENT AND REMINDERS

I. Pre-Survey Invitation for First Group of Students

Dear |Student|,

I am writing to invite you to participate in a research study. The purpose of the study is to examine minority students' experiences, and to compare them with non-

minority students' experiences, as they relate to financial support, interactions with faculty and peers, departmental climate, and background factors at the doctoral level. The results of this study will be a part of my doctoral dissertation.

I am inviting you to be in this study because you are listed as a Ph.D. student enrolled in a science program at [this university] and a U.S. citizen/permanent resident. I obtained your name and address from the Office of the Registrar. Approximately six hundred students will take part in this study at [this university].

There are several ways in which you can participate in this study: 1) Focus group/survey: I will ask you to meet with other participants for a focus group discussion and a paper/pencil survey that you will be asked to complete at the same time; 2) Individual interview/survey: This is similar to (1) above but you will not be in a group setting. For both types of participation, the questions are about your academic and family background, the kind of financial support you have received as a graduate student and its value to you, the value of your interactions and relationships with your faculty and peers, and the impact of your department's policies and practices on your Ph.D. progress. The procedure will therefore start with completion of a section of the survey questions which will be followed by focus-group discussion of the questions on the survey. The entire process will take approximately two and a half hours of your time; or 3) Web-survey only: I will ask you to fill out a web-survey which will take approximately 20-25 minutes to complete. The questions on the survey are the same as in (1) and (2) above.

If you wish to be contacted about this study, please reply to this e-mail with one of the following statement: "I am interested in the focus group/survey;" "I am interested in the individual interview/survey;" or "I am interested in the web-survey." If you are not interested in participating, please respond "Do not contact."

If you are interested in participating or if you have questions, please contact me at [email address] or [telephone number] to discuss the study.

Thank you very much for your consideration of my research. I look forward to

hearing from you.

Sincerely,

Margaret Mwenda

II. Survey Invitation with URL Link for First Group of
Students

Dear |Student|,

Following my communication last week, I am writing to invite you to take a survey whose link is posted at the end of this email. As I mentioned earlier, the purpose of this study is to examine minority students' experiences, and to compare these with non-minority students' experiences, as they relate to financial support, interactions with faculty and peers, departmental climate, and background factors at the doctoral level. The results of this study will be a part of my doctoral dissertation.

I am inviting you to be in this study because you are listed as a Ph.D. student enrolled in a science program at [this university] and a U.S. citizen/permanent resident. I obtained your name and address from the Office of the Registrar. Approximately six hundred students will take part in this study at [this university].

At the end of this email I have provided a URL link to an online survey. If you agree to participate in this study, I ask that you complete the survey which asks questions about your academic and family background, the kind of financial support you have received as a graduate student and its value to you, the value of your interactions and relationships with your faculty and peers, and the impact of your department's policies and practices on your Ph.D. progress. The survey will take 20 to 25 minutes to complete. You are free to skip any questions that you would prefer not to answer or end your participation at any time by closing the web browser without submitting the survey.

If you choose to not participate in this survey, please reply to this e-mail with the statement "Do not contact." If I do not hear from you and if you do not submit a survey, I will be contacting you in approximately one week to provide a friendly reminder about the survey.

I will keep the information you provide confidential, however federal regulatory agencies and [this university's] Institutional Review Board (a committee that reviews and

approves research studies) may inspect and copy records pertaining to this research. To help protect your confidentiality, we will use a numerical code to identify your responses. The study identification code will be linked to your email address and name. The list linking your name and your study identification code will be stored in a separate location that is accessible only to the researcher. All study forms and data will be maintained in locked offices and in password protected computer files. When I write a report about this study I will do so in such a way that you cannot be identified.

There are no known risks from being in this study, and you will not benefit personally. However I hope that others may benefit in the future from what we learn as a result of this study.

You will not have any costs for being in this research study. You will not be paid for being in this research study. Taking part in this research study is completely voluntary. If you decide not to be in this study, or if you stop participating at any time, you won't be penalized or lose any benefits for which you otherwise qualify.

If you have any questions about the research study itself or to report a research related injury, please contact me at [telephone number] or [email address]. If you have questions about the rights of research subjects, please contact the Human Subjects Office at [address]. To offer input about your experiences as a research subject or to speak to someone other than the research staff, call the Human Subjects Office at the number above.

Thank you very much for your consideration. It is my hope that you will take a few moment to fill out the survey.

If you agree to participate in the study, please click on the link below which will take you to the survey. After completing the survey, click on the SUBMIT button. Your response to the survey will serve as an indication of your willingness to participate in this study.

Click on the link below to access the web-survey.

|LINK1|

Sincerely,

Margaret Mwenda

III. Survey Reminder for First Group of Students

Dear |Student|,

This is a friendly reminder to participate in a research study on doctoral students' experiences in science, technology, engineering, and mathematics (STEM) disciplines. As you may recall, the purpose of the study is to examine minority students' experiences, and to compare them with non-minority experiences, as they relate to financial support, interactions with faculty and peers, departmental climate, and background factors at the doctoral level. The results of this study will be a part of my doctoral dissertation.

I invited you to be in this study because you are listed as a Ph.D. student enrolled in a science program at [this university] and a U.S citizen/resident. I obtained your name and address from the Office of the Registrar. Approximately six hundred students will take part in this study at [this university].

