ABSTRACT

LUNSFORD, LAURA GAIL. Mentoring and Talent Development: Doctoral Advisors and Their Protégés. (Under the direction of Denis O. Gray).

This study examines the effect of mentoring on five doctoral student outcomes: satisfaction with advisor, intellectual property events, publications, presentations, and degree progress. Psychosocial support, citizenship, discipline, and identity were examined as four moderator variables. Doctoral students who began their program between August, 2000 and January, 2003, provided information about mentoring from their advisor and other individuals, satisfaction with their advisor, doctoral productivity, and degree progress. Two mentoring factors, career and psychosocial support, significantly interact and predict satisfaction with advisor. At high levels of career or psychosocial support, this interaction has the most effect. Discipline was a significant moderator of career and psychosocial support on number of publications. Citizenship and identity were not significant moderators of mentoring and the five dependent variables. Number of semesters of undergraduate research was significantly related to satisfaction with advisor, intellectual property events, presentations, and degree progress. Most individuals reported having a network of mentors.
MENTORING AND TALENT DEVELOPMENT:
DOCTORAL ADVISORS AND THEIR PROTÉGÉS

by

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of North Carolina State University in partial
fulfillment of the requirements for the Degree of
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Chair of Advisory Committee
Denis O. Gray
DEDICATION

This dissertation is dedicated to the Park Scholars and their faculty mentors at NC State University who inspired me to understand better the complex phenomenon of mentoring on talent development.
BIOGRAPHY

Laura Gail Lunsford was born in Durham, North Carolina. She earned a B.A. in Psychology and a minor in French from NC State University, where she was awarded the John T. Caldwell Scholarship and selected as the 1988 Student Commencement Speaker. Lunsford earned a M.S. in Human Development and Family Studies from the University of North Carolina, at Greensboro, where she was a Holderness Fellow. She has worked at the North Carolina School of Science and Mathematics, the nation’s first residential, public boarding school; NC State University; and the Fuqua School of Business at Duke University. She was the first full-time director of the Park Scholarships program, now one of the most prestigious undergraduate merit scholarships in America. NC State named her the young alumna of the year in 2004 and in 2005 she participated in Rotary International’s Group Study Exchange Program to the Lesser Antilles. The NC State Department of Psychology awarded her the John Oliver Cook Dissertation Award in 2006. She was selected for the National Science Foundation 2007 East Asia and Pacific Summer Institute to develop international research collaborations in Australia.
ACKNOWLEDGEMENTS

I am deeply grateful for the excellent support, endlessly patient advice, and focused questions from Denis Gray, my dissertation chairman. My dissertation committee members, Craig Brookins, Lynne Baker-Ward, and Cathy Zimmer, have worked together well and for my benefit – thank you. The John Oliver Cook Dissertation Award from the NC State Department of Psychology provided important financial support for this study, for which I am appreciative. The fun rivalry with my friend Jennifer Schneider in the race to complete our respective theses, has provided a welcome relief to the tension and the anxiety associated with dissertation writing; I won.

Many faculty have been encouraging of my doctoral work. Two faculty warrant special mention. Paul Mulvey encouraged—or was that harassed?—me to apply to a PhD program, which to his credit included writing a letter of reference. My weekly conversations with Dr. Ridgeway, about mentoring and many other topics, improved my thinking about what it means to be a mentor.

Rena Subotnik, director, Center for Gifted Education Policy at the American Psychological Association, and Kathy Kram, professor of Organizational Behavior at Boston University, are two other individuals who have been generous with their time, expertise, and feedback to my early questions about mentoring.

I have been in graduate school for the duration of my marriage to Art Padilla and I am thankful for his support. His interest in mentoring and keen probing of my research questions increased my understanding of the topic. Our lively, intellectual discussions have made life much more interesting.
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INTRODUCTION

The social ties between scientific masters and apprentices are, as we shall see, enduring and consequential, for it is in the course of apprenticeships that young scientists learn the scientific role. (Zuckerman, 1977, p. 96)

Mentoring is an ancient concept. Two thousand years ago, Homer referred to the notion of mentoring in The Iliad. When Odysseus was faced with a long journey away from home, he left his son Telemachus under the care of his old friend Mentor. More recently, Zuckerman (1977) found that mentoring was central to the development of talented scientists who became Nobel Prize winners. The NSF considers mentoring so important that it annually confers a Presidential Award for Excellence in Science, Mathematics, and Engineering Mentoring and provides awardees a $10,000 grant to continue their work. Yet, we know remarkably little about mentoring, including what it means to mentor someone or how the process of mentoring works.

What is mentoring? Mentoring has been associated with peer mentoring, coaching, sponsorship, apprenticeship, teaching, and role modeling. While it remains an ill-defined construct, most researchers seem to define it as a one-on-one relationship between an experienced, usually older, person and a junior, inexperienced person (Allen, Eby, Poteet, Lentz, & Lima, 2004; Ehrich, Hansford, & Tennent, 2004).

Mentoring occurs in many settings. This study focuses on one of these, American doctoral graduate education. Graduate schools educate some of the nation’s most talented individuals. The process is a sort of modern-day guild, involving a graduate advisor who guides or mentors a graduate student through the
dissertation requirement, the capstone of doctoral education. Thus, doctoral education is an appropriate setting in which to explore further what behaviors and outcomes characterize mentoring relationships for talented individuals.

This paper will first present the rationale and objectives for this study. Then the literature on mentoring and doctoral students is reviewed. The study method is described next, followed by an analysis of the data. The paper concludes with a discussion of the results, including implications for future studies.

Statement of the Problem

No researcher has advanced an overarching, theoretical framework to describe the mentoring process. This deficit explains, in part, the disconnected research, lack of a mentoring construct, and haphazard advancement of knowledge (Jacobi, 1991; Merriam, Thomas, & Zeph, 1987) on the topic.

Protégés appear to benefit from having a mentor, but the findings account for a small amount of the variance. In the business and organizational management literature it is accepted that mentoring is a frequent occurrence and that employees who report having a mentor are significantly better compensated (Dreher & Cox, 1996), promoted more often (Roche, 1979), and more satisfied with their jobs and careers (Allen et al., 2004; Mobley, Jaret, Marsh, & Lim, 1994; Underhill, 2006), than employees who do not report having a mentor. However, the effect sizes in this literature are small (Allen et al., 2004). Similarly, studies of doctoral students report that 50-75% of students report having mentors and that these protégés have significantly more publications and are more satisfied with their program than non-mentored students (Cronan-Hillix, Gensheimer, Cronan-Hillix, & Davidson, 1986;
Nettles & Millett, 2006; Tenenbaum, Crosby, & Gliner, 2001); these effects are also small.

Another problem is that a casual relationship between mentoring and protégé benefits has not been established. It is possible that successful individuals, who might therefore attract a mentor, are more likely to make more money, receive promotions, or be more productive even without having a mentor. Perhaps having a mentor is merely a marker of a successful individual. If this were true, then assigning mentors or developing mentor programs might not have the same benefits for those, perhaps less talented, protégés. Only recently are mentoring researchers beginning to acknowledge that individual characteristics and conditions must also be considered when studying this relationship (Underhill, 2006).

We should know more about mentoring since it requires significant investment in time and resources (Allen et al., 2004; Merriam, 1983). There is little empirical support that mentoring contributes to protégé success. Knowing more about the psychological processes involved in the formation and development of mentoring relationships would be an important advance in our knowledge. In addition, knowing more about mentoring would allow organizations to focus limited resources on those mentoring relationships with the greatest positive outcomes.

Objectives

This study has three objectives. The first is to determine if mentoring influences student success. Specifically, are students who receive psychosocial support or career support more likely to graduate faster, produce more scholarly work, or be more satisfied with their advisor than students who do not receive such
support? The second objective is to investigate the conditions, suggested by the literature, under which mentoring might have the most positive benefits in terms of student satisfaction, scholarly productivity, and progress toward degree. Finally, this study explores the existence of a mentoring network for doctoral students and the factors that are related to receiving more mentoring support.
Individual scientists affect their environments as well as being creatures of them. (Zuckerman, 1977, p. 173).

What questions has mentoring research answered? Do good mentors make their protégés more successful? Who initiates the mentoring relationship? The research, spanning the disciplines of education (Josselson, 1988), business (Allen et al., 2004), psychology (Kram, 1985), and sociology (Zuckerman, 1977), has been equivocal on these and related questions. Thus, the focus of this review will be three-fold: 1) to review briefly the theoretical antecedents in mentoring research that relate to doctoral advisor-student relationships; 2) to review critically the empirical research focused on graduate students and mentoring; and 3) to summarize relevant findings from recent literature reviews of mentoring in other related disciplines.

Theoretical Perspectives

Theories are important for the practitioner and the scientist because they provide a rational and explicit framework in which to organize information and to guide research (Miller, 1989). Indeed, knowledge is advanced when researchers collect data to prove or disprove theories (Kukla, 1989). Theories of human behavior direct our attention to why people behave in certain ways, and they are often characterized as either mechanistic—individuals are blank slates to be taught—or organismic—individuals organize information based upon interaction with the external world (Miller, 1989). Most modern theories of human behavior adopt an organismic approach, including the theories presented here.
There are different perspectives that guide mentoring research. A resiliency approach (Garmezy, 1985) undergirds youth mentoring research (Rhodes, 2002), while social exchange (Ensher, Thomas, & Murphy, 2001) and developmental approaches (Green & Bauer, 1995) characterize the research on adult mentoring relationships. Recently, mentoring researchers (Higgins & Kram, 2001) proposed use of a developmental network perspective, i.e., a network of mentor-like relationships. Mentoring, in the context of graduate education, is usually studied as one factor that affects attrition and time to degree (Council of Graduate Schools, 2004b; Ferrer de Valero, 2005), rather than as a topic of independent interest.

**Developmental**

Two researchers on adult development established the importance of mentoring in independent studies during the late 1970’s. In *Adaptation to Life* (1977), Vaillant reported on 95 healthy men in the longitudinal Harvard Grant Study. He conducted biographical interviews with the men when they were in their late forties. A Freudian perspective was used to analyze the archival and interview data and to categorize the men according to their use of healthy and unhealthy defense mechanisms. Vaillant found mentoring to be a rare but important relationship in young adulthood for the successful men, i.e., men who used healthy defense mechanisms. In contrast, the unsuccessful men had mentors either too early or too late, if at all. His work suggests a ‘developmental window’ when a young adult most benefits from having a mentor.

Mentoring researchers have cited Levinson’s (1979) work as a mentoring study (Rose, 2003, p. 474), although his focus, like Vaillant’s, was on understanding
adult development. He selected forty men, ten each from four professions, for biographical interviews. Levinson found mentoring to be an infrequent occurrence, but an important relationship. He found that “a mentor can be of great practical help to a young man as he seeks to find his way and gain new skills” (Levinson, 1979, p. 334). In addition to confirming invariant stages of adult development as posited by Erikson (1963), Levinson identified young adulthood as the time when mentors had the most influence on protégés. A later study of forty-five women, fifteen each from three professions, also reported mentoring relationships to occur infrequently. Mentors were most important when protégés were young adults, although women had difficulty finding mentors (Levinson & Levinson, 1996). Only women who were graduate students reported having a mentor in young adulthood, which suggests graduate school may be important in connecting talented women with mentors. Women who found mentors later in life reported them to be supportive but distant.

Kram (1985) extended Levinson’s (1979) findings by examining 18 mentor-protégé pairs in an organizational setting. She used a developmental framework with a focus on the development of the relationship rather than on the development of the individual. Kram conducted in-depth interviews with a stratified sample by age and rank of the mentors and discerned two distinct mentoring functions: psychosocial and career. Psychosocial support refers to activities like role modeling, acceptance, counseling, and friendship. Career support refers to activities such as sponsorship, coaching, protection, and challenging assignments. Kram identified four developmental stages of mentoring relationships: initiation, cultivation, separation, and redefinition. The first stage lasts for about six months and is a time for the
protégé and mentor to learn about one another. The second stage lasts from two to five years and provides a time for the functions to be fully realized. Separation lasts from six months to two years and involves the protégé outgrowing the mentor and learning to work more autonomously. In the redefinition stage there is an indefinite period where the “stress of separation diminish(es), and new relationships are formed” (Kram, 1985, p.49). Kram also found mentoring to be an infrequent activity.

*Erik Erikson’s Eight Stages of Man*

The research of Levinson, Vaillant, and Kram is grounded in an Eriksonian developmental perspective, presented here as a candidate for an overarching theory of mentoring. Erikson’s theory (1963) directs attention to which mentoring functions are important during certain ages. He authored the first life-span theory of development by adding a social aspect to Freud’s stages of psychosexual development and extending the stages through adulthood. Individuals are confronted by necessary developmental challenges that must be resolved for healthy psychological development to occur. Psychosocial strength, such as love or wisdom, emerges as a person resolves each developmental crisis; refer to Table 1. The eight stages occur in a predictable, cumulative order, and the progress in each stage builds upon the crises resolved in the earlier stages (Erikson, 1968). Erikson believed these challenges were universal, although how these challenges were expressed was influenced by culture. For example, in American society a successful resolution of the intimacy crisis is to establish a separate physical home when one marries. In Native American culture, however, the intimacy crisis is
resolved when a woman leaves her family to live with her husband’s family (Erikson, 1968). A recognition of strength, healthy development, and the interplay between an individual and his or her culture was fundamental to Erikson’s thinking (Erikson, 1963; Marcia, Waterman, Matteson, Archer, & Orlofsky, 1993). “Identity grows and is nurtured or frustrated in a complex bonding of self and society. It is not simply asserted or assigned” (Marcia et al, 1993, p. 21). The two stages of Erikson’s theory that correspond to the age of doctoral students will be reviewed next.

Table 1.

**Erikson’s Eight Stages: Psychosocial Crises and Strengths**

<table>
<thead>
<tr>
<th>Stage VIII</th>
<th>Old Age</th>
<th></th>
<th></th>
<th></th>
<th>Integrity vs. Despair, Disgust, WISDOM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stage VII</td>
<td>Adulthood</td>
<td></td>
<td></td>
<td></td>
<td>Generativity vs. Stagnation, CARE</td>
</tr>
<tr>
<td>Stage VI</td>
<td>Young Adulthood</td>
<td></td>
<td></td>
<td></td>
<td>Intimacy vs. Isolation, CARE</td>
</tr>
<tr>
<td>Stage V</td>
<td>Adolescence</td>
<td></td>
<td></td>
<td></td>
<td>Identity vs. Identity Confusion, LOVE</td>
</tr>
<tr>
<td>Stage IV</td>
<td>School Age</td>
<td></td>
<td></td>
<td></td>
<td>Industry vs. Inferiority, FIDELITY</td>
</tr>
<tr>
<td>Stage III</td>
<td>Play Age</td>
<td></td>
<td></td>
<td></td>
<td>Initiative vs. Guilt, COMPETENCE</td>
</tr>
<tr>
<td>Stage II</td>
<td>Early Childhood</td>
<td></td>
<td></td>
<td></td>
<td>Autonomy vs. Shame, Doubt, WILL</td>
</tr>
<tr>
<td>Stage I</td>
<td>Infancy</td>
<td></td>
<td></td>
<td></td>
<td>Basic Trust vs Basic Mistrust, HOPE</td>
</tr>
</tbody>
</table>
Identity versus role diffusion.

Individuals form their identity during their late teenage years and early twenties. The developmental task before the teenager and young adult is to establish a set of beliefs and to wonder ‘who am I?’ Individuals in this stage place increasing importance on peer relationships, rather than parent or sibling relationships. Research has found that sub-domains of identity exist, e.g., in mathematics or sports, but that the sub-domains contribute to an overall sense of identity (Chickering & Reisser, 1993; Marcia et al., 1993) that must be established for healthy development to proceed. Identity formation is a cognitive task of reconciling self. Individuals in the identity stage might benefit from a mentor who helps them explore their beliefs or career opportunities. Thus, outcomes for protégés at this stage might focus on establishing a sense of self, making professional connections, and developing career competencies.

Marcia (1966) extended Erikson’s notion of identity by proposing that identity flows along two dimensions, commitment (high or low) and exploration (high or low), yielding four possible identity statuses: diffusion, foreclosure, moratorium, and achieved. Young people who are neither committed to a set of beliefs nor are motivated to establish their beliefs have a diffuse identity; they have little interest or desire in exploring their identity. A person with a foreclosed identity is committed to an identity, by taking on family and parental beliefs as his or her own, but is low in exploration as he or she has not experienced a period of questioning these beliefs. Moratorium refers to the period where individuals explore their beliefs and adopt
different attitudes. These individuals have a strong desire to explore their identity but are not yet committed to a set of beliefs. Finally, students with an identity-achieved status have explored their beliefs and are committed to one identity.

Some scientists believe that higher cognitive skills are necessary in order to engage in the work required by moratorium and identity achieved states (Manaster, 1977; Marcia et al., 1993). Therefore, academically talented students may be more likely to experience an identity crisis. This should not be surprising because Erikson’s theory was based on his experience with Harvard students and other ‘great’ individuals, e.g., Young Man Luther; thus his notion of ‘crisis’ may only apply to cognitively complex individuals who have the benefit of higher intelligence and the luxury of time in which to explore identity.

Some researchers suggest this developmental stage now extends through the late twenties in modern America (Côté, 2000). Côté coined the word ‘youthhood’ to refer to this period since the individuals have not yet moved into adulthood but are no longer adolescents. In fact, Côté suggests that a diffuse identity may be the norm for people through their twenties and results in lack of career pursuits, living with one’s parents after college, and low achievement.

*Intimacy versus isolation.*

Traditionally, individuals in their mid- to late twenties must resolve the crisis of intimacy versus isolation. However, Côté’s (2,000) work suggests this stage might now occur later. The challenge in this stage is to develop close and sustained relationships with others. The ability to love is the psychosocial strength that emerges from a successful resolution of this crisis.
Women, unlike men, traditionally develop their identity through their relationships with others (Josselson, 1988) and appear to resolve the identity and intimacy crises in tandem (Marcia et al., 1993). For example, Josselson (1988) found women anchored their identity in one of four contexts: family of origin, new family (husband/children), career, or friends. Students with a career anchor “typically had mentors who took a personal interest in their careers, as well as significant others who validated the importance of their work” (Josselson as quoted in Chickering & Reisser, 1993, p. 177). Furthermore, Josselson (1988) reported that women who were identity achieved usually had a mentor who helped identify career options. The implications for mentoring for individuals in the intimacy stage are less clear, in part because of the contradictory research about when this stage occurs for women.

*Developmental Network Theory*

Higgins and Kram (2001) proposed a theory that focuses on a network of individuals who provide career support at a given time. This is in contrast with the traditional concept of mentoring, where a protégé receives support from one individual. This theory captures the various definitions of mentoring used in the literature by suggesting there are different types of mentoring relationships. A person (a developer) is considered part of a protégé’s network if the protégé lists him or her as providing career support during one point in time. There are two dimensions to one’s network, diversity and strength, which yield four network typologies. Network diversity refers to the extent to which developers are from different social networks or organizations. Network strength refers to how much time the individuals spend
together or how close the relationship is. Strength falls along a continuum; however, it is considered to be dichotomous for theoretical purposes and is weak or strong.

The four developmental network typologies are receptive (low diversity and weak ties), traditional (low diversity and strong ties), opportunistic (high diversity and weak ties), and entrepreneurial (high diversity and strong ties). The authors suggest that individual and organizational characteristics may moderate the type of developmental network a protégé establishes. Furthermore, the typology is related to protégé career outcomes. The authors acknowledge that the protégé may change their network type over time, which may affect career outcomes. The strength of this theory is that it recognizes there are likely to be multiple people who provide career support and proposes a way to investigate this network.

Mentoring and Graduate School

Research on doctoral graduate programs has focused on mentoring as one of many institutional factors that affect doctoral completion and attrition. A consideration of all the perspectives on doctoral completion is beyond the scope of this paper. However, the approaches include both institutional and individual factors. For example, the PhD Completion-Attrition Kaleidoscope is one such theory, and it posits there are four socio-demographic factors (gender, race, age, citizenship) and six institutional factors (processes and procedures, selection, mentoring, financial support, program environment, and research mode of field) that interact with student qualities to affect completion or attrition behavior (Council of Graduate Schools, 2004b). Another recent, large study considered socialization, of which having a
mentor was one factor, as one of five outcome measures of doctoral education (Nettles & Millett, 2006).

Summary of Theoretical Perspectives

A psychosocial, developmental framework might provide an overarching theory to suggest the types of activities that are appropriate for protégés of different ages and the outcomes that should be expected from a mentoring relationship (refer to Table 3). Erikson’s theory also directs attention to who would be a mentor or protégé and why. First, who mentors? Younger people mentor for different reasons than older individuals. For example, teenagers, in the identity stage, might mentor younger children to fulfill their needs to establish a sense of self. Adults in the generativity stage may serve as mentors to leave a legacy or to ‘give back.’ Second, who are the protégés? There is a developmental window from late adolescence to young adulthood when individuals most benefit from having a mentor. Early mentoring researchers imply a sense of “readiness”. That is, individuals must have a need that can be met by a more experienced person in order to want or to benefit from a mentor.

Marcia’s theory of identity status suggests what needs might be best met by mentors. For example, a mentor who provides career support may be appropriate for a student with an identity-achieved status but not for a student with a diffuse identity, who has little career commitment. Identity development may provide an explanation for why some individuals naturally seek a mentor. Those people who most need or are ready for career guidance may seek a mentor. This might explain one finding where future Nobel prize winners searched for talented professors in their area to
serve as mentors (Zuckerman, 1977). A study of gifted and creative people found that those who did not have mentors could be characterized by a lack of career focus and lack of enthusiasm (Torrance, 1984)—what Marcia et al. (1993) would call a diffuse identity status. In addition, recent research suggests that in modern Americans an extended period of adolescence may now be the norm that lasts through the twenties. Thus, identity status may be an important mechanism that determines what type of mentoring support graduate students need.

Table 2.

Expected Protégé and Mentor Outcomes by Psychosocial Stage and Identity Status

<table>
<thead>
<tr>
<th>Psychosocial Stage</th>
<th>Protégé Needs</th>
<th>Expected Protégé Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Industry vs. Inferiority</strong></td>
<td>Psychosocial – makes up for deficits.</td>
<td>Improved grades, school attendance, positive peer relationships in school and community; decreased anti-social activity.</td>
</tr>
<tr>
<td><strong>Identity vs. Identity Confusion</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diffusion</td>
<td>Psychosocial – emotional support.</td>
<td>Increased confidence, self-awareness.</td>
</tr>
<tr>
<td>Moratorium</td>
<td>Psychosocial - emotional support.</td>
<td>Increased confidence, self-awareness.</td>
</tr>
<tr>
<td>Foreclosure</td>
<td>Instrumental – career advice, advocacy</td>
<td>Career related.</td>
</tr>
<tr>
<td>Identity Achieved</td>
<td>Instrumental – career advice, advocacy</td>
<td>Career related.</td>
</tr>
<tr>
<td><strong>Intimacy vs. isolation</strong></td>
<td>Psychosocial – emotional support</td>
<td>For women: psychosocial support may be important; research suggests this stage occurs before or with the identity stage.</td>
</tr>
<tr>
<td><strong>Generativity vs. Stagnation</strong></td>
<td>Psychosocial</td>
<td>Increased mentor satisfaction to have given back or to have left a legacy.</td>
</tr>
</tbody>
</table>

There are four limitations of Erikson’s theory. First, researchers have expressed concerns about the universality of the identity crisis (Manaster, 1977).
Second, development may proceed differently for women than for men; some researchers have found that women proceed through stage four and five in tandem (Josselson, 1988). A third limitation of this perspective is that it does not acknowledge individual differences in personality and ‘attractiveness’ of protégés to mentors. Some individuals might be more coachable, teachable, or simply more attractive to take on as a protégé. A consideration of students who are attentive, motivated, open to experience, and conscientious has more to do with personality theory than developmental theory, although personality characteristics are associated with an individual’s ability to successfully move through identity crises (Marcia et al., 1993). A final criticism of this theory is that it elucidates the content of mentoring relationships but not the process by which mentors and protégés engage.

The last two theoretical approaches situate mentoring as one factor in a macro environment and suggest the importance of collecting data on additional factors when studying mentoring relationships. The Developmental Network framework highlights the importance of capturing information about multiple mentors or ‘developers’ who provide career assistance to protégés. There are four patterns of developmental networks that may be associated with career outcomes, of which the traditional notion of mentoring as a one-one intense relationship is one. Thus, research on mentoring may not detect effects if the ‘network’ of mentor-like support is not taken into account. Theories on doctoral completion consider mentoring as one of the factors that affect completion or attrition. This approach places mentoring in an even larger macro context of demographic and institutional factors that should be considered when studying mentoring relationships in graduate settings.
The theoretical frameworks present three implications for the current study. One, research is needed to clarify the relationship between career and psychosocial support functions, e.g., do they operate independently or do they interact? Second, a closer investigation of identity status and an individual’s receptivity to being mentored is warranted. Third, additional factors such as how many individuals provide mentor-like behaviors, protégé demographic characteristics, and institutional characteristics should be considered.

Empirical Studies on Mentoring and Graduate Students

Ten studies were identified, through a search of ERIC, PsycInfo, and the Social Science Citation Index databases, using a combination of the keywords ‘empirical’ and ‘quantitative,’ with ‘advising,’ ‘advisors,’ ‘graduate,’ ‘mentors,’ and ‘mentoring.’ Mentoring researchers were contacted to determine if there were additional articles in peer-reviewed journals; none were located; however, one conference paper was added. The business, education, and psychology literatures were similarly examined. A full review of those studies would be too extensive for this review; thus, relevant findings from recent literature reviews are presented instead. Each study will be critically reviewed by the research design and method employed (refer to Table 3). Cross-sectional studies will be reviewed in three groups: surveys from one discipline (Group 1); surveys across disciplines (Group 2); and archival or interview data collection methods across disciplines (Group 3). Longitudinal studies comprise Group 4 studies.
Table 3.

Summary of Empirical Research on Doctoral Students

<table>
<thead>
<tr>
<th>Year</th>
<th>Author</th>
<th>Sample / Year in School</th>
<th>Who was Mentor?</th>
<th>Mentor Instrument</th>
<th>Discipline Matters</th>
<th>Mentor Functions Studied</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>1986</td>
<td>Cronan-</td>
<td>N=90; 47% female; Psychology. Various</td>
<td>Faculty</td>
<td>40-item survey</td>
<td>Yes</td>
<td>Not examined</td>
<td>1) 53% had Mentors. 2) Mentor + related to Protégé publications.</td>
</tr>
<tr>
<td></td>
<td>Hillix et al</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1998</td>
<td>Neumark &amp; Gardecki</td>
<td>705 female students from 55 Economics programs. / Alumni</td>
<td>Dissertation Chair</td>
<td>No</td>
<td>Not examined</td>
<td>Not examined</td>
<td>1) More female faculty + related to quicker time to degree for female students. 2) Female Dissertation Chair – related to time to degree.</td>
</tr>
<tr>
<td>2000</td>
<td>Clark et al</td>
<td>Sample 1, N=281 72% female; Sample 2, N= 41 71% female; Psychology. Alumni</td>
<td>Faculty</td>
<td>Survey</td>
<td>Yes</td>
<td>Psychosocial, Career</td>
<td>1) More female faculty + related to quicker time to degree for female students. 2) Female Dissertation Chair – related to time to degree.</td>
</tr>
<tr>
<td>2004</td>
<td>Schlosser &amp; Gelso</td>
<td>N=160, 40% female; Education, one institution. / Alumni</td>
<td>Advisor</td>
<td>30-item Advisory Working Alliance Inventory</td>
<td>Not examined</td>
<td>Psychosocial, Career, Role Modeling</td>
<td>1) Support for three factors. 2) AWAI stable.</td>
</tr>
<tr>
<td>2005</td>
<td>Maher et al</td>
<td>N=163 Protégés of color; 99 matched pairs. Business; Multiple institutions. / Alumni</td>
<td>Unknown</td>
<td>No</td>
<td>Not examined</td>
<td>Not examined</td>
<td>Later finishers reported poor mentoring; early finishers reported positive working relationships with faculty and other graduate students.</td>
</tr>
<tr>
<td>2005</td>
<td>Ortiz-Walters &amp; Gilson</td>
<td>N= 4,114 respondents ABD</td>
<td>Dissertation Chair or Faculty</td>
<td>19 Item Scale</td>
<td>Not examined</td>
<td>Psychosocial, Career, Network</td>
<td>1) Same race pairs + related to Psychosocial, Career support, satisfaction &amp; comfort. 2) Deep-level similarity + related to Psychosocial, Career, Network support, satisfaction &amp; comfort. 3) Interpersonal support &amp; comfort mediated similarity and receipt of mentoring support.</td>
</tr>
</tbody>
</table>

Group 2: Cross-sectional, mail surveys, across disciplines

<table>
<thead>
<tr>
<th>Year</th>
<th>Author</th>
<th>Sample / Year in School</th>
<th>Who was Mentor?</th>
<th>Mentor Instrument</th>
<th>Discipline Matters</th>
<th>Mentor Functions Studied</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>2001</td>
<td>Tenenbaum et al</td>
<td>N= 198, 51% female. / Various</td>
<td>Advisor</td>
<td>Dreher &amp; Ash Scale</td>
<td>Yes</td>
<td>Psychosocial, Career, Network</td>
<td>1) Support for three factors. 2) Gender differences of mentor but not Protégé. 3) Career support + related to publications with Mentor. 4) Psychosocial support – related to publications with Mentor and + related to satisfaction with Mentor.</td>
</tr>
<tr>
<td>2005</td>
<td>Zhao et al</td>
<td>N= 4,114 respondents ABD</td>
<td>Advisor</td>
<td>Advisor behaviors</td>
<td>Yes</td>
<td>Psychosocial, Career, Advising, Cheap Labor</td>
<td>1) Support for three factors. 2) Mentor behaviors + related to protégé satisfaction. 3) Demographic variables have little effect on Mentor behaviors, Protégé satisfaction.</td>
</tr>
</tbody>
</table>
Table 3 (continued).