At the end of this email I have provided a URL link to an online survey. If you agree to participate in the study, I ask that you complete the survey which asks questions about your academic and family background, the kind of financial support you have received as a graduate student and its value to you, the value of your interactions and relationships with your faculty and peers, and the impact of your department's policies and practices on your Ph.D. progress. The survey will take 20 to 25 minutes to complete. You may skip any questions that you would prefer not to answer or end your participation at any time by closing the web browser without submitting the survey.

If you choose to not participate in this survey, reply to this e-mail with the statement "Do not contact." If I do not hear from you and if you do not submit a survey, I will email you a similar reminder a week from now.

I will keep the information you provide confidential, however federal regulatory agencies and the [university's] Institutional Review Board (a committee that reviews and approves research studies) may inspect and copy records pertaining to this research. To help protect your confidentiality, we will use a numerical code to identify your responses.

The study identification code will be linked to your email address and name. The list linking your name and your study identification code will be stored in a separate location that is accessible only to the researchers. All study forms and data will be maintained in locked offices and in password protected computer files. When I write a report about this study I will do so in such a way that you cannot be identified.

There are no known risks from being in this study, and you will not benefit personally. However I hope that others may benefit in the future from what we learn as a result of this study.

You will not have any costs for being in this research study. You will not be paid for being in this research study. Taking part in this research study is completely voluntary. If you decide not to be in this study, or if you stop participating at any time, you won't be penalized or lose any benefits for which you otherwise qualify.

If you have any questions about the research study itself or to report a research related injury, please contact me at [telephone number] or [email]. If you have questions about the rights of research subjects, please contact the Human Subjects Office at [address]. To offer input about your experiences as a research subject or to speak to someone other than the research staff, call the Human Subjects Office at the number above.

Thank you very much for your consideration. It is my hope that you will take a few moment to fill out the survey. The link to the survey is provided below.

If you agree to participate in the study, please click on the link which will take you to the survey. After completing the survey, click on the SUBMIT button. Your response to the survey will serve as an indication of your willingness to participate in this study.

Click on the link below to access the web-survey.

|LINK1|

Sincerely,

Margaret Mwenda

IV. Pre-Survey Invitation for Second Group Students

Dear |Student|,

I am writing to invite you to participate in a research study. The purpose of the study is to examine minority students' experiences, and to compare them with non-minority students' experiences, as they relate to financial support, interactions with faculty and peers, departmental climate, and background factors at the doctoral level. The results of this study will be a part of my doctoral dissertation.

I am inviting you to be in this study because you are listed as a Ph.D. student enrolled in a science program at [this university] and a U.S. citizen/permanent resident. I obtained your name and address from the Office of the Registrar. Approximately six hundred students will take part in this study at [this university].

If you agree to participate, you will be asked to complete an online survey which asks questions about your academic and family background, the kind of financial support you have received as a graduate student and its value to you, the value of your interactions and relationships with your faculty and peers, and the impact of your department's policies and practices on your Ph.D. progress. The survey will take 20 to 25 minutes to complete.

Please respond to this email in one of three ways: 1) Yes, I am interested in participating; 2) No, I am not interested in participating; or 3) Maybe, contact me.

In one week, I will send you an e-mail with additional information about the study and a URL link to the survey to those who express an interest. If your response is "maybe" please let me know the best way to contact you. If you have any questions about the research study itself, please contact me at [telephone number] or [email address]. Thank you very much for your consideration of my research study.

Sincerely,

Margaret Mwenda

V. Survey Invitation with URL for Second Group of
Students

Dear |Student|,

Following my communication last week, I am writing to invite you to take a survey whose link is posted at the end of this email. As I mentioned earlier, the purpose of this study is to examine minority students' experiences, and to compare these with non-minority students' experiences, as they relate to financial support, interactions with faculty and peers, departmental climate, and background factors at the doctoral level. The results of this study will be a part of my doctoral dissertation.

I am inviting you to be in this study because you are listed as a Ph.D. student enrolled in a science program at [this university] and a U.S. citizen/permanent resident. I obtained your name and address from the Office of the Registrar. Approximately six hundred students will take part in this study at [this university].

At the end of this email I have provided a URL link to an online survey. If you agree to participate in this study, I ask that you complete the survey which asks questions about your academic and family background, the kind of financial support you have received as a graduate student and its value to you, the value of your interactions and relationships with your faculty and peers, and the impact of your department's policies and practices on your Ph.D. progress. The survey will take 20 to 25 minutes to complete. You are free to skip any questions that you would prefer not to answer or end your participation at any time by closing the web browser without submitting the survey.

If you choose to not participate in this survey, please reply to this e-mail with the statement "Do not contact." If I do not hear from you and if you do not submit a survey, I will be contacting you in approximately one week to provide a friendly reminder about the survey.

I will keep the information you provide confidential, however federal regulatory agencies and [the university's] Institutional Review Board (a committee that reviews and

approves research studies) may inspect and copy records pertaining to this research. To help protect your confidentiality, we will use a numerical code to identify your responses. The study identification code will be linked to your email address and name. The list linking your name and your study identification code will be stored in a separate location that is accessible only to the researcher. All study forms and data will be maintained in locked offices and in password protected computer files. When I write a report about this study I will do so in such a way that you cannot be identified.

There are no known risks from being in this study, and you will not benefit personally. However I hope that others may benefit in the future from what we learn as a result of this study.

You will not have any costs for being in this research study. You will not be paid for being in this research study. Taking part in this research study is completely voluntary. If you decide not to be in this study, or if you stop participating at any time, you won't be penalized or lose any benefits for which you otherwise qualify.

If you have any questions about the research study itself or to report a research related injury, please contact me at [telephone number] or [email address]. If you have questions about the rights of research subjects, please contact the Human Subjects Office at [address]. To offer input about your experiences as a research subject or to speak to someone other than the research staff, call the Human Subjects Office at the number above.

Thank you very much for your consideration. It is my hope that you will take a few moment to fill out the survey.

If you agree to participate in the study, please click on the link below which will take you to the survey. After completing the survey, click on the SUBMIT button.

Your response to the survey will serve as an indication of your willingness to participate in this study.

Click on the link below to access the web-survey.

|LINK1|

Sincerely,

Margaret Mwenda

VI. Survey Reminder for Second Group of Students

Dear |Student|,

This is a friendly reminder to participate in a research study on doctoral students' experiences in science, technology, engineering, and mathematics (STEM) disciplines. At the end of this email I have provided a URL link to an online survey. As you may recall, the purpose of the study is to examine minority students' experiences, and to compare them with non-minority experiences, as they relate to financial support, interactions with faculty and peers, departmental climate, and background factors at the doctoral level. The results of this study will be a part of my doctoral dissertation.

I invited you to be in this study because you are listed as a Ph.D. student enrolled in a science program at [this university] and a U.S citizen/resident. I obtained your name and address from the Office of the Registrar. Approximately six hundred students will take part in this study at [this university].

If you agree to participate in the study, I ask that you complete the survey which asks questions about your academic and family background, the kind of financial support you have received as a graduate student and its value to you, the value of your interactions and relationships with your faculty and peers, and the impact of your department's policies and practices on your Ph.D. progress. The survey will take 20 to 25 minutes to complete. You may skip any questions that you would prefer not to answer or end your participation at any time by closing the web browser without submitting the survey.

If you choose to not participate in this survey, reply to this e-mail with the statement "Do not contact." If I do not hear from you and if you do not submit a survey, I will email you a similar reminder a week from now.

I will keep the information you provide confidential, however federal regulatory agencies and the [university's] Institutional Review Board (a committee that reviews and approves research studies) may inspect and copy records pertaining to this research. To

help protect your confidentiality, we will use a numerical code to identify your responses. The study identification code will be linked to your email address and name. The list linking your name and your study identification code will be stored in a separate location that is accessible only to the researchers. All study forms and data will be maintained in locked offices and in password protected computer files. When I write a report about this study I will do so in such a way that you cannot be identified.

There are no known risks from being in this study, and you will not benefit personally. However I hope that others may benefit in the future from what we learn as a result of this study.

You will not have any costs for being in this research study. You will not be paid for being in this research study. Taking part in this research study is completely voluntary. If you decide not to be in this study, or if you stop participating at any time, you won't be penalized or lose any benefits for which you otherwise qualify.

If you have any questions about the research study itself or to report a research related injury, please contact me at [telephone number] or [email]. If you have questions about the rights of research subjects, please contact the Human Subjects Office at [address]. To offer input about your experiences as a research subject or to speak to someone other than the research staff, call the Human Subjects Office at the number above.

Thank you very much for your consideration. It is my hope that you will take a few moment to fill out the survey. The link to the survey is provided below.

If you agree to participate in the study, please click on the link which will take you to the survey. After completing the survey, click on the SUBMIT button. Your response to the survey will serve as an indication of your willingness to participate in this study.

Click on the link below to access the web-survey.

|LINK1|

Sincerely,

Margaret Mwenda

VII. Thank You Note for All Participants

Dear |Student|

This is to thank you for participating in my study about graduate student experiences. I truly appreciate your willingness to take the time and effort to fill the survey. Many thanks.

Sincerely,

Margaret Mwenda

APPENDIX B
DATA COLLECTION INSTRUMENTS

I. Survey of Doctoral Students in STEM Fields

This survey asks how your experiences as Ph.D. students in science programs are affected by financial aid, background information, your relationship and interactions with faculty and peers, and your departments' practices. The survey has five sections that ask about your academic experiences and achievements, financial support and its impact on several outcomes, interaction with faculty and peers, department, and background (demographics).

Please take approximately 25 minutes now to respond to the survey. You can start it now and return to it later to complete it. Individual respondents or responses will not be identified.

1. What academic program are you in? (e.g. Engineering)

2. What is your academic major? (e.g. Industrial engineering)

3. Semester you started your Ph.D. program:

_____Fall

_____Spring

_____Summer

4. Year of Ph.D. program entry (e.g. 2004).
5. Semester you anticipate completing your Ph.D. program:
_____Fall
_____Spring
_____Summer
6. Year of anticipated Ph.D. completion (e.g. 2009).
7. Cumulative Ph.D. GPA: _____
8. I have presented a research paper/poster at the following conferences during my Ph.D. program (Check all that apply).
_____International conference
_____National Conference
_____Regional Conference
_____UI Conference
_____Other

If you selected other, please specify:

9. How many times have you presented or co-presented paper(s) or poster(s) at conferences/symposia while in your Ph.D. program? (This is a total of all the

conferences at which you have made a presentation. For instance, if you presented at a National Science Foundation conference twice and at the National Institute of Health Annual conference three times, your total would be five).

10. Number of publications (e.g. articles, book chapters, books) you have published or co-published with peers or faculty:

11. This question asks about the type of financial support you have received in your graduate study. For each of the semesters, please indicate the type of funding you received. If you received multiple types of funding, select all that apply for that particular semester or year. For the year(s)/semester(s) that does not apply to you (either because you were not enrolled yet or you stopped out for any reason), please select "not applicable."