<table>
<thead>
<tr>
<th>Year</th>
<th>Study</th>
<th>Methodology</th>
<th>Sample Size</th>
<th>Sample Characteristics</th>
<th>Instrument</th>
<th>Support</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>2003</td>
<td>Rose</td>
<td>S1: N=82; 72% female; S2: N=250; 50% female; S3: N=380; 50% female.</td>
<td>Imaginary Ideal Faculty</td>
<td>Ideal Mentor Scale</td>
<td>Yes</td>
<td>Psychosocial, Career, Integrity</td>
<td>1) Support for three factors. Citizenship reported.</td>
</tr>
<tr>
<td>2006</td>
<td>Nettles &amp; Millett</td>
<td>N=9,036 from 21 doctoral institutions in 5 disciplines.</td>
<td>Advisor</td>
<td>4 items about advisor support, Questions about who is mentor.</td>
<td>Yes</td>
<td>Not examined</td>
<td>1) 50-75% students in 5 areas had mentor. 2) Race + related to having mentor in science &amp; math. 3) M + related to protégé productivity.</td>
</tr>
<tr>
<td>2001</td>
<td>Ferrer de Valero</td>
<td>Archival and 24 graduate students, 16 faculty.</td>
<td>No</td>
<td>none</td>
<td>Yes</td>
<td>Not examined</td>
<td>Shorter time to degree and high completion rates associated with strong student-advisor relationship.</td>
</tr>
<tr>
<td>2000</td>
<td>Kahn</td>
<td>N=128; 66% female; from 12 departments counseling psychology.</td>
<td>Not Reported</td>
<td>Noe's Mentor Function Survey (MFS)</td>
<td>n/a</td>
<td>Psychosocial, Career</td>
<td>1) MFS + related to research self-efficacy and research interest in 98 and 99. 2) Increase in MFS + related to research self-efficacy.</td>
</tr>
<tr>
<td>1995</td>
<td>Green &amp; Bauer</td>
<td>N= 161; 23% female.</td>
<td>Advisor</td>
<td>Noe's Mentor Function Survey</td>
<td>Psychosocial, Career</td>
<td>1)More talented students + related to having a mentor. 2) No mentoring benefits found after talent of student considered.</td>
<td></td>
</tr>
</tbody>
</table>
Group 1: Cross-sectional, Mail Survey, One Discipline

Cronan-Hillix et al. (1986) found that about half of the students had mentors, and protégés were more productive than the students without mentors. Ninety out of 164 psychology doctoral students at a large Midwestern university returned a 40-item mentoring survey (Cronan-Hillix et al., 1986). About three-fourths of the respondents had earned a masters degree, 47% were female, and their mean age was 29.7 years; citizenship was not reported. Having a mentor was measured by a yes/no survey question asking if the student had a mentor.

About half (53%) of the graduate students reported having a mentor. Protégés did not differ significantly from non-mentored students by gender, age, years in graduate school, or having a master’s degree; chi-square results were not reported. Having a mentor was significantly related to the program in which the student was enrolled, $\chi^2(5, N=90) = 13.22$, p < .05. All students in experimental and social interest programs reported having a mentor, but only 40% of students in the ecological psychology program reported having a mentor. Five measures of student productivity were examined. Students who reported having a mentor were significantly more productive. Four measures—publications authored, first-author publications, conference papers, and first-author conference papers—were dichotomized into ‘one or fewer’ or ‘two or more.’ The first three measures were significantly correlated with having a mentor, although the correlations were not reported. The fifth student productivity measure, number of research projects, was dichotomized into ‘four or fewer’ or ‘five or more.’ The Fisher’s Exact Test showed that being involved in five or more research projects was significantly related to
having a mentor, (M=2.7), p < .05. Students who reported having a mentor were significantly more likely to report that their mentor discussed research ideas with them, \( \chi^2 (4, N=87) = 12.55, p < .05. \)

The productivity measure and the lack of reporting correlations are concerns about this study. The low frequencies on the student publication measures led the authors to dichotomize these variables. However, publishing is an infrequent activity and it would have been preferable to transform the data or define the dichotomy as ‘none’ and ‘one or more’. Knowing the correlation between having a mentor and the first three measures of student productivity would allow for an estimate of effect sizes.

Another study found few significant effects of mentoring and role modeling on female doctoral student success in economics programs (Neumark & Gardecki, 1998). Data were collected from American graduate program directors who were surveyed in 1994 about the cohort of female doctoral students from 1973 to 1994. Fifty-five of 122 program directors returned at least one section of the survey, yielding data on 709 female graduate students. The data were matched to published rankings on economic departments. Students were assumed to have a female mentor if their dissertation chair was female. The number of female role models was calculated from the number of female faculty during each student’s third year. Three measures of success, the dependent variables, were calculated: the quality of the first job after graduate school, estimated time to first job, and proportion of students who completed the PhD Econometric models were estimated, controlling for mathematics GRE and citizenship (U.S. versus non-U.S.).
The proportion of female students with female dissertation chairs was .06—somewhat larger than the .04 estimate of women faculty. This finding suggests that female doctoral students were somewhat more likely to pair with a female dissertation chair than would have occurred by chance. Ordinary Least Squares regressions were estimated to determine the effect of role modeling and mentoring on job placement variables; the results were not significant, but were not in the expected direction. The coefficients for female faculty (-.03) and female dissertation chair (-.04) were negative. Regressions were calculated with role modeling and mentoring as the predictors for how long the women spent in graduate school. The presence of more female role models was significantly associated with a quicker time to degree (R=-.26). However, mentoring and having a female dissertation chair were associated, but not significantly, with a longer time in graduate school (R=.28).

The lack of significant results might be because other factors influenced female student success—for example, the number of female graduate students in each program. The graduate student experience might have changed considerably over the twenty years of data analyzed for this study, which might affect the results. The researchers acknowledged that there was not enough variability on the role modeling and mentoring variables to detect effects.

In another study, researchers found that students had multiple mentors (Clark, Harden, & Johnson, 2000). A survey was sent to a random sample of 1,000 members or associates of the American Psychological Association, who lived in the U.S. and earned their PhD or PsyD between 1994 – 1996. The response rate was 79% (N=787). The survey questions were based on the career and psychosocial
mentoring functions identified by Kram (1985). Neither citizenship nor the programs or institutions represented by the respondents was reported. After reading a definition of mentoring respondents reported if they had a faculty mentor from their degree program, and the total number of mentors they had. The authors did not indicate if additional mentors had to be faculty in the degree program.

About 2/3 of the respondents (n=521) reported having at least one mentor. Of these 521 protégés, 35% reported having two mentors, 11% reported three mentors, and another 11% reported having four or more mentors. About 1/5 of the protégés endorsed three important characteristics of mentors: supportive, intelligent, and knowledgeable.

There were significant differences in mentoring and program satisfaction by type of degree. Graduates of PhD programs were more likely to report having a mentor than graduates of PsyD programs, $\chi^2 (1, N=781) = 17.13, p<.0001$. Mentored graduates reported being more satisfied with their doctoral training (Mean = 4.03, standard deviation = .95) than graduates who did not have mentors (Mean = 3.64, standard deviation = 1.07), t (472) = 4.85, p<.001. However, PsyD graduates were more satisfied with their doctoral training (Mean =4.18, standard deviation =.84) than PhD graduates (Mean =3.78, standard deviation =1.05), t(555) = 5.59, p<.001, even though more PhD graduates were mentored.

The lack of a sophisticated data analysis strategy was a weakness of this study. A multivariate analysis would have provided a clearer interpretation of the possible interaction of having a mentor, type of program, and program satisfaction. It
is likely that missing data was the reason why the entire sample was not included in the analyses, but there was no documentation of how missing data was handled.

A fourth study investigated the specific behaviors that comprise mentoring by developing the Advisor Working Alliance Inventory (AWAI). Two samples of doctoral counseling psychology students were surveyed to establish scale consistency and reliability (Schlosser & Gelso, 2001). Students rated their advisor on 30 specific behaviors. The researchers designed survey items to measure three factors: Rapport, Identification, and Task. The business and organizational literature refers to these same factors as psychosocial, role model, and career support.

The scale was developed using a convenience sample of six graduate students and one full professor. Then, 16 departments were randomly selected from the list of accredited programs published in the American Psychologist and asked to participate in the study. Thirteen program directors provided 359 names of doctoral counseling psychology students. The average age of the 281 respondents was 30 years old, 72% (N=202) were female, and they represented different years in graduate school. Student citizenship was not reported; however, race was reported: about 70% of the sample was Caucasian, 13% was Asian, 10% was African American, 7% was Hispanic, 1% was Native American, and 6% reported more than one ethnicity. Factor analysis provided support for a three-factor structure, but the items loaded differently on the Identification and Task factors than predicted. Thus, the factors were renamed Rapport, Apprenticeship, and Identification-individuation and explained 22%, 21%, and 14% of the variance respectively. The Cronbach alpha was .95. There were no significant differences by gender on the mean scores.
The researchers administered the survey once, and then again two weeks later to a second sample of 57 doctoral students to establish scale reliability. Forty-one students, mean age of 29 years, completed both surveys. Twenty-nine were women (71%). The Cronbach's alphas were .90 for Time 1, and .93 for Time 2. The subscales were stable, although the reliability for the identification-individuation subscale was lower (.57 at Time 1 and .63 at Time 2). No significant differences were found for first-year students compared to non-first year students. The authors noted that this study was subject to “common method variance resulting from reliance on concurrent self-report data” (p.165).

The authors reported the ‘r’ statistic, but the $R^2$ was estimated and reported here for ease of comparison to other studies. The AWAI was significantly correlated with the graduate student's attitude toward research ($r = .28$, $p < .001 / R^2 = .078$). There were no significant differences in duration of relationship and scores on the AWAI. Relationship duration was categorized into 6 six-month intervals, starting with < 6 months, to examine a curvilinear relationship between similar subscales used as criterion variables (research self efficacy, attitudes toward research) and the AWAI. There were no significant correlations between relationship duration and research self-efficacy for relationships of less than 6 months or greater than 48 months. The other time intervals were significantly correlated with the AWAI, with the greatest correlation between AWAI scores and research self-efficacy at 13-24 months ($r = .49$, $p < .001 / R^2 = .24$). Research attitudes were significantly correlated with the AWAI when the relationship had lasted 7-12 months ($r = .45$, $p < .01 / R^2 = .20$), 13-24 months ($r = .35$, $p < .01 / R^2 = .12$), and 37-48 months ($r = .52$, $p < .001$/
R² = .27). The authors noted that these time periods match the approximate times when a student might be conducting thesis or dissertation research.

Other researchers were interested in what constrained or facilitated women’s doctoral degree progress. They used focus groups to design a 46-item survey with a 3-item Likert response scale (Maher, Ford, & Thompson, 2004). A survey was mailed to 295 alumni who were admitted between 1978 and 1989 to the College of Education at Stanford University; 160 alumni returned the survey. The respondents were categorized, according to their time to degree, as early (under 4.25 years), average (4.5 – 6.5 years), and late (6.75 or more years) finishers. The analysis compared the response pattern on the survey items of the early (62 people) and late (59) finishers by using chi-square goodness of fit tests on the response distributions. The early finishers did not report constraints on their progress.

Seven items significantly differentiated the early from the late finishers: goal to finish in a timely manner, prior research experience, prior professional experience, ability to ‘work’ the system, support from spouse, friends, etc, support from other doctoral students, and dissertation plans went smoothly. Fifteen of the constraining factors showed a different pattern of response for the early and late finishers. These factors included items such as lack of a plan to finish, poor mentoring, faculty obstruction, few research experiences, irrelevant classes, and several items about funding. The themes the authors identified were that early finishers were: more committed to completing their degree; more likely to develop supportive working relationships with faculty; less likely to have funding problems; more likely to report
family support; less likely to have difficulty with research opportunities; and more able to ‘work’ the system.

This study presents validity problems in that a considerable time had elapsed for many of the alumni since their time in graduate school, which may have affected their correctly remembering the factors that affected their time to degree. In addition, only those who had successfully completed a degree were surveyed, even though the authors acknowledged that 50% of doctoral students do not complete their program. Finally, the sample size is not large enough to detect effects, and a 3-response Likert scale does not differentiate the items.

The final study in Group 1 focused on the effects of protégé-mentor similarity on types of mentoring support protégés reported receiving; interpersonal support and relationship comfort were examined as possible mediators (Ortiz-Walters & Gilson, 2005). Surveys were emailed to 358 PhD business graduates who were members of a national association. Only graduates ‘of color’ were included in the sample. The response rate was 45.5% (n=163). Respondents were asked to provide email addresses for their academic mentors (either their dissertation chair or faculty member with whom they worked most closely). The final sample was 163 protégés; 99 of these had matched mentors with demographic information, and 74 of the 163 had full survey responses from protégés and mentors.

Surface-level similarity was defined as race. Deep-level similarity was determined from the responses on a 5-item, 7-point Likert response scale. A sample item is: “My mentor (student) and I analyze problems in similar ways.” Mentoring support was assessed from a 19-item scale of academic mentoring with three
factors: psychosocial, instrumental, and networking support. Interpersonal comfort, relationship satisfaction, and commitment were determined from 2, 4, and 4 survey items respectively. Mentor race, protégé and mentor gender, and gender similarity were controls in the analysis.

ANOVA were estimated to examine surface-level racial similarity on receipt of types of mentoring support. Protégés with same race mentors received significantly more psychosocial \((F=5.66, p<.05)\) and instrumental \((F=6.04, p<.05)\) support, and reported being more satisfied \((F=2.74, p<.10)\) and interpersonally comfortable \((F=4.76, p<.10)\). The researchers then controlled for racial similarity in a MANOVA analysis and found that protégés of color who reported more deep-level similarity with their mentors also reported significantly higher levels of relationship satisfaction \((F=3.70, p<.001)\), interpersonal comfort \((F=6.14, p<.001)\), as well as more psychosocial \((F=5.23, p<.001)\), instrumental \((F=3.19, p<.001)\), and networking \((F=1.83, p<.001)\) support.

The study examined interpersonal comfort, and commitment to the relationship as mediators between surface-level similarity, deep-level similarity, and mentoring support. Interpersonal support completely mediated surface-level similarity \((B \text{ went from } .43, p<.05 \text{ to } B=.09, \text{ n.s.})\), and partially mediated psychosocial \((B \text{ went from } .55, p<.01 \text{ to } .22, p<.10)\) and instrumental \((B \text{ went from } .63, p<.001 \text{ to } .35, p<.05)\) mentoring support. An examination of deep-level similarity showed that interpersonal support completely mediated deep-level similarity and networking mentoring support \((B \text{ went from } .33, p<.01 \text{ to } .10, \text{ n.s.})\). Interpersonal support partially mediated deep-level similarity with psychosocial \((B \text{ went from } .73, p<.001 \text{ to } \)
.36, p<.001) and instrumental (B went from .57, p<.001 to .21, p<.10) mentoring support in addition to relationship satisfaction (B went from .66, p<.001 to .18, p<.10). Surface-level similarity was not significantly related to mentor relationship satisfaction.

It is possible that gender may influence surface-level and deep-level similarity, but it was not considered here. Another limitation of this study is that it did not survey the significant percentage of students, estimated to be about 50%, who do not complete doctoral programs. Thus, the results may not be generalizable to all doctoral students. In addition, it is possible that those with negative relationships with their mentors may have been less likely to complete the survey.

Group 2: Cross-sectional, Mail Survey Across Disciplines

Mentoring has been found to influence productivity and satisfaction of graduate students in various disciplines (Tenenbaum et al., 2001). Researchers surveyed 431 students in all nine departments offering a doctoral degree at the University of California at Santa Cruz. One hundred ninety-eight students completed the questionnaire. Fifty-one percent of the students were female; citizenship and race were not reported. Respondents had a mean age 29 years. The departments were grouped into three areas: humanities, social science, and natural science. Humanities students participated at a significantly lower rate than did the natural and social sciences students, $\chi^2 (df = 2, n=179) = 9.00$, p < .05.

The survey asked about mentoring support, satisfaction, and productivity. A 19-item modified version of Dreher and Ash’s mentor survey assessed the psychosocial and career support from the primary advisor. Respondents rated their
satisfaction with their advisor and with their graduate experience. Another section asked about the student’s working relationship with his or her advisor. Finally, the number of journal publications, poster presentations, and conference talks in which the respondent participated was collected and used as a measure of scholarly productivity.

Principal component analysis extracted three factors from the 19-item mentor survey—networking, career, and psychosocial support—which accounted for 63% of the variance. The networking factor was not expected, although the authors acknowledge that factor might have been an artifact of modifying Dreher & Ash’s survey. Men and women were significantly more likely to have male advisors, \( \chi^2 \) (df=1, n=187) =7.16, \( p < .01 \), than female advisors, but there were no significant differences by student gender. MANOVA showed that women advisors (M=3.72, SD = .97) provided significantly more psychosocial support than did male advisors (M=3.24, SD = .94), F (1,182) = 7.68, \( p = .006 \). Hierarchal multiple regression was performed to examine the effect of student characteristics on mentoring support and student productivity and satisfaction. After controlling for discipline, advisor gender, student gender, and student years in graduate school, instrumental support was found to be significantly correlated with publications with advisor (\( r = .28, p < .01 \)) and with positive working relationship with advisor (\( r = .18, p < .01 \)). Psychosocial support was significantly, negatively correlated with publications with advisor (\( r = -.20, p < .05 \)). In contrast, it was positively correlated with satisfaction with advisor (\( r = .81, p < .001 \)), satisfaction with graduate school (\( r = .25, p < .05 \)), and positive
working relationship with advisor (r = .48, p < .01). No significant effects were found for the networking factor.

It would have been helpful to have a better description of how scholarly productivity was measured and used in the analysis. The method section defined scholarly productivity as one variable, yet the statistical analysis included two measures of scholarly productivity (publications with advisor and publications without advisor). It was not clear if the other measures, such as conference presentations and poster sessions, were included in the publication measure.

In another study three researchers examined how students chose their advisor and how satisfied they are with their advisor (Zhao, Golde, & McCormick, 2005). These researchers used the Survey on Doctoral Education and Career Preparation data set. There was complete survey data on 4,114 graduate students in 11 disciplines from 27 universities (a 43% response rate). Missing data on key variables (discipline and advisor) led to the exclusion of 104 students, leaving 4,010 students in the final data set. Most respondents (93%) were full-time graduate students; their citizenship was not reported. The 11 disciplines were grouped into four categories: humanities, social sciences, physical sciences, and biological sciences. Students reported their satisfaction with the advising relationship (4 items); advisor behaviors (24 items); and how they were matched with their advisor, including reasons they chose their advisor (13 items) if they were not assigned an advisor. Advisor behaviors included advising items like, “gives me regular and constructive feedback on my research”; personal touch items like, “takes an interest in my personal life”; and career development items like, “teaches me to write grant
and contract proposals." The number of students who chose their advisor, versus having one assigned, was not reported.

Factor analysis indicated that three factors—reputation, intellectual compatibility, and pragmatic benefit—accounted for how students chose their advisors. The Cronbach alphas for each factor were .73, .52, and .43 respectively. Factor analysis was computed on the advisor behaviors and four factors were extracted. These factors were academic advising, personal touch, career development, and cheap labor, with corresponding Cronbach alphas of .89, .90, .85, and .68. The authors reported there were strong mean differences on these factors by discipline, but did not report the statistics.

Regression was run on student characteristics, including discipline, as predictors of the seven factors described above. Older students were less likely to choose their advisor for pragmatic or reputation reasons and reported more advising and career development behaviors from their advisor (the statistical results were not reported). Choosing an advisor for pragmatic reasons was significantly and moderately correlated with discipline with the largest $R^2$ at 23.7% ($F=108.788$, $p < .001$). Students in the biological and physical sciences were more likely to choose an advisor for pragmatic reasons than students in the social sciences. The authors found that advisor behavior was related to student satisfaction. Hierarchical regression was computed, controlling for background characteristics and discipline. The results showed that the addition of advisor choice and advisor behavior increased the $R^2$ from less than 1% to 54.3% ($F=208.739$, $p < .001$).
This study did not provide complete statistics about the findings. It was a conference proceeding paper rather than a journal article, which might explain its incomplete data analysis section. However, this study made an important contribution by acknowledging that the mentoring or advising relationship may be initiated by the student or by the faculty member.

Rose’s (2003) approach was to develop a scale to assess the qualities of an ideal graduate school mentor. She was interested in mentor functions, but extended previous research by including personality variables in the scale construction. The items were based on Anderson and Shannon’s (1988) theoretical work, which proposed five mentor functions: teaching, sponsoring, encouraging, counseling, and befriending. Students were asked to rate, on a 5-item Likert scale, the extent to which each item was an attribute of an ideal mentor (regardless of whether they had a mentor or not). Rose developed the scale in three rounds, using independent samples. After each administration, the items that did not have sound statistical properties were dropped. Thus, there were 111 items in the first administration, 103 items in the second administration, and 76 items in the final administration.

The first sample was a convenience sample of 82 PhD students at an Eastern state university. The majority of the students were female (72%) and U.S. citizens (82%). The respondents had a mean age of 29.5 years and had been in graduate school an average of three years. There were 250 PhD students from a Midwestern Research university in the second sample. This sample was half female, 69% U.S. citizens, and respondents represented 54 departments. The students had been in graduate school an average of 2.3 years. The third sample was comprised of 380
PhD students from 45 departments at another Midwestern Research I university. About half of the students were female, three-fourths were U.S. citizens, and the respondents had been in graduate school an average of 4.3 years.

Two items were endorsed by over 75% of the respondents as qualities of an ideal mentor. These items were: “My ideal mentor would communicate openly, clearly, and effectively,” and, “My ideal mentor would provide honest feedback (both good and bad) about my work.” A five-factor solution was expected but factor analysis provided support for only three factors. The first factor, Integrity, focused on questions about the mentor respecting the student. The second and third factors, Guidance and Relationship, were similar to the career and psychosocial functions found in other studies. Contrary to Rose’s expectations, the items representing one NEO Personality Inventory factor loaded on two of the mentor factors, Integrity and Relationship. No personality items loaded on the Guidance factor, suggesting that career support may be independent of personality traits.

The limitation of this study is that it asked students to rate an ideal rather than an actual mentor relationship. Thus, it is not clear if the results would apply to actual mentoring relationships. The study is the only one that has tried to tie personality characteristics to mentoring behaviors, even though it did not succeed in doing so.

Nettles & Millett (2006) surveyed over 14,000 doctoral students who had completed their first year of study by the fall of 1996. The researchers were interested in understanding the doctoral experience, particularly the factors that influence timely doctoral completion, with the goal of recommending how doctoral education might be improved. Students of color were over-sampled and respondents
were entered into a drawing for cash payments. There was a 70% response rate, with 9,036 students in eleven fields at twenty-one universities. African Americans comprised 10% of the sample, which was 7% Hispanic, 9% Asian American, 58% white, and 16% international citizens. Fifty percent of the sample was female. The fields of study were collapsed into five disciplines. Twenty-eight percent of the students were in engineering, 10% were in education, 15% were in humanities, 21% were in sciences and mathematics, and 27% were in social sciences.

The researchers focused on nine areas: financing, socialization, research productivity, satisfaction, performance, and progress; rate of progress, completion, and time to degree; predictors of student experiences and performance; predictors of major distinction by field; predictors of major distinction by race and sex; and implications for policy and practice. Mentoring was considered as part of the socialization experience.

A definition of mentoring was provided and students were asked if someone fulfilled that role. The definition was, “someone on the faculty to whom students turned for advice, to review a paper, or for general support and encouragement” (Nettles & Millett, 2006, p. 98). About 2/3 of the students (69%) reported having a mentor. Most of the students identified a mentor within their first year of their graduate program. The researchers concluded that, “Students experience the socialization process of doctoral education in much the same ways regardless of field, race-ethnicity, or sex” (Nettles & Millett, 2006, p. 103). The exception to this is that the experience of African American students in engineering seems to be “troubling” (p. 212). Students who aspired to faculty positions after graduation
usually rated their interactions with faculty more positively. Having a mentor was also significantly associated with greater research productivity.

It seems that a study of this magnitude would have used more sophisticated measures of mentoring and scholarly productivity. Research productivity was a single measure that included presentations, and publications. This study assumed that students receive mentoring from one only person, and that mentoring may affect the outcomes of presentations and publications in the same way. It is unclear if this assumption is justified.

**Group 3: Archival and Interview Studies Across Disciplines**

Ferrer de Valero (2001) was interested in the factors that influence time to degree and completion rates for doctoral programs. This study examined archival data of students who started doctoral programs in science, engineering, or social science from the fall 1986 semester to the spring 1990 semester (Ferrer de Valero, 2005). Students were categorized as ‘Completers’ if their doctorate was earned by the end of the fall 1995 semester. ‘Noncompleters’ were either still in school or had quit school. Departments were grouped into four clusters based on the average time to degree (short or long) and completion rates (high or low) of their graduate students. Citizenship of the graduate students was not reported.

To supplement the archival data, semi-structured interviews were conducted with graduate students, who had completed all program requirements but the dissertation, and with faculty, who had five or more years of experience in the department. Two departments were randomly selected from each of the four clusters. Three graduate students and two faculty were selected from these eight
departments. The interviews lasted 45-60 minutes and focused on questions about financial support, degree requirements, departmental policies and practices, advising, and departmental climate.

A complex pattern of themes emerged among the clusters. The student-advisor relationship emerged as a theme that “promot[ed] rather than imped[ed] time-to-degree and completion rates” (Ferrer de Valero, 2001, p. # 356). Students in the high completion rate and short time-to-degree departments expressed closer relationships with their advisors than students in the other clusters. These relationships included career and personal advising.

Group 4: Longitudinal

Two studies used a longitudinal design to examine the effects of mentoring on graduate student success. During the fall of 1998 (T1) one researcher mailed surveys to 351 entering students in 12 doctoral counseling psychology departments (Kahn, 2000). One year later (T2) the survey was sent to the 155 first-year respondents. A total of 125 students returned both surveys. The average age of the respondents was 31.44 years. Eighty percent of the sample was white, and 2/3 of the sample was female; citizenship was not reported. The survey included a modified version of Noe’s Mentor Function Survey (MFS) and included questions about global research perceptions, research efficacy, and research interests.

Preliminary analyses showed no significant changes in the means of the four measures after one year. Change scores were estimated for the MFS and global research perception instrument. Two hierarchal regression analyses were conducted to predict changes in research self-efficacy and in research interest. The criterion
measures at T1 were entered first. The second step was not clearly described nor did it add prediction to the model. In the third step, global research perceptions and MFS were added. Increase on the MFS was significantly associated with an increase in research self-efficacy, $\beta = .20$, $p < .01$. The second regression had research interest as a criterion and showed that an increase in the MFS from T1 to T2 was significantly correlated with an increase in research interest $\beta = .12$, $p < .05$ from T1 to T2; global research perceptions were not significantly correlated with research interest.

The author acknowledged that change scores have been found to be unreliable in other studies. The data were presented at a conference and a complete data analysis had not been conducted, which may also have been why the tables and text did not always agree. This raises concerns about the accuracy of the reported findings.

The final study in Group 4 is Green and Bauer’s research on the student-advisor relationship. This longitudinal study added to previous research by examining if mentoring functions contributed independently to student success over time (Green & Bauer, 1995). During the fall of 1991 (T1) surveys were sent to 357 incoming doctoral students at a Midwestern University; 233 surveys were returned. Follow-up surveys were administered three weeks before the end of the first academic year (T2) and again three weeks prior to the end of the second academic year (T3). There was complete data on 161 students; 23% were female, 62% were white, and 60% were U.S. citizens. A comparison of non-respondents at T2 and T3
with respondents showed that non-respondents were significantly more likely to have a lower GPA (t=2.50, df=203; p < .01) the first semester.

Student talent was measured with Graduate Record Examination verbal and quantitative subscores, semesters of undergraduate research experience, and undergraduate grade point average. Commitment to the program was measured at T1 and T3. The mail survey included a slightly modified version of the 21-item Noe's Mentor Function Survey that measured career and psychosocial functions. Number of publications and submissions was used to measure research productivity. There were five control variables: department, gender, citizenship, if mentor was assigned, and if the student attended the same institution as an undergraduate.