Some definitions:

- i. Fellowships - nationally competitive financial awards granted directly by sponsoring organization (e.g. Ford Foundation)
- ii. Traineeship - financial support awarded by individual academic departments or institutions including university related fellowships
- iii. Loans - loans provided by federal government and other loans from market-based lenders
- iv. Teaching Assistantship - university related funding that requires teaching services
- v. Research Assistantship - university related funding that requires research services

12. This section asks about your perception of the value of different types of financial support and the role such support plays in your continued enrollment in your Ph.D. program.

Please indicate the extent to which each type of financial aid listed below has been beneficial in enabling you to stay enrolled in your Ph.D. program.

Some definitions:

1. Fellowships - nationally competitive financial awards granted directly by sponsoring organization (e.g. Ford Foundation)
2. Traineeship - financial support awarded by individual academic departments or institutions including university related fellowships
3. Loans - loans provided by federal government and other loans from market-based lenders
4. Teaching Assistantship - university related funding that requires teaching services
5. Research Assistantship - university related funding that requires research services

Forms of Financial Aid	Very Beneficial	Moderately Beneficial	Not at all Beneficial	I have not had this kind of financial support
Research Assistantship				
Teaching Assistantship				
Fellowship				
Traineeship				
Loans				
Off-campus employment				
Other Sources of funds				

13. Below are several statements about changes or outcomes that may have occurred as a result of your graduate education. Please indicate the degree to which you agree or disagree that your assistantship(s) and/or fellowship(s) contributed to the outcomes. If you did not experience the outcomes below as a result of your assistantship(s) or fellowships(s), please select "not applicable."

As a result of my assistantship(s) and/or fellowship(s):

Outcomes	Strongly Agree	Moderately Agree	Moderately Disagree	Strongly Disagree	Not Applicable
I developed strong research skills					
I developed strong teaching skills					
I improved time management skills					
My knowledge of issues in my discipline/field increased					
My understanding of the expectations of my profession increased					
I developed skills (e.g. teaching & research) that I would not have developed otherwise					
I received opportunities to conduct collaborative research with faculty					
I received opportunities to conduct collaborative research with peers					
The amount of work required negatively impacted my academic performance					

14. Please indicate the degree to which you agree or disagree that your assistantship(s) and/or fellowship(s) contributed to the outcomes listed below. If you did not experience the outcomes below, please select "not applicable."

In general:

Outcomes	Strongly Agree	Moderately Agree	Moderately Disagree	Strongly Disagree	Not Applicable
My teaching responsibilities slow down my progress towards Ph.D. completion					
My teaching responsibilities provide training for the requirements in my profession					
My research responsibilities provide training for the requirements in my profession					
I would not re-enroll in my program semester after semester without financial aid					
I would encourage all doctoral students to seek financial aid which requires teaching					
I would encourage all doctoral students to seek financial aid which requires research					

15. These questions ask about your relationship/interaction with your advisor(s) and peers. Below is a list of faculty advisor and peer characteristics that you may have experienced in your doctoral program.

Please indicate, on the left columns how important these characteristics or attributes are in enabling you to be successful (e.g. academic performance, participation in academic activities, continued enrollment) in your Ph.D. program. Also indicate, on the right columns the extent to which you have experienced these characteristics or attributes with faculty advisor(s) and peers in your program.

Faculty or Peer Interactions	How important are the following advisor and peer characteristics to your Ph.D. success				To what extent have you experienced these attributes in your Ph.D. program?		
	Very Important	Moderately Important	Moderately Unimportant	Not at all Important	Always	Sometimes	Never
Faculty accessibility							
Open and honest communication with faculty							
Trust between you and faculty advisor							
Faculty advisor approachability							
Faculty advisor's interest in personal welfare							

Question 15 continued.

Faculty advisor's willingness to share opportunities for professional development							
Career advising by faculty advisor							
Informal (social) interactions with faculty advisor							
Faculty advisor treating you as junior colleague							
Peer academic support (e.g. study groups)							
Peer social support							
Peer academic advice (e.g. coursework, critique of work)							
Peer advice on departmental policies/practices							

16. Please describe other faculty advisor and peer attributes that you feel enhance your success in graduate school.

17. Please describe ways in which your faculty advisor has had an impact (negative/positive) on your Ph.D. success (e.g. academic performance - GPA, collaborative research, preparing for comprehensive exams, dissertation progress)?

18. Please describe ways in which your peers (fellow Ph.D. students) have affected (negative/positive) your Ph.D. success (e.g. academic performance - GPA, collaborative research, comprehensive exams, and dissertation).

Background Characteristics

19. Age_____

20. Sex

_____male

_____female

21. Please select race/ethnic background that best applies to you.

- African American
 Hispanic
 American Indian/Alaskan Native
 White
 Asian American/Pacific Islander
 Other

If you selected other, please specify: _____

22. Marital status

- Married
 Single
 Other

If you selected other, please specify: _____

23. Number of dependents living with you: _____

24. What impact (negative/positive), if any, do the background characteristics listed above have on your Ph.D. success (e.g. academic performance, publications, dissertation research, progress toward completion)?

Thank you for your participation!