The results indicated that more talented students were significantly more likely to report receiving mentoring from their advisors, $R^2 = .17$ (F = 5.36, df = 6, 160, p < .05) at T2. Reporting career or psychosocial support at T2 did not significantly correlate with student productivity at T3, when talent was entered in the regression equation. Finally, the authors’ hypothesis that mentoring might increase student commitment at T3 was not supported. The results showed commitment at T1 significantly predicted commitment at T3, but mentoring at T2 did not significantly influence commitment at T3.

Findings from Mentoring Literature Reviews

A full review of the mentoring literature is beyond the scope of this paper. However, the five most recent reviews will be critically considered, with a focus on findings that might be relevant to doctoral settings (see Table 4).
Merriam and colleagues followed up on an earlier literature review (Merriam, 1983). They reviewed 26 empirical studies of mentoring in higher education (Merriam et al., 1987), most of which were unpublished dissertations. The sample was predominately female and mostly constituted of administrators. A few studies investigated faculty and graduate student mentoring but only one study examined senior faculty mentoring junior faculty. The authors concluded that all the research findings were equivocal because the results varied by definition of mentoring used and by data collection method employed.

A later review extended Merriam et al.’s work by focusing on studies of undergraduates, mentoring, and academic outcomes (Jacobi, 1991). The author included ‘noteworthy’ studies, but did not define the characteristics of such a study, nor did she indicate how many studies she reviewed. Like Merriam et al. (1987), this paper noted the problem of ‘definitional diversity’ (Jacobi, 1991, p.506) as a methodological issue affecting the outcomes in mentoring research. In addition, Jacobi noted a need for valid and reliable instruments for measuring mentoring relationships and outcomes. Jacobi identified five characteristics of mentoring relationships. These relationships are helping relationships; involve psychosocial and career support; are reciprocal; are personal; and involve a more experienced person, the mentor, in a relationship with a less experienced person, the protégé. The review concluded with an overview of four theoretical approaches found in the literature; two of these were involvement and integration models, one was a social support model, and the fourth approach was a developmental model. Areas identified for future research were: establishing the frequency of mentoring, effects
of gender and race on mentoring, and appropriate academic outcomes for undergraduate protégés.

Table 4.

**Mentoring in Professional Settings: Summary of Reviews**

<table>
<thead>
<tr>
<th>Year</th>
<th>Author(s)</th>
<th>Type of Review</th>
<th>Number of Studies</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>1987</td>
<td>Merriam et al</td>
<td>Literature Review. Higher education.</td>
<td>26</td>
<td>Subjects mostly administrators; ambiguous findings because of varying definitions; no assessment of outcomes.</td>
</tr>
<tr>
<td>1991</td>
<td>Jacobi</td>
<td>Literature Review. Focus on undergraduates.</td>
<td>Not provided.</td>
<td>3 functions: psychosocial, career, role modeling. 1/2 to 2/3 of students reported being mentored. No clear construct of mentoring; no direct evidence of mentoring’s effect on academic success. Inconclusive if mentor and protégé should be same race, gender.</td>
</tr>
<tr>
<td>2004</td>
<td>Ehrich et al.</td>
<td>Literature Review. Education Business/Medical</td>
<td>159 education, 151 business, 8 medicine</td>
<td>Mentor benefits included networking and collegiality. Protégé benefits included psychosocial and instrumental support. Problems most cited were lack of time, mismatch.</td>
</tr>
<tr>
<td>2006</td>
<td>Underhill</td>
<td>Meta-analysis. Business.</td>
<td>14</td>
<td>Having a mentor + related to protégé career outcomes; Protégés with informal mentors + career outcomes.</td>
</tr>
</tbody>
</table>

Three researchers were interested in the positive and negative effects of mentoring relationships (Ehrich et al., 2004). The authors located 159 studies from 1986-1999 in education, most of which focused on teacher training; 151 studies from 1986-2000 in business; and eight from the medical profession. The authors did not indicate if mentoring programs were formal, assigned, or informal, naturally occurring. Factual data and content analysis were conducted on these studies.
Thirty-five percent of the studies from education reported positive outcomes. The authors found that the top four benefits protégés reported receiving from mentors were: psychosocial support, technical knowledge, networking, and feedback. Mentors reported networking, reflection, career development, and personal satisfaction most frequently as outcomes from mentoring a protégé. Almost half of the education studies reported problems for mentors, and 42% reported problems for protégés. Lack of time and mismatch on professional expertise or personality were the most frequently cited problems in a mentoring relationship.

The studies from medicine and business reported positive outcomes for mentors, although the percentage was not reported. The two most frequently cited positive outcomes by mentors were networking and collegiality. Protégés cited career and skill development most often as positive outcomes. The author found similar negative outcomes for these fields as for education listed above, but percentages were not reported.

A meta-analysis on mentoring relationships and adults reported that employees with mentors reported significantly more positive objective and subjective career outcomes than employees without mentors (Allen et al., 2004). These researchers examined 43 empirical studies in the business literature. Five hypotheses were tested and full or partial support was found for all five.

The authors reported sample-weighted mean r as a conservative estimate of effect sizes, but they will be converted to the $R^2$ value for ease of comparison with the other studies. First, mentored employees reported significantly better career outcomes in terms of compensation (weighted mean $r = .12 / R^2 = .014$) and
promotions (weighted mean $r = .31 / R^2 = .096$) than non-mentored employees. The type of mentoring support received was significantly related to positive outcomes. Career-related mentoring was significantly, positively correlated with career outcomes such as salary increases (weighted mean $r = .08 / R^2 = .006$) and more promotions (weighted mean $r = .10 / R^2 = .01$). Likewise, psychosocial support was significantly, positively related to career outcomes such as compensation (weighted mean $r = .04 / R^2 = .0016$) and promotions (weighted mean $r = .06 / R^2 = .0036$). The authors speculated that career support would be related to objective career outcomes, and that psychosocial support would be related to subjective career outcomes. There was mixed support for these two hypotheses because both types of mentoring support were related to both subjective and objective career outcomes. Finally, the authors found that career support was related to overall job satisfaction, although there were small effect sizes.

Most recently, Underhill (2006) conducted a meta-analysis of empirical studies of mentoring in corporate settings and found positive outcomes for protégés. Only fourteen of 106 identified studies met the criteria for inclusion: published after 1983, included protégé outcomes, and listed sufficient statistical information (Underhill, 2006). The response rates for the 14 studies were between 22-75%. A random effects model was used to analyze effect sizes, and thirteen protégé outcome measures were examined. Having a mentor was significantly associated with increased organizational commitment, job satisfaction, self-esteem, and perceptions of career opportunities, as well as decreased work stress and work-family conflict. However, the effect sizes were small. Promotions and income were
not significantly related to having a mentor. Underhill examined whether the type of mentor program (informal or naturally occurring and formal or assigned) mattered. Protégés with informal mentors showed small but significant positive effects on career outcomes when compared to protégés in formal mentoring programs. Gender and ethnicity could not be examined because only three of the studies reported protégé gender and none of the articles analyzed ethnicity.

Research Summary

The research indicates three consistent findings on mentoring and doctoral students and several areas of inconclusive findings. First, most students appear to have mentors. Second, the frequency of mentoring varies by student discipline. Third, career support and psychosocial support are two established types of mentoring. What is less clear is who is considered to be a mentor. The results regarding race, gender, citizenship, and the importance of match are inconclusive. Mentoring has been considered as both an independent and dependent variable. However, when it is an independent variable there are positive, significant, but small, effects with mentoring related to increases in doctoral student satisfaction and scholarly productivity.

Frequency and Number of Mentors

Three studies found that 50-75% of doctoral studies report having mentors (Clark et al., 2000; Cronan-Hillix et al., 1986; Nettles & Millett, 2006). These results mirror findings in the business literature (Jacobi, 1991). However, only one survey question was used to assess having a mentor and a definition of mentoring was rarely provided. Early work on mentoring used biographical interviews to study
mentoring and found mentoring relationships to be a rare occurrence (Kram, 1985; Levinson, 1979; Vaillant, 1977).

Only one study asked about the presence of multiple mentors. These researchers found that 2/3 of the students reported having a mentor and more than half of the mentored students reported having more than one mentor (Clark et al., 2000). Higgins & Kram’s (2001) theoretical work suggests this finding may not be unique. More research is needed in this area.

**Discipline**

Several studies found the discipline or program to be significantly related to the frequency of mentoring and types of mentoring support reported. Students in psychology programs were more likely to report having a mentor if they were in a research program rather than an applied program (Clark et al., 2000). Departments that have shorter times to degree and higher completion rates have more students with mentors. This finding suggests that the amount of mentoring graduate students receive might vary by departmental characteristics (Ferrer de Valero, 2005). Students from humanities and social sciences were more likely to report receiving academic advising and personal touch behaviors and less career behaviors from their mentors than students in the physical or biological sciences (Zhao et al., 2005).

**Mentoring Behaviors**

The research suggests that the career and psychosocial functions first identified by Kathy Kram (1985) also characterize mentor functions in doctoral programs. These functions have been found across disciplines (Clark et al., 2000; Ferrer de Valero, 2005; Green & Bauer, 1995; Rose, 2003; Tenenbaum et al., 2001;
Zhao et al., 2005), year in graduate school (Clark et al., 2000; Kahn, 2000; Rose, 2003; Schlosser & Gelso, 2001, Tenenbaum et al., 2001), and for men and women (Tenenbaum et al., 2001; Zhao et al., 2005). Some studies have identified a third type of mentoring support; identification/role modeling or networking (Rose, 2003; Schlosser & Gelso, 2001; Tenenbaum et al., 2001; Zhao et al., 2005). Psychosocial support and career support has also been identified in the business literature (Ehrich, 2004).

Who Mentors?

The studies varied with regard to who could be considered a mentor. Some studies asked individuals to report if they had a mentor, but did not define what a mentor was (Kahn, 2000). In another study, only faculty could be mentors (Clark et al, 2000). Other studies assumed that the advisor provided mentoring (Green & Bauer, 1995; Schlosser & Gelso, 2001; Tenenbaum, 2001; Zhao, 2005), or asked respondents to imagine an ideal mentor and answer the survey questions with that person in mind (Rose, 2003).

Race, Gender, and Citizenship

Only one of the studies on doctoral students examined race (Ortiz-Walters & Gilson, 2005). The researchers reported that students of color with mentors of color reported significantly more psychosocial and career support, as well as more comfort and satisfaction with the relationship. However, the same study also found that having shared values, regardless of whether the mentor was the same race or not, was significantly related to these same outcomes. Race has not been examined in the business literature (Underhill, 2006). The effects of protégé or mentor race are
usually considered as a control variable, perhaps because of the low numbers of
minority protégés and mentors.

The findings about gender remain equivocal. One study found that students,
male and female, were more likely to have male mentors (Tenenbaum et al., 2001).
Yet, another study reported that women were more likely to have female dissertation
chairs (Neumark & Gardecki, 1998). Neumark & Gardecki (1998) reported that
female doctoral students graduated faster if more females were on the faculty, but if
their dissertation chair was female then students took longer to graduate.
Tenenbaum et al. (2001) found that female advisors provided significantly more
psychosocial support than male advisors.

International students comprise 25-30% of the enrollment in U.S. Research I
graduate programs and 14% of the enrollment in U.S. doctoral programs (Council of
Graduate Schools, 2004a). Yet citizenship has not been examined in the mentoring
research on doctoral students. If citizenship is reported at all it is used as a control
variable. It is possible that non-U.S. citizens may have different cultural notions of
mentoring relationships; this is an area needing more study.

Mentoring Outcomes: Satisfaction, Productivity, and Time to Degree

Some studies consider mentoring to be a dependent variable (Ortiz-Walters &
Gilson, 2005), while other studies consider mentoring to be an independent variable
(Green & Bauer, 1995). When mentoring is studied as an independent variable,
significant but modest effects on doctoral student satisfaction (Tenenbaum et al.,
2001; Zhao et al., 2005) have been found. Graduate students who receive
psychosocial support from their mentor are significantly more likely than those who
received less support or no support (no mentor) to be satisfied with their program or mentor (Tenenbaum et al., 2001; Zhao et al., 2005). Individuals who have mentors in graduate school are significantly more likely to evidence more scholarly productivity, usually defined as publishing articles or presenting papers, (Cronan-Hillix et al., 1986; Nettles & Millett, 2006; Tenenbaum et al., 2001), or interest in research (Kahn, 2000), than students without mentors. In contrast, Green & Bauer (1995) found that when student talent and previous research experience was taken into account, these positive mentoring effects disappeared (Green & Bauer, 1985). Tenenbaum et al. (2001) found that receiving psychosocial support was significantly negatively correlated with student productivity. Having a good advising relationship has been associated with higher doctoral completion rates and shorter times to degree (Ferrer de Valero, 2005). Only one of the literature reviews reported negative effects of mentoring, and none of the empirical studies did so.

What is Not Known

The research points to four areas needing additional study. First, more research is warranted to clarify what type of mentoring support, psychosocial or career, is related to better student outcomes, and how might talent influence this relationship. Second, more sophisticated research is needed to clarify what it means to be mentored. Third, when small, significant effects are reported, such as have been reported in the mentoring literature, moderator variables should be considered (Frazier, Tix, & Barron, 2004). The conditions under which a student might most benefit from having a mentor are not well understood. For example, do U.S. citizens benefit more in a U.S. doctoral program from mentoring than non-U.S. citizens? How
might discipline influence protégé outcomes? The developmental, psychosocial
theory that undergirds most mentoring research suggests a developmental window
(Levinson, 1979; Vaillant, 1977), which coincides with identity development, when an
individual benefits from mentoring. However, identity commitment has not been
researched in relation to mentoring. Finally, do individuals have only one mentor at a
time or are they embedded in a network of mentors?
METHOD

Nearly half of the laureates who were interviewed, while conceding the scientific significance of their research, were convinced it was not their best work. (Zuckerman, 1977, p. 210)

Research Objectives and Hypotheses

The focus of this study is to investigate how mentoring influences five doctoral student outcomes. This research extends previous work by using a multi-measure approach in assessing mentoring, by examining four variables that might influence mentoring outcomes, and by collecting information about multiple mentors. The three research questions addressed in this study are described below.

First, does mentoring influence student outcomes? The study will use more sophisticated measures to investigate whether students who receive more mentor-like behaviors from their advisor are more satisfied with their advisor, produce more scholarly products, and make faster degree progress. Furthermore, does protégé ability, as measured by undergraduate grade point average and previous research experience, mitigate this relationship?

H1a: Doctoral students who report receiving more psychosocial and career support from their advisor will be more satisfied, produce more scholarly products, and make faster degree progress than doctoral students who report receiving less psychosocial and career support from their advisor.

H1b: The relationship in H1a will be significant even after controlling for protégé talent (measured by undergraduate grade point average and number of semesters of undergraduate research experience).
The second research question focuses on the conditions that might influence mentoring. Psychosocial support and career support are the types of mentoring examined in this study. Four moderators will be considered here: psychosocial support, identity status, discipline, and citizenship.

H2a: Psychosocial support will moderate the effect of career support on doctoral student outcomes.

H2b: Identity status will moderate the effects of psychosocial and career support on doctoral student outcomes.

H2c: Discipline will moderate the effects of psychosocial and career support on doctoral student outcomes.

H2d: Citizenship will moderate the effects of mentoring support on doctoral student outcomes.

The third research question will explore the possibility of mentoring networks for graduate students. In addition, the characteristics of mentored and non-mentored students will be compared.

Participants

The population of interest is doctoral students, who started their program between 2 1/2 years to 5 1/2 years ago. This cohort should have had sufficient time to develop a relationship with their advisor and to produce scholarly work.

Graduate Deans from two large, research-intensive universities, henceforth referred to as U1 and U2, agreed to allow students, who began their doctoral program between August 2000 and January 2003, to participate in this study. The Institutional Research Board at both institutions granted approval for the study.
These two institutions, located in the southeast and southwest of the United States, were selected by convenience and because of their sizable doctoral student populations. U1 students in twelve departments were excluded from the sample because these departments were participating in another study on doctoral completion.

Procedure

Students were contacted by email using data files provided by each institution. The Graduate Deans provided email addresses for individuals who began their doctoral programs in the specified time frame. Each individual was emailed an invitation to complete an anonymous, online survey. Respondents were emailed as soon as each University provided the student data file. The U1 students were emailed in March 2006 and the U2 students were emailed in April 2006. A reminder email was sent within 7-10 days. As an incentive, participants were entered in a drawing for one of five $100 gift certificates from Amazon.com if they sent a separate email certifying completion of the survey. Respondents who used the same email, provided in the data file, to certify completion of the survey were not contacted again. A second reminder was emailed 14 days after the original invitation. U1 provided alumni email addresses and those addresses were emailed if they were different (n=134) from the email address in the student data file. The total number of students in the two data files was 2,004 (1,073 from U1 and 931 from U2).

Respondents at one institution were sent letters if their email was returned. About 1/4 of the emails (n= 505) were returned as undelivered, 258 from U1 and 247 from U2. U1 provided a correspondence address for the 258 individuals whose email
was not delivered; 105 of these letters were returned. The mailing generated a trivial number of respondents, and it is likely that most of the letters were not forwarded; therefore, these individuals were not considered as part of the contacted population. Thus, 1,499 individuals were contacted.

A number of cases were not used in the analysis because of missing data. Some people did not complete a sufficient number of the mentoring and identity items. Thus, 75 cases, which were missing more than two items on either of the two mentoring factors, were deleted from the data set. An additional 66 cases were eliminated because more than two items were missing on one of the four identity subscales. One more case was deleted because the response to ‘Satisfaction with Advisor,’ a dependent variable, was missing. The number of individuals who reported being ‘on leave’ or ‘who had quit graduate school’ was too small for statistical analysis; thus, these 20 cases were eliminated from the analysis. A small number of individuals failed to indicate their University (n=1) or how long they had been in the program (n=12), or failed to answer items about scholarly productivity (n=9), extent to which they considered their advisor to be a mentor (n=3), semesters of undergraduate research (n=8), or their citizenship (n=2). All of these cases were deleted, leaving 477 cases to be analyzed. The response rate may be calculated by considering all people who responded to the survey (45%, n= 674) or by considering only those respondents who had usable data (32%, n= 477). Table 5 lists the response rates.
Table 5.

Sample and Response Rates

<table>
<thead>
<tr>
<th></th>
<th>U1</th>
<th>U2</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N (%)</td>
<td>N (%)</td>
<td>N (%)</td>
</tr>
<tr>
<td>Total population.</td>
<td>1,073</td>
<td>931</td>
<td>2,004</td>
</tr>
<tr>
<td>Bounced emails.</td>
<td>258 (24)</td>
<td>247 (27)</td>
<td>505 (25)</td>
</tr>
<tr>
<td>Contacted population.</td>
<td>815 (76)</td>
<td>684 (73)</td>
<td>1,499 (75)</td>
</tr>
<tr>
<td>Took survey.</td>
<td>318 (39)</td>
<td>353 (52)</td>
<td>674 (45)</td>
</tr>
<tr>
<td>Deleted Cases. *</td>
<td>135 (42)</td>
<td>59 (17)</td>
<td>194 (29)</td>
</tr>
<tr>
<td>Sample for Analysis.</td>
<td>218 (27)</td>
<td>259 (38)</td>
<td>477 (32)</td>
</tr>
</tbody>
</table>

*3 individuals did not list a university; thus U1 + U2 do not sum to 194.

Table 6.

Demographic Characteristics of Respondents and Non-Respondents

<table>
<thead>
<tr>
<th></th>
<th>U1</th>
<th>U2</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Population (N = 1073)</td>
<td>Respondents (N = 218)</td>
<td>Respondents (N = 259)</td>
</tr>
<tr>
<td></td>
<td>N (%)</td>
<td>N (%)</td>
<td>N (%)</td>
</tr>
<tr>
<td>Citizenship</td>
<td></td>
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<td>197 (76)</td>
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<td>12 (5)</td>
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<td>491 (46)</td>
<td>62 (28)</td>
<td>50 (19)</td>
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<tr>
<td>Race (of Citizens)</td>
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<tr>
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<td>459 (43)</td>
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</tr>
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<td>Education</td>
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<td>54 (25)</td>
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<tr>
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<td>47 (22)</td>
<td>22 (8)</td>
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<td>Humanities</td>
<td>21 (2)</td>
<td>12 (5)</td>
<td>49 (19)</td>
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<td>Mathematics</td>
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<td>20 (9)</td>
<td>7 (3)</td>
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<td>Science</td>
<td>362 (34)</td>
<td>83 (38)</td>
<td>100 (39)</td>
</tr>
<tr>
<td>Social Science</td>
<td>1 (0)</td>
<td>2 (1)</td>
<td>41 (16)</td>
</tr>
</tbody>
</table>

*Data provided collapsed Permanent Residents with Citizens for U1.
The frequencies and percentages for demographic variables are presented in Table 6. U1 provided demographic data on the total population, which allowed a comparison to be made between non-respondents and respondents (see Table 6). There are some differences between the respondents and non-respondents at U1. Fewer individuals responded in Engineering; however, this was likely confounded with international status since the majority of students in this discipline were international students. International status and race also appeared to affect the responses. Significantly more women from U2 responded than did women from U1, \( F (1, 474) = 7.06, p < .01 \). This finding may be a result of the exclusion of 12 departments at U1, two of which had were humanities and social science departments with large female enrollments. Between 2/3 and 3/4 of the respondents at each University were U.S. citizens. About the same number of white students and students of color responded from both universities. U1 had more part-time students who responded. The sample is representative of the U.S. student graduate population at U1 and U2, with the exception of a lower response rate for international doctoral students.

Measures

An online survey, consisting of four sections, was administered to the participants; it took between 10-20 minutes to complete (see Appendix A). Section A included questions about enrollment, program milestones, and factors contributing to degree progress. These questions were adapted from the Survey on Doctoral Education and Career Preparation (Golde & Dore, 2001). Mentoring behaviors and number of mentors were the focus of Section B. Section C asked questions about
scholarly productivity. The final section, Section D, included the 24-item Objective Measure of Ego Identity Status (OMEIS) (Adams, 1998), and demographic and career questions.

**Mentoring**

Several measures of mentoring support are used in this study. Respondents rated mentoring behaviors they received from their advisor, the extent to which they considered their advisor a mentor, how much and what type of mentoring they received from others, and how many people they considered a mentor.

Fourteen behavioral mentoring items were taken from the Advisor Working Alliance Inventory (AWAI). The AWAI was selected because it was the only instrument with established validity and reliability for graduate students (Schlosser & Gelso, 2001). The AWAI consists of 30 items that assess three dimensions of the advisor relationship: Rapport (11 items), Apprenticeship (14 items), and Identification-individuation (5 items). The AWAI has good variability on the scores (Schlosser & Gelso, 2001).

Since survey length was a concern for this study, the AWAI was modified. The Identification-Individuation items (n=5) were dropped, since this factor had not been found in previous studies and was not of interest in the current study. The seven items with the highest loadings on the Rapport and on the Apprenticeship factors were selected, thereby reducing the total number of items on the AWAI-r (AWAI-revised) to 14. Responses were on a 5-response Likert scale from 1(strongly disagree) to 5 (strongly agree). Some items are reverse coded. Rapport refers to trust and emotional support the student receives from his or her advisor. ‘My advisor
welcomes my input into our discussions’ is an example of a Rapport item, and ‘I do *not* think that my advisor believes in me’ is an example of a Rapport reverse-coded item. Items on the Apprenticeship subscale refer to career support the advisor provides. A sample item is: ‘My advisor facilitates my professional development through networking.’ A reverse-coded item on the Apprenticeship factor is: ‘My advisor does *not* help me stay on track in our meetings.’ The AWAI-r score range is from 14 – 70, with a higher score indicating a mentor-like relationship with the advisor.

Confirmatory Factor Analysis (CFA) was estimated for the AWAI-r. The convergence criterion was satisfied and the CFA results for the AWAI-r provided a good fit of the data to the predicted model as indicated by a Bentler’s Comparative Fit Index of .9 or higher, low standard errors, and a good distribution of the residuals (Hatcher, 1994). The Chi-Square statistic is significant and high, but according to Hatcher (1994) this is not uncommon for large samples and should not be a reason to reject the model if the other indices of fit are adequate.

Table 7 shows the factor loadings for each item. Reliabilities were computed for the AWAI-r (alpha = .91) and for the two subscales of Rapport (alpha = .89) and Apprenticeship (alpha = .84). The Rapport (\( \bar{X} = 4.21, \text{sd} = .77 \)) and Apprenticeship (\( \bar{X} = 3.56, \text{sd} = .85 \)) factors are used in the analysis by computing the mean score for each factor. The factor scores range from 1-5, with 5 indicating receiving more rapport or apprenticeship behaviors from the advisor.

Individuals were also asked directly about mentoring, and this answer was examined to determine if it was correlated to the ratings of the AWAI-r items. After
the AWAI-r, the survey provided this definition and instruction: “A mentor is someone who provides support and advice to a less experienced person. Please think of this definition when answering the next set of questions.” Respondents were then asked to indicate on a scale from 1 (strongly disagree) to 5 (strongly agree) if they agreed with this statement, “I consider my advisor to be a mentor.” The mean score on this item was 3.53, standard deviation of 1.2. Many mentoring studies use a similar question to determine the presence of a mentor; thus, the validity of this item was examined. An ordinary least squares regression was estimated to predict the extent to which an advisor was considered to be a mentor from the two AWAI-r factors. The model was significant, $R^2 = .62$, $F(2, 474) = 388$, $p < .001$. This suggests that individuals are thinking of similar constructs when rating specific mentor-like behaviors and when asked only if they have a mentor.

Table 7.

AWAI: Rapport (R) and Apprenticeship (A) Items

<table>
<thead>
<tr>
<th>Factor loadings</th>
<th>Item</th>
</tr>
</thead>
<tbody>
<tr>
<td>R</td>
<td>A</td>
</tr>
<tr>
<td>.72</td>
<td>.72</td>
</tr>
<tr>
<td>.80</td>
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<td>.72</td>
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<tr>
<td>.64</td>
<td>.64</td>
</tr>
<tr>
<td>.84</td>
<td>.84</td>
</tr>
</tbody>
</table>
Questions were asked about the extent, 1 (not at all) to 5 (a great deal), to which other individuals, i.e. another faculty member, a graduate student, a family member, a friend outside of the program, and other, provided emotional, networking, and career support. The answers were summed for each type of support to create three variables that measured support from individuals other than the advisor: emotional support ($\bar{X} = 14.64, \text{SD} = 2.9$), networking support ($\bar{X} = 8.95, \text{SD} = 3.17$), and career support ($\bar{X} = 10.13, \text{SD} = 3.25$).

Individuals were asked to indicate how many faculty members, other than their advisor, they considered to be a mentor and how many individuals, other than faculty, whom they considered to be a mentor. The answers to these two questions ranged from 0 to 4; 4 was the highest possible response and designated four or more. Respondents reported an average of 1.2, standard deviation of 1.06, faculty mentors who were not their advisor, and an average of 1.04, standard deviation of 1.12, mentors other than their advisor or other faculty.

**Identity**

The Objective Measure of Ego Identity (OMEIS) was selected to measure identity status. This measure has established validity and reliability, and there is a short version (Adams, 1998) of 24-items. There are six items for each of the four identity statuses, which cover three domains: occupation, politics, and religion. Subjects responded using a scale from 1 (strongly disagree) to 6 (strongly agree).

The original categorical scoring plan was abandoned in favor of four continuous measures because of problems with low frequencies in two categories. The categorical approach totals the responses to yield four sub-scores, which range
from 6-36. There is a sub-score for each identity status: diffusion, moratorium, foreclosed, and identity achieved. The scoring manual provides a classification procedure to assign an identity status based on the sub scores (Adams, 1998, p. 25). However, the cell sizes for foreclosure (n = 2) and identity achievement (n = 49) were too small for statistical analysis so this classification system was discarded.

Raw subscale scores can also be used, which is appropriate for correlational analyses (Adams, 1998). The range for each of the four subscales is from 6 (low) to 36 (high). The analysis used the respondent’s scores on the four identity sub scales: diffusion ($\bar{X} = 16.05$, standard error = .25), foreclosure ($\bar{X} = 9.93$, standard error = .19), moratorium ($\bar{X} = 12.48$, standard error = .22), and identity achievement ($\bar{X} = 24.5$, standard error = .22).

The OMEIS has been used on college students and on young adults, although no studies were found where the OMEIS was used with doctoral student samples. Adams (1998) reported on studies using college students. A sample of University of Texas at Austin students found that 43 students (14%) were in Identity Achievement, 142 were in Moratorium (47%), 56 were in Foreclosure (18%) and 64 were in Diffusion (21%). A sample of Utah State University students reported similar findings with 49 students identified as Identity Achievement (19%), 138 as Moratorium (54%), 26 as Foreclosure (10%), and 43 as Diffusion (17%). Test-retest reliabilities for these college samples were reported from .71 to .92, and alphas for identity subscales ranged from .69 to .73 for Diffusion, .81 to .86 for Foreclosure, .70 to .77 for Moratorium, and .84 to .89 for Identity Achievement (as reported in Adams, 1998).
Confirmatory Factor Analysis was estimated on the OMEIS scale responses. The convergence criterion was satisfied and the CFA results provided a good fit of the data to the predicted model, a Bentler’s Comparative Fit Index of .9 or higher, low standard errors, and a good distribution of the residuals (Hatcher, 1994). The Chi-Square statistic for both computations was significant and high, but, according to Hatcher (1994), this is not uncommon for large sample sizes like this one and should not alone be reason to reject the model if the other indices of fit are adequate.