II. Interview Questions

Introduction Question

1. What made you grow interested in mathematics/science?

Financial Support Question

2. What types of financial aid have you received through your doctoral degree to the present?
3. How has the financial aid/support you have reported receiving in your graduate study been beneficial/of value to you as a graduate student?
4. Are there any aspects of financial support that were not beneficial

Faculty Advisor & Peer Questions

5. Do you have an advisor or a mentor?
6. How would you describe your relationship with your advisor?
7. How would you describe your relationship and interactions with your mentor?
8. In what ways has your advisor-advisee relationship and interactions been beneficial (or not beneficial) to your success as a doctoral student?
9. Describe the nature of your interactions with your peers in your department.
10. What role have your peers played in facilitating your success (academic and social) as a doctoral student?
11. Are there interactions that are not beneficial?

Background Information Question

12. What background factors and individual characteristics do you attribute to your success as a doctoral student? (Race, gender, marital status, other).

13. In what ways do these factors present challenges, if any? (Success includes academic performance; passing of qualifying examinations; presenting at conferences and progress through the doctoral program).

Alternatively: How have your background factors (e.g. race, gender, SES) and individual characteristics either negatively or positively affected your experiences (both academic and social) as a doctoral student in your discipline?

Closing Questions

14. Among all the things we have discussed (background factors, financial support, advisor-advisee relationships, and peer relationships) which one(s) has/have facilitated/contributed to your academic performance and progress towards completion of your doctorate the most?
15. Which of the above have presented the most challenges to your professional development, sense of belonging, and progress towards completion?

APPENDIX C
INFORMED CONSENT DOCUMENT

Project Title: Experiences of Doctoral Students in STEM Programs: Background Factors, Financial Support, & Relationships with Faculty and Peers

Principal Investigator: Margaret Mwenda

This consent form describes the research study to help you decide if you want to participate. This form provides important information about what you will be asked to do during the study, about the risks and benefits of the study, and about your rights as a research participant. If you have any questions about or do not understand something in this form, you should ask the research team for more information. You should discuss your participation with anyone you choose such as family or friends. Do not agree to participate in this study unless the research team has answered your questions and you decide that you want to be part of this study.

This is a research study. I am inviting you to participate in this research study because you are a doctoral minority student in one of the Science, Technology, Engineering, or Mathematics discipline at [this university]. The purpose of the study is to examine minority students' experiences as they relate to financial support, interactions with faculty and peers, departmental climate, and background factors at the doctoral level. Approximately 30 people will take part in this study at [this university]. The results of this study will be a part of my doctoral dissertation.

If you agree to take part in this study, your involvement will last for approximately two hours. This will be a one-time focus group participation with a follow-up approximately one month after the focus group, if the need arises, to clarify data that may not be clear.

You will be asked to answer two sets of questions: one, a questionnaire with approximately 15 questions; and two, focus group questions that builds on the questionnaire questions. You will be asked to fill out a section on the questionnaire.

After you have answered the questions, the group will discuss the responses to the questions. For instance, the questionnaire will ask about the type of financial aid you have received while in graduate school and this will be followed by a focus group discussion about benefits of such financial packages. We will follow this process for other sections of the questionnaire including your background information, your interactions with faculty and peer, and your experience within your academic department. You will be asked to provide your e-mail address on the paper survey to enable me to send you a copy of the analysis of the focus group results so that you can verify the accuracy with which I have presented your views and perceptions. This will also allow you to edit the content of my analysis to render it accurate. You will be asked to give your questionnaire to the researcher at the end of the group discussion. These procedures will be conducted in a conference room within your academic department or college. You can skip any question that you prefer not to answer on the questionnaire and during the group discussion.

One aspect of this study involves making audio recordings of the focus group discussion. The recording will ensure the accuracy of the proceedings of the focus group and thereafter accuracy of analysis and conclusions. I will use a digital recorder for the focus group discussion and no one but me will have access to the data. I will destroy the digital data as soon as I have transcribed the focus group discussion and saved the transcript as a password-protected document on my personal computer in my home office.

You may be uncomfortable discussing your personal history and information with the group. You do not have to participate in any discussions or present any information that you do not wish to disclose.

It is possible that the things you talk about in the group discussion may not be kept confidential. We will talk about the confidentiality of information discussed during

the group session and will encourage all participants to keep what is heard during the discussions confidential.

You will not benefit personally from being in this study. However, we hope that others may benefit in the future from what we learn as a result of this study.

You will not have any costs for being in this research study. You will not be paid for being in this research study.

I will keep your participation in this research study confidential to the extent permitted by law. However, federal regulatory agencies and [the university's] Institutional Review Board (a committee that reviews and approves research studies) may inspect and copy records pertaining to this research. To help protect your confidentiality, we will use a numerical code to identify your study information. The study identification code will be linked to your email and name. The list linking your name and your study identification code will be stored in a separate location that is accessible only to the researcher. All study forms and data will be maintained in locked offices and in password protected computer files. The audio recording of the group discussion will be stored in a password protected file and will be transcribed at which time I will remove all forms of identifiers including names of persons. Further, when I write my dissertation about this study or share the study data set with others, I will do so in such a way that you cannot be directly identified.

Taking part in this research study is completely voluntary. You may choose not to take part at all. If you decide to be in this study, you may stop participating at any time. If you decide not to be in this study, or if you stop participating at any time, you won't be penalized or lose any benefits for which you otherwise qualify

I encourage you to ask questions. If you have any questions about the research study itself or to report a research related injury, please contact me at [telephone number].

If you have questions, concerns, or complaints about your rights as a research subject or about research related injury, please contact the Human Subjects Office at

[address]. General information about being a research subject can be found by clicking on the Human Subjects Office web site [URL link]. To offer input about your experiences as a research subject or to speak to someone other than the research staff, call the Human Subjects Office at the number above.

If you agree to be in the study, please e-mail me and I will contact you with the time and location of the focus group session. If you do not wish to be in the study, please let me know in an e-mail reply. Thank you very much for your consideration of the study

REFERENCES

- Abedi, J. & Benkin, E. (1987). The effects of students' academic, financial, and demographic variables on time-to-completion. *Research in Higher Education*, 27(1), 3-14.
- Astin, A. W. (1975). *Financial aid and student persistence* (Report No. HERI-75-1). Los Angeles, CA: Higher Education Research Institute. (ERIC Document Reproduction Service No. ED112804).
- Austin, A. E. (2002). Preparing the next generation of faculty: graduate school as socialization to academic careers. *The Journal of Higher Education*, 73(1), 94-122.
- Bair, C. R. & Haworth, J.G. (1999). *Doctoral student attrition and persistence: A meta-synthesis of research*. Paper presented at the annual meeting of the Association for the Study of Higher Education, San Antonio, TX. (ERIC Document Reproduction Service No. ED437008)
- Bean, J. P. & Eaton, S.G. (2001). A psychological model of college student retention. In J. M. Braxton (Ed.), *Reworking the student departure puzzle* (pp. 48-60). Nashville, TN: Vanderbilt University Press.
- Bean, J. P. & Metzner, B. S. (1985). A conceptual model of nontraditional undergraduate student attrition. *Review of Educational Research*, 55(4), 485-540.
- Berg, H. M. & Ferber, M.A. (1983). Men and women graduate students: Who succeeds and why? *Journal of Higher Education*, 54(6), 163-189.
- Black, T. R. (1999). *Doing quantitative research in the social sciences: An integrated approach to research design, measurement, and statistics*. Thousand Oaks, CA: SAGE
- Border, C. B. & Barba, W. C. (1998). *Graduate student support and the graduate education experience*. Paper presented at the Annual Meeting of the Association for the Study of Higher Education, Miami, Florida. Retrieved from ERIC database. (ED 427577).
- Bowen, W. G. & Rudenstine, N. L. (1992). *In pursuit of the Ph.D.*. Princeton, NJ: Princeton University Press.
- Brazziel, M.E and Brazziel, W.F. (2001). Factors in decision of underrepresented minorities to forgo science and engineering doctoral study: A pilot study. *Journal of Science Education and Technology*, 10(3), 273-281.
- Brus, C. P. (2006). Seeking balance in graduate school: A realistic expectation or a dangerous dilemma? *New Directions for Student Services*, 115, 31-45.
- Bureau of Labor Statistics (2010-11). U.S. Department of Labor. *Occupational Outlook Handbook, 2010-11 Edition*, Retrieved April 5th, 2010 from <http://www.bls.gov/oco/oco2003.htm>

- Capomacchia, A.C. and Garner, S.T. (2004). Challenges of recruiting American minority graduate students: The coach model. *American Journal of Pharmaceutical Education*, 68(4).
- Caracelli, V.J. & Greene, J. C. (1993). Data analysis strategies for mixed-method evaluation designs. *Educational Evaluation and Policy Analysis*, 15(2), 195-207.
- Chubin, D. E., May, G. S., & Babco, E. L. (2005). Diversifying the engineering workforce. *Journal of Engineering Education*, 2005.
- Chubin, D. E. & Malcom, S. M. (October 6, 2008). Making a case for diversity. *Inside Higher Ed*. Retrieved April 1, 2010 from <http://www.insidehighered.com/views/2008/10/06/chubin>.
- Council of Graduate Schools (2007). *Graduate education: The backbone of American competitiveness and innovation*. Washington, D.C. Retrived April 27, 2010 from http://www.cgsnet.org/portals/0/pdf/GR_GradEdAmComp_0407.pdf
- Creswell, J. W. & Miller, D. L. (2000). Determining validity in qualitative inquiry. *Theory into Practice*, 39(3), 124-130.
- Creswell, J. W. (2003). *Research design: Qualitative, quantitative, and mixed methods approaches*. Thousand Oaks, CA: Sage Publications
- Curtis, M. J. & Hunley, S. A. (1994). *Minority and non-minority undergraduate psychology majors' familiarity with school psychology and factors in their selection of graduate schools*. Paper presented at the Annual Meeting of the National Association of School Psychologist, Seattle, WA. (ERIC Document Reproduction Service No. ED371272).
- Davidson, M. and Foster-Johnson, L. (2001). Mentoring in the preparation of graduate researchers of color. *Review of Educational Research*, 7(4), 549-574.
- De Valero, Y. F. (2001). Departmental factors affecting time-to-degree and completion rates of doctoral students at one land-grant research institution. *The Journal of Higher Education*, 72(3), 341-367.
- Dillman, D.A. (2000). *Mail and Internet surveys: The tailored design method*. New York: Wiley.
- Durkheim, E. (1953). *Sociology and philosophy*. Glencoe, IL: 1953
- Ellinger, A. D., Watkins, K. E., & Marsick, V. J. (2005). Chapter 19 – Case study research methods. In R. A. Swanson & E. F. Holton III (Eds.), *Research in organizations: Foundations and methods of inquiry*. Retrieved from http://library.books24x7.com.proxy.lib.uiowa.edu/book/id_11859/viewer.asp?bookid=11859&chunkid=0923726601
- Ehrenberg, R. G. & Mavros, P. G. (1995). Do doctoral students' financial support patterns affect their time-to-degree and completion probability? *The Journal of Human Resources*, 30(3), 581-609.