Cronbach coefficient alphas were computed for the OMEIS (alpha=.74) and the four identity factors: Foreclosed (alpha =.78), Moratorium (alpha =.74), Diffusion (alpha =.59), and Achieved (alpha =.56). The reliabilities for the OMEIS subscales are lower than has been found in other studies and is a concern.

**Citizenship**

Citizenship was assessed from an item asking the individual to select if he or she was a: U.S. Citizen, Permanent Resident, or Non U.S. Citizen. This variable is dummy coded with U.S. Citizen as the referent.

**Progress**

Progress toward degree was calculated from respondents’ answers to seven questions about common degree milestones, such as ‘Classes and coursework’ and “Advancement to candidacy.” Respondents indicated if the milestone was a requirement of their program, and if they had completed that milestone or not. A modified Guttman scale was used to assign a score to each individual, since some milestones indicate that the candidate has completed all the previous items. The
following scores were assigned for completion of these items: 7 - graduated or orally defended their dissertation successfully (since it is a short time to graduation after defense); 6 - orally defended their proposal; 5 - written dissertation proposal; and 4 - advancement to candidacy. The remaining respondents received a 1, 2, or 3 according to the sum of these three milestones: classes, master’s degree, and comprehensive exams. Each person was given credit for completing a milestone if it was not a program requirement. Thus, progress scores ranged from 1 – 7, with 7 indicating the most progress. The average score is 5.2, with a standard deviation of 1.67.

Scholarly Productivity

Individuals reported on how many publications, presentations, and patent events they had. These questions were adapted from a scale developed by Schneider (2007). Three productivity variables were calculated from these responses: intellectual property events, publications, and presentations. Intellectual Property Events is a categorical yes/no variable; 39 individuals responded with a yes. Number of publications is a continuous variable that was estimated by summing the number of publications (including in press) that the individual reported having with faculty as co-authors, in refereed journals, and in published proceedings. The mean number of publications is 3.2, standard deviation of 5.5. Half (54%) of the sample reported no publications, so it is not unexpected that this variable is skewed (3.5) and kurtotic (17.7). Number of presentations is a continuous variable that was calculated by summing the number of times the individual reported having presented at national, international, or local conferences. The mean number of presentations
reported is 4.6, standard deviation of 4.8. This variable has a skew of 1.75 and kurtosis of 4.6. Only 19% of the sample reported no presentations.

The presentation and publication productivity variables were negatively skewed and displayed kurtosis. However, underestimates of variance disappear in samples over 200 (Tabachnick & Fidell, 2001). Log transformations were unsatisfactory since the kurtosis and skew were not appreciably reduced and the results would be difficult to interpret. Thus, the data were not transformed. The distribution was fit by the negative binomial distribute, which was the distribution used when computing the regression equations.

Satisfaction with Advisor

Satisfaction with advisor was determined from responses to a 5-level Likert scale where a response of 5 indicates more satisfaction. Only one item comprises this variable, so it is treated as an ordered categorical variable in the analysis. The mean score on this variable is 3.8, standard deviation of 1.2.

Demographics

Individuals were asked to report on these demographic variables: race, sex, time since beginning the doctoral program, number of semesters of undergraduate research, undergraduate grade point average, as well as the rank, sex, and race of their major advisor. Race and sex variables were dummy coded, white and male were the respective referent ‘0’ codes. Time in the program was converted from days and months to number of semesters and treated as a continuous variable. Respondents had been in school an average of 9.4 semesters, standard deviation of 1.76. Undergraduate grade point average was on a 4.0 scale. Respondents were
asked to provide the scale, if their GPA was not on a 4.0 scale, e.g., 5 out 7; these
GPAs were converted to a 4.0 scale. GPA ranges from 2.2 to 4.0, with a mean of
3.48, standard deviation of .37. Thirty-one people did not report their GPA; rather
than delete these cases from the data set, the statistics using GPA were estimated
on the smaller sample of 446 cases. Individuals reported a mean of 2 semesters of
undergraduate research experience, standard deviation of 2.17, although 37% of the
sample reported no semesters of undergraduate research. The respondents
reported their institution and their field of study. The fields of study were collapsed
into six disciplines: education, engineering, humanities, mathematics, science, and
social science.

The average age of the respondents was 34 years and one month, standard
deviation of 7.5 months; the median age was 31 years, 6 months; and the mode was
29 years, 4 months. Individuals reported an average time of 4 years working with
their current advisor, standard deviation of 1.5 years.

Career Expectancy

Individuals were asked to report on the areas in which they anticipated
working. The possible responses include items such as ‘Full-time academic faculty,’
‘Academic administrative,’ and ‘Government/Industry/Corporate.’ This item is
considered in the exploratory analysis.

Research Design and Data Analysis

The research design is cross-sectional and predictive. A total of 477 cases
are used in the analysis. No more than 10 independent variables and covariates
were used to test the two hypotheses. For this many independent variables, a
sample size of 184 is needed to detect a small effect (.10) at the .05 alpha level for power at the .90 level (Cohen & Cohen, 1983). Thus, the sample size provided sufficient power to accept or reject the hypotheses.

Logistic regressions were estimated for the two categorical criterions: satisfaction with advisor and intellectual property events. Ordered logistic regression was estimated to predict satisfaction with advisor. Regression, with a negative binomial distribution, was used to analyze the hypotheses for these two dependent variables: Publications and Presentations. These variables are not normally distributed; there are few occurrences, but there is a wider dispersion than would be appropriate for the Poisson distribution. Ordinary least squares regression was used to analyze the hypotheses, with progress toward degree as the dependent variable.
RESULTS

To begin with, it is striking that more than half (forty-eight) of the ninety-two laureates who did their prize winning research in the United States by 1972 had worked as either students, postdoctorates, or junior collaborators under older Nobel laureates.

(Zuckerman, 1977, p. 99)

This section presents the descriptive statistics for the sample, the results of the hypothesis testing, and the exploratory comparisons of the mentoring experiences and networks of doctoral students.

There are 477 individuals in the sample. Of these, 53% are female, 66% are European American, 73% are U.S. citizens, and 82% were enrolled at the time of the survey. About half of the respondents studied engineering (14%) or science (38%). The remaining students were distributed among the disciplines of education (20%), humanities (13%), social science (9%), or mathematics (6%). Almost two-thirds (63%) of the respondents reported that their advisor was a full professor. Two thirds of the respondents were married or partnered. Refer to Table 8 for descriptive sample statistics.

Graduate students reported mentoring to be important to their doctoral success. Respondents endorsed any of eight factors that contributed to their success as a graduate student. Financial support was the most frequently endorsed item. Two-thirds of the respondents endorsed mentoring/advising, with family support and social or peer support being the third and fourth most frequently endorsed items (see Table 9). Less than half of the sample endorsed program quality, professional guidance, or program requirements as factors contributing to their graduate student success.
Table 8.

Descriptive Sample Statistics

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</tr>
</thead>
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</tr>
<tr>
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<tr>
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<td>Enrolled</td>
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<td>73</td>
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</tr>
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<td></td>
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</tr>
<tr>
<td>Single</td>
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<td>35</td>
</tr>
</tbody>
</table>

Table 9.

Factors Contributing to Graduate Student Success

<table>
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<tr>
<th>Factor</th>
<th>Number Endorsing (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Financial</td>
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</tr>
<tr>
<td>Mentoring/Advising</td>
<td>300 (63)</td>
</tr>
<tr>
<td>Family</td>
<td>239 (50)</td>
</tr>
<tr>
<td>Social/Peer</td>
<td>187 (39)</td>
</tr>
<tr>
<td>Program Quality</td>
<td>184 (39)</td>
</tr>
<tr>
<td>Professional Guidance</td>
<td>122 (26)</td>
</tr>
<tr>
<td>Program Requirements</td>
<td>109 (23)</td>
</tr>
<tr>
<td>Other</td>
<td>73 (15)</td>
</tr>
</tbody>
</table>
Hypothesis One: Mentoring, Satisfaction, Productivity, and Progress

Hypothesis 1a and 1b state that students who receive more mentoring will be more satisfied with their advisor, more productive, and making faster progress, even after protégé talent is taken into account. Refer to Table 10 for the means, standard deviations, and correlations of the dependent variables, and to Table 11 for the means and standard deviations of the mentoring variables. Appendix B is a correlation table of all variables of interest.

Mentoring was assessed through multiple questions, but only one set of questions will be used to measure mentoring in the hypothesis testing. The networking, career, and emotional support questions do not target the advisor relationship, which is of interest here. In addition, the extent to which an individual considered their advisor a mentor was highly correlated with the AWAI-r. Thus, the AWAI-r factors (psychosocial and career support), which focus on the advisor relationship, are the mentoring measures used in the data analysis.

The procedure to test the first hypothesis was to enter the number of semesters since beginning the program and the two AWAI-r factors to predict each of the five dependent variables. If the regression was significant, then a second regression was estimated by adding the talent variables, GPA, and number of semesters of undergraduate research. Five regressions were estimated, one for each dependent variable.
Table 10.

Dependent Variables: Means, Standard Deviations, and Pearson Correlations

<table>
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<th>Variable</th>
<th>Mean</th>
<th>Standard Deviation</th>
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<th>Max</th>
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<th>2.</th>
<th>3.</th>
<th>4.</th>
<th>5.</th>
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</thead>
<tbody>
<tr>
<td>1. Satisfaction with Advisor</td>
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<td>5</td>
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<td></td>
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<tr>
<td>2. Intellectual Property Events</td>
<td>0.08</td>
<td>0.27</td>
<td>0</td>
<td>1</td>
<td>.03</td>
<td>.03</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Publications</td>
<td>1.66</td>
<td>3.10</td>
<td>0</td>
<td>28</td>
<td>.14**</td>
<td>.28***</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Presentations</td>
<td>4.63</td>
<td>4.77</td>
<td>0</td>
<td>32</td>
<td>.12**</td>
<td>.09*</td>
<td>.32***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Progress</td>
<td>5.20</td>
<td>1.67</td>
<td>1</td>
<td>7</td>
<td>.09*</td>
<td>.05</td>
<td>.21***</td>
<td>.25***</td>
<td></td>
</tr>
</tbody>
</table>

*p<.05, **p<.01, ***p<.001

Table 11.

Mentoring Variables and Covariates: Means and Standard Deviations

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Rapport</td>
<td>4.21</td>
<td>0.77</td>
</tr>
<tr>
<td>2. Apprenticeship</td>
<td>3.56</td>
<td>0.85</td>
</tr>
<tr>
<td>3. Advisor is Mentor</td>
<td>3.53</td>
<td>1.21</td>
</tr>
<tr>
<td>4. Undergrad. Research</td>
<td>2.04</td>
<td>2.18</td>
</tr>
<tr>
<td>5. GPA</td>
<td>3.49</td>
<td>0.37</td>
</tr>
<tr>
<td>6. Semester in Program</td>
<td>9.40</td>
<td>1.77</td>
</tr>
<tr>
<td>7. Network Support</td>
<td>8.95</td>
<td>3.17</td>
</tr>
<tr>
<td>8. Career Support</td>
<td>10.13</td>
<td>3.25</td>
</tr>
<tr>
<td>9. Emotional Support</td>
<td>14.64</td>
<td>2.91</td>
</tr>
<tr>
<td>10. Faculty Mentors</td>
<td>1.24</td>
<td>1.06</td>
</tr>
<tr>
<td>11. Mentors, not Faculty</td>
<td>1.04</td>
<td>1.12</td>
</tr>
</tbody>
</table>
Satisfaction with Advisor & Intellectual Property Events

Logistic regression is the appropriate analysis for the categorical dependent variables Satisfaction with Advisor and Intellectual Property Events. Satisfaction with Advisor is comprised of one Likert item; therefore, it must be treated as an ordered categorical variable. Intellectual property events is a yes/no variable indicating whether a respondent has had an intellectual property event; ‘no’ is coded as the referent. Logistic regression results are interpreted by using the odds ratios, which indicate the multiplicative changes in the dependent variable odds for a unit change in the predictor variables. The odds ratio also indicates the size and direction of the effect. For example, an odds ratio of 1.0 means that the predictor, e.g., psychosocial support, has no effect on the criterion, e.g., satisfaction with advisor. Pseudo R\(^2\) is used to estimate the effect size (Hagle & Mitchell, 1992).

Logistic regression was estimated with the independent variables of Rapport and Apprenticeship and the covariate, number of semesters since beginning the program. Satisfaction with Advisor was the dependent variable. The model is significant, \(X^2 (3, N=477) = 561, p<.001;\) pseudo R\(^2\) = .41. Rapport and Apprenticeship are significant predictors in the model. Since the model was significant, a second logistic regression was estimated by adding the talent variables, number of semesters of undergraduate research and GPA. Table 12 presents the logistic regression result for this model, which is significant, \(X^2 (5, N=446) = 531, p<.001.\) For a one-unit increase in Rapport, the odds are 7.6 times greater that students report more satisfaction with their advisor. The Rapport odds increased from 7.53 to 7.6 with the addition of the talent variables. Apprenticeship
has an even greater effect. For a one-unit increase in apprenticeship support, the odds are ten times greater that students are more satisfied with their advisor. The apprenticeship odds increased from 9.4 to 9.97 with the addition of the talent variables. Number of semesters of undergraduate research is significantly, negatively related to satisfaction with advisor. The difference between the two models’ chi-square was estimated by hand and the change was significant, \(X^2(2, N=446) = 30, p<.001\), although the Pseudo \(R^2\) increased a tiny amount (.01).

Logistic regression was estimated with Intellectual Property Events as the dependent variable and Apprenticeship and Rapport as the independent variables. The model is significant, \(X^2(3, N=477) = 9.50, p<.05\); pseudo \(R^2 = .04\). However, Apprenticeship is the only significant predictor. The odds of having an intellectual property event are 2.3 times greater for a one-unit increase in Apprenticeship. Since the model was significant, a second logistic regression was estimated with the addition of GPA and number of semesters of undergraduate research. While the full model is statistically significant, \(X^2(5, N=446) = 15.11, p<.01\); pseudo \(R^2 = .06\), the change in chi-square is not significant, indicating that GPA and Number of semesters of undergraduate research did not significantly add to the prediction (refer to Table 12). Individuals who report a one-unit increase in apprenticeship support from their advisors have twice the odds of reporting an intellectual property event, even after talent is considered.