- Fries-Britt, S. & K. A. Griffin. (2007). The black box: how high-achieving Blacks resist stereotypes about Black Americans. *Journal of College Student Development*, 48(5), 509-524.
- Gardner, S. K. (2007). I heard it through the grapevine: Doctoral student socialization in chemistry and history. *Higher Education*, 54(5), 723-740.
- Gardner, S. K. (2008). What's too much and what's too little? The process of becoming an independent researcher in doctoral education. *The Journal of Higher Education*, 79(3), 326-350.
- Girves, J. E. & Wemmerus, V. (1988). Developing models of graduate student degree progress. *The Journal of Higher Education*, 59(2), 163-189.
- Glaser, B. G. & Strauss, A. (1967). *The discovery of grounded theory: Strategies for qualitative research*. Chicago, IL: Aldine.
- Golde, C. M. (1996). How departmental contextual factors shape doctoral student attrition. *Dissertation Abstracts International*. 57(08), 3415A. Retrieved March 23, 2010, from ProQuest Digital Dissertations database. (Publication No. AAT 9702896).
- Golde, C. M. (1998). Beginning graduate school: Explaining first year doctoral attrition. In M.S. Anderson (Ed.), *The experience of being in graduate school: An exploration* (pp. 55-64). San Francisco, CA: Jossey-Bass.
- Golde, C. M. (2000). Should I stay or should I go? Student descriptions of the doctoral attrition process. *Review of Higher Education*, 23(2), 199-227.
- Golde, C. M. (2005). The role of department and discipline in doctoral student attrition: Lessons from four departments. *The Journal of Higher Education*, 76(6), 669-700.
- Gonzalez, J. C. (2006). Academic socialization experiences of Latina doctoral students: A qualitative understanding of support systems that aid and challenges that hinder the process. *Journal of Hispanic Higher Education* 5(4), 347-365.
- Greene, J.C., Caracelli, V. J., & Graham, W. F. (1989). Towards a conceptual framework for mixed-method evaluation designs. *Educational Evaluation and Policy Analysis*, 11(3), 255 – 274.
- Hagedorn, L. S. (2005). How to measure retention: A new look at an old problem. In Alan Seidman (Ed.), *College student retention: Formula for student success* (pp. 89-105). Westport, CT: American Council on Education and Praeger Publishers.
- Hall, R. M. & Sandler, B.R. (1982). *The classroom climate: A chilly college climate for women?* Washington: Association of American Colleges.
- Herzig, A.H. (2002). Where have all the students gone? Participation of doctoral students in authentic mathematical activity as a necessary condition for persistence towards the Ph.D. *Educational Studies in Mathematics*, 50(2), 177-212.
- Herzig, A.H. (2004). Becoming mathematicians: Women and students of color choosing and leaving doctoral mathematics. *Review of Educational Research*, 74(2), 171-214.

- Hill, R.D., Castillo, L.G., Ngu, L.Q., and Pepion, K. (1999). Mentoring ethnic minority students for careers in academia: The WICHE doctoral scholars program. *The Counseling Psychologist* 27(6), 827-845.
- Hoffer, T.B., Welch, V., Williams, K., Hess, M. (2007). *Doctorate Recipients from United States Universities: Summary Report 2006*. Chicago, IL: National Opinion Research Center.
- Lovitts, B. E. (2001). *Leaving the ivory tower. The causes and consequences of departure from doctoral study*. Lanham, MD: Rowman and Littlefield.
- Malcom, S. M., Chubin, D. E., & Jesse, J. K. (2004). *Standing our ground: A guidebook for STEM educators in the post-Michigan era*. American Association for the Advancement of Science, Washington, D.C. Retrieved April 27, 2010 from http://www.aaas.org/standingourground/PDFs/Standing_Our_Ground.pdf.
- Merriam, S. B. (1998). *Qualitative research and the case study application in education*. San Francisco, CA: Jossey-Bass Publishers.
- Metz, G. W. (2004). Challenges and changes to Tinto's persistence theory: A historical review. *Journal of College Student Retention*, 6(2), 191-207.
- Millet, C.M. & Nettles, M. T. (2006a). *Three magic letters: Getting to Ph.D.* Baltimore, MD: The John Hopkins University Press.
- Millet, C.M. & Nettles, M.T. (2006b). Expanding and cultivating the Hispanic STEM doctoral workforce: Research on doctoral student experiences. *Journal of Hispanic Higher Education* 5(3), 258-287.
- Morris, L.K. & Daniel, L.G. (2008). Perceptions of a chilly climate: Differences in traditional and non-traditional majors for women. *Research in Higher Education*, 49, 256-273.
- Munoz-Dunbar, R. & Stanton, A. L. (1999). Ethnic diversity in Clinical Psychology : Recruitment and admission practices among doctoral programs. *Teaching Psychology* 26(4), 259- 263.
- National Academy of Sciences. (2007). *Rising above a gathering storm: energizing and employing America for a brighter economic future*. Washing D.C. Retrieved February 15th, 2010 from http://books.nap.edu/openbook.php?record_id=11463&page=68
- National Coordination Office for Information Technology Research and Development. (2005). *Computational science: ensuring America's competitiveness*. Arlington, VA. Retrieved February 15th, 2010 from http://www.nitrd.gov/pitac/reports/20050609_computational/computational.pdf
- National Economic Council. (2009). *A strategy for American innovation: driving towards sustainable growth and quality jobs*. Retrieved February 15, 2010 from <http://www.whitehouse.gov/administration/eop/nec/StrategyforAmericanInnovation/>
- National Science Board. (2010). *Science and Engineering Indicators: 2010*. Arlington, VA (NSB 10-01). Retrieved February 15th, 2010 from <http://www.nsf.gov/statistics/seind10/pdf/front.pdf>

- National Science Foundation, Division of Science Resources Statistics (2006). *Science and Engineering Indicators 2006*. Arlington, VA (NSB 06-01). Retrieved November 28, 2007 from <http://www.nsf.gov/statistics/seind06/c2/c2h.htm> .
- National Science Foundation, Division of Science Resources Statistics (2009). *Women, minorities, and persons with disabilities in science and engineering: 2009*, NSF 09-305, Arlington, VA. Retrieved April 20, 2010 from <http://www.nsf.gov/statistics/wmpd/pdf/nsf09305.pdf>
- National Science Foundation, Division of Science Resources Studies(2000), *Modes of Financial Support in the Graduate Education of Science and Engineering Doctorate Recipients*, NSF 00-319, Mark Morgan, Quantum Research Corporation; Joan S. Burrelli and Alan I. Rapoport, NSF/SRS (Arlington, VA 2000).
- National Science Foundation (2009). *Scholarship in Science, Technology, Engineering and Mathematics (S-STEM)*. Retrieved November 1, 2009 from http://www.nsf.gov/pubs/2009/nsf09567/nsf09567.htm#pgm_intr_txt.
- National Science Foundation (2009). *Evaluation of NSF's program of grants and Vertical Integration of Education in the Mathematical Sciences (VIGRE)*. National Science Academies, Washington: D.C. Retrieved March 20th, 2010 from http://www.nap.edu/openbook.php?record_id=12716&page=R1
- Nerad, M. & Cerny, J. (1993). From facts to action: Expanding the graduate division's educational role. In L. L. Baird (Ed.), *Increasing graduate student retention and degree attainment* (pp. 27-29). San Francisco, CA: Jossey-Bass.
- Nerad, M. & Miller, S. M. (1996). Increasing student retention in graduate and professional programs. In J. G. Haworth (Ed.), *Assessing graduate and professional education: Current realities, future prospects* (pp. 61-76).
- Obama, B. (2009). Remarks by the president on the "Educate to Innovate" Campaign and science teaching and mentoring awards. Retrieved February 15th, 2010 from <http://www.whitehouse.gov/the-press-office/remarks-president-educate-innovate-campaign-and-science-teaching-and-mentoring-award>.
- Oden, K. L. (2003). The impact of the doctoral engineering environment on African-American and White students. *Dissertation Abstracts International*, 64(06), 2000A. Retrieved March 23, 2010, from ProQuest Digital Dissertations database. (Publication No. AAT 3095179).
- Pascarella, E. T. & Terenzini, P. T. (1980). Predicting freshman persistence and voluntary dropout decisions from a theoretical model. *The Journal of Higher Education*, 51(1), 60-75.
- Pascarella, E. T. & Terenzini, P. T., & Wolfle, L. M. (1986). Orientation to college and freshman year persistence/withdrawal decisions. *The Journal of Higher Education*, 57(2), 155-175.
- Pascarella, E. T. & Terenzini, P. T. (1990). *How college affects students: Findings and insights from Twenty years of research*. San Francisco, CA: Jossey-Bass.
- Rossmann, G. B. & Wilson, B. L. (1994). Numbers and words revisited: Being shamelessly eclectic. *Quality and Quantity*, 28, 315-327.

- Sedlacek, W. E. (1999). Black students on White campuses: 20 years of research. *Journal of College Student Development, 40*(5), 538-550.
- Spady, W. G. (1970). Dropouts from higher education: An interdisciplinary review and synthesis. *Interchange, 1*(1), 64-85.
- Steel, C. M. (1997). A threat in the air: How stereotypes shape intellectual identity and performance. *American Psychologist, 52*(6), 613-629.
- St. John, E. P. & Andrieu, S.C. (1995). The influence of price subsidies on within-year persistence by graduate students. *Higher Education, 29*(2), 143-168.
- Taylor, S. J. & Bogdan, R. (1998). *Introduction to qualitative research methods*. NY: John Wiley & Sons, Inc.
- Tinto, V. (1975). Dropout from higher education: A theoretical synthesis of recent research. *Review of Educational Research, 45*(1), 89-125.
- Tinto, V. (1993). *Leaving college: Rethinking the causes and cures of student attrition*. Chicago, IL: University of Chicago Press.
- U.S. Census Bureau. (2000). Demographic profiles. Retrieved April 5th, 2010 from <http://www.census.gov/prod/2001pubs/c2kbr01-1.pdf>
- U.S. Department of Education. (2009). *Graduate Assistance in Areas of National Need Program*. Federal Register: November 17, 2009 (Volume 74, Number 220). Washington, DC. Retrieved March 24, 2010 from <http://www2.ed.gov/legislation/FedRegister/announcements/2009-4/111709b.html>
- Vaquera, G. (2007). Testing theories of doctoral student persistence at a Hispanic service institution. *Journal of Student Retention, 9*(3), 283-305.
- Weidman, J. C., Twale, D. J., & Stein, E. L. (2001). *Socialization of graduate and professional students in higher education: A perilous passage?* San Francisco, CA: Jossey-Bass.
- Weidman, J. C. & Stein, E. L. (2003). Socialization of doctoral students to academic norms. *Research in Higher Education, 44*(6), 641-656.