In summary, these findings support the hypothesis because the two mentoring factors, apprenticeship and rapport, remained significantly related to satisfaction with advisor even after talent was considered. Apprenticeship, one type
of mentoring, is also significantly related to more scholarly productivity, as measured by intellectual property events.

Table 12.
Main Effects of Logistic Regression: Satisfaction with Advisor and Intellectual Property Events

<table>
<thead>
<tr>
<th>Variable</th>
<th>Satisfaction with Advisor</th>
<th>Intellectual Property Events</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coefficient</td>
<td>Odds Ratio</td>
</tr>
<tr>
<td>Semester Program</td>
<td>-.03</td>
<td>.97</td>
</tr>
<tr>
<td>Rapport</td>
<td>2.03***</td>
<td>7.61***</td>
</tr>
<tr>
<td>Apprenticeship</td>
<td>2.30***</td>
<td>9.97***</td>
</tr>
<tr>
<td>GPA</td>
<td>.27</td>
<td>1.31</td>
</tr>
<tr>
<td>Undergraduate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Research</td>
<td>-.10*</td>
<td>.90*</td>
</tr>
</tbody>
</table>

Model pseudo $R^2 = .42 (X^2=531, 5, p < .001)$ pseudo $R^2 = .06 (X^2 = 15.11, 5, p < .01)$

*p<.05, **p<.01, ***p<.001

Publications & Presentations

The AWAI-r factors, Apprenticeship and Rapport, were regressed on number of reported publications, using negative binomial regression (see Table 13). The model is statistically significant, $X^2(3, N=477) = 33.78, p<.001$; pseudo $R^2 = .02$. Apprenticeship is the only significant predictor, $p<.001$. A second regression was estimated with the two talent variables added to the equation. The model is statistically significant, $X^2(5, N=446) = 34.10, p<.001$; pseudo $R^2 = .02$; however, the change in $X^2$ was estimated by hand and was not significant. Individuals who receive one more unit of apprenticeship support have odds 79% greater that they have an additional publication.

The same regression procedure was used with Number of Presentations as the dependent variable (see Table 13). The model is statistically significant, $X^2(3,$
N=477) = 27.80, p<.001; pseudo $R^2 = .01$. Apprenticeship and the covariate, Number of Semesters since beginning the Program, are significantly related to number of presentations. The odds ratio for Apprenticeship indicates that the odds are 37% higher of having a presentation for a one-unit increase in Apprenticeship. The odds ratio for Number of Semesters since beginning the Program is small at 1.10. A second regression was estimated by adding the two talent variables. The model is statistically significant, $X^2(5, N=446) = 41.90, p<.001$; pseudo $R^2 = .02$. The change in $X^2$ was estimated by hand and is significant, $X^2(2) = 14.10$. Number of semesters of undergraduate research, but not GPA, was significantly related to number of presentations. Apprenticeship support remained significant. In fact, the odds are 40% greater that individuals who receive one more unit of apprenticeship will have one more presentation. The odds for semesters since beginning the program and number of semesters of undergraduate research are small, 9% and 7% respectively.

Table 13.

Main Effects of Negative Binomial Regression: Publications and Presentations

<table>
<thead>
<tr>
<th>Variable</th>
<th>Publications</th>
<th></th>
<th></th>
<th>Presentations</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coefficient</td>
<td>Odds Ratio</td>
<td>Coefficient</td>
<td>Odds Ratio</td>
<td>Coefficient</td>
<td>Odds Ratio</td>
</tr>
<tr>
<td>Semester Program</td>
<td>.06</td>
<td>1.06</td>
<td>.09***</td>
<td>1.09***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rapport</td>
<td>-.08</td>
<td>.92</td>
<td>-.15</td>
<td>.86</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Apprenticeship</td>
<td>.58***</td>
<td>1.79***</td>
<td>.34***</td>
<td>1.40***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GPA</td>
<td>.17</td>
<td>1.18</td>
<td>.24</td>
<td>1.27</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Undergraduate</td>
<td>.07</td>
<td>1.07</td>
<td>.06**</td>
<td>1.07**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Research</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Model: pseudo $R^2 = .02$ ($X^2=34.10, 5, p < .001$) pseudo $R^2 = .02$ ($X^2=41.90, 5, p < .001$)

*p<.05, **p<.01, ***p<.001
In summary, these findings support hypothesis one. Receiving career-type mentoring is significantly associated with more scholarly productivity, in this case, more publications and more presentations, even after talent is taken into consideration. However, the effects sizes are very small.

**Progress**

Ordinary least squares regression was estimated with Rapport and Apprenticeship as the independent variables. Progress was the dependent variable, which ranged from 1-7 indicating progress on common degree milestones. The covariate, number of semesters since beginning the program, was not considered because it is confounded with degree progress. The model is significant, $R^2 = .01$, $F(2, 474) = 3.26$, $p < .05$. Apprenticeship is a significant predictor of Progress. A second regression was estimated with the addition of the talent variables. Apprenticeship and number of semesters of undergraduate research were significant predictors, $R^2 = .04$, $F(4, 441)$, $p < .01$. Thus, there is support for hypothesis one in that receiving more mentoring, Apprenticeship influences progress toward degree even after talent is considered. The unstandardized regression coefficients and beta weights from the multiple regression are presented in Table 14.

### Table 14.

**Unstandardized Regression Coefficients and Beta Weights for Predicting Progress**

<table>
<thead>
<tr>
<th>Variable</th>
<th>$B$</th>
<th>$\beta$</th>
<th>$P$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rapport</td>
<td>-.05</td>
<td>-.02</td>
<td>.708</td>
</tr>
<tr>
<td>Apprenticeship</td>
<td>.28*</td>
<td>.15</td>
<td>.021</td>
</tr>
<tr>
<td>Undergraduate Research</td>
<td>.10**</td>
<td>.13</td>
<td>.006</td>
</tr>
<tr>
<td>GPA</td>
<td>.33</td>
<td>.08</td>
<td>.113</td>
</tr>
</tbody>
</table>

$^*p<.05$, $^{**}p<.01$, $^{***}p<.001$
Hypothesis Two: Mentoring, Satisfaction, Productivity, and Progress

The second set of hypotheses examines the conditions that might affect mentoring outcomes. It is posited that Rapport, Citizenship, Identity Commitment, and Discipline will moderate the relationship between the two mentoring factors, rapport and apprenticeship, and the five dependent variables. The appropriate regression was estimated separately for each of the five dependent variables with each moderator. All of the significant independent variables and interactions were entered into the final model. The predictor and moderator variables were entered first, followed by the interaction terms. Statistical researchers suggest entering multiple moderator terms together to control for Type I error (Frazier et al., 2004).

Satisfaction with Advisor & Intellectual Property Events

There was one significant interaction with mentoring on satisfaction with advisor. Discipline, Citizenship, and their interactions with mentoring were not significantly related to Satisfaction with Advisor and were dropped from the final model. Identity Achievement was significantly related to satisfaction with advisor. For one unit increase in Identity Achievement the odds of being more satisfied with the advisor are 5% higher. Rapport*Apprenticeship was the only significant interaction. The logistic regression predicting Satisfaction with Advisor was significant, $X^2(9, N=477) = 581, p<.001; \text{pseudo } R^2 = .43$ (see Table 15). The pseudo $R^2$ increased .01. Number of semesters of undergraduate research is also positively, significantly related to higher Satisfaction with Advisor.
The Rapport*Apprenticeship interaction was plotted to examine the effects of Rapport, conditional on Apprenticeship, and Apprenticeship, conditional on Rapport, on Satisfaction with Advisor. Both plots suggest the same interpretation, so only Apprenticeship, conditional on Rapport, will be explained here. The effect of Apprenticeship depends on the level of Rapport in predicting how satisfied someone is with his or her advisor. Apprenticeship increases satisfaction the most at high levels of Rapport. However, there is a ceiling effect that limits the interaction. If a person reports high Rapport support, then they are already quite satisfied with their advisor and additional Apprenticeship support makes little difference (see Figure1).

Logistic regression was estimated to analyze the moderators on intellectual property events (see Table 15). There were no significant moderators of mentoring on intellectual property events. The first model would not converge since there were so few intellectual property events for the discipline of social science. Thus, the disciplines were collapsed into three, rather than five, dummy coded disciplines with Engineering as the referent. Citizenship and the Rapport*Apprenticeship interaction were not significant and were dropped from the analysis. The identity status of Diffusion was significant as a main effect when the Identity Status variables were entered alone, but this effect was not significant in the full model. The final model is significant, \( X^2 (11, N=477) = 41.58, p<.001; \) pseudo \( R^2 = .16 \). Individuals who reported an additional semester of undergraduate research have higher odds (18%) of an intellectual property event. Apprenticeship disappeared as a main effect, and Discipline carried the relationship.
In summary, Rapport and Apprenticeship significantly interact and influence satisfaction with advisor. When discipline is entered into the model predicting intellectual property events, the predicted variance increased from .06 to .16. However, mentoring no longer predicts having scholarly productivity, as measured by having an intellectual property event.

Figure 1. Effect of Apprenticeship, Conditional on Rapport, on Satisfaction with Advisor.
Table 15.
Interactions: Satisfaction with Advisor & Intellectual Property Events

<table>
<thead>
<tr>
<th>Variable</th>
<th>Satisfaction with Advisor</th>
<th>Intellectual Property Events</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coefficient</td>
<td>Odds Ratio</td>
</tr>
<tr>
<td>Semester Program</td>
<td>-.05</td>
<td>.95</td>
</tr>
<tr>
<td>Rapport</td>
<td>.32</td>
<td>1.37</td>
</tr>
<tr>
<td>Apprenticeship</td>
<td>.06</td>
<td>1.06</td>
</tr>
<tr>
<td>Undergrad. Research</td>
<td>-.10*</td>
<td>.90*</td>
</tr>
<tr>
<td>Discipline</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Science/Mathematics</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>SocialScience/Human.</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Education</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Identity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Achieved</td>
<td>.05*</td>
<td>1.05*</td>
</tr>
<tr>
<td>Diffusion</td>
<td>.01</td>
<td>1.01</td>
</tr>
<tr>
<td>Moratorium</td>
<td>.02</td>
<td>1.02</td>
</tr>
<tr>
<td>Foreclosure</td>
<td>.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Rapport*Apprenticeship</td>
<td>.55**</td>
<td>1.73**</td>
</tr>
</tbody>
</table>

Model pseudo $R^2 = .43 \ (X^2 = 581, 9, p < .001)$ pseudo $R^2 = .16 \ (X^2 = 41.55, 11, p < .001)$

*p<.05, **p<.01

Publications & Presentations

Negative binomial regressions were estimated to analyze the effects of the moderators on the scholarly productivity measure of Publications (see Table 16). Discipline was the significant moderator of mentoring and number of publications. Citizenship, its interactions, and the Rapport*Apprenticeship Interaction were not significant and therefore were not included in the final model. The model predicting Publications is significant, model pseudo $R^2 = .11 \ (X^2 = 177, 19, p < .001)$. Including these additional variables increased the pseudo $R^2$ by .09. Number of semesters since beginning the program and two of the Identity Statuses, Diffusion and Moratorium, are significant as main effects. Increases in Diffusion scores change the odds of publishing very little, only 6%. Increases in Moratorium scores lead to slightly lower odds of publishing more. There is a significant main effect of
Table 16.

Interactions: Mentoring, Publications, and Presentations

<table>
<thead>
<tr>
<th>Variable</th>
<th>Publications</th>
<th></th>
<th>Presentations</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coefficient</td>
<td>Odds Ratio</td>
<td>Coefficient</td>
<td>Odds Ratio</td>
</tr>
<tr>
<td>Semester Program</td>
<td>.14 *</td>
<td>1.14 ***</td>
<td>.08 **</td>
<td>1.09 **</td>
</tr>
<tr>
<td>Rapport</td>
<td>.55</td>
<td>1.73</td>
<td>-.14</td>
<td>.86</td>
</tr>
<tr>
<td>Apprenticeship</td>
<td>-.07</td>
<td>2.51</td>
<td>.33 ***</td>
<td>1.39 ***</td>
</tr>
<tr>
<td>Undergrad Res.</td>
<td>.02</td>
<td>1.02</td>
<td>.05 **</td>
<td>1.05 **</td>
</tr>
</tbody>
</table>

**Discipline**

<table>
<thead>
<tr>
<th></th>
<th>Publications</th>
<th></th>
<th>Presentations</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Social Science</td>
<td>1.78</td>
<td>.17</td>
<td>.33</td>
<td>1.39</td>
</tr>
<tr>
<td>Science</td>
<td>.31</td>
<td>.73</td>
<td>.16</td>
<td>1.18</td>
</tr>
<tr>
<td>Mathematics</td>
<td>10.93 *</td>
<td>0.00 *</td>
<td>.77</td>
<td>.46 *</td>
</tr>
<tr>
<td>Humanities</td>
<td>.51</td>
<td>.60</td>
<td>.32</td>
<td>1.38</td>
</tr>
<tr>
<td>Education</td>
<td>4.93 **</td>
<td>.007 **</td>
<td>.31</td>
<td>.74</td>
</tr>
</tbody>
</table>

**Discipline Interactions**

<table>
<thead>
<tr>
<th></th>
<th>Publications</th>
<th></th>
<th>Presentations</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Social Sci*Rapport</td>
<td>1.77 *</td>
<td>.17 *</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Science*Rapport</td>
<td>.62</td>
<td>.54</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Math*Rapport</td>
<td>1.06</td>
<td>2.89</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Humanities*Rapport</td>
<td>1.22 *</td>
<td>.30 *</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Education*Rapport</td>
<td>.47</td>
<td>.63</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Social Sci.*App</td>
<td>2.03 **</td>
<td>7.61 **</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Science*App</td>
<td>.59</td>
<td>1.80</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Math*App</td>
<td>.97</td>
<td>2.64</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Humanities*App</td>
<td>.95 *</td>
<td>2.59 *</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Education*App</td>
<td>1.30 **</td>
<td>3.67 **</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Identity**

<table>
<thead>
<tr>
<th></th>
<th>Publications</th>
<th></th>
<th>Presentations</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Achieved</td>
<td>.00</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diffusion</td>
<td>.06 ***</td>
<td>1.06 ***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Moratorium</td>
<td>.04 *</td>
<td>.96 *</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Foreclosure</td>
<td>.01</td>
<td>.99</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Model \( R^2 = .12 \) (\( X^2 = 190, 23, p < .001 \)) \( R^2 = .03 \) (\( X^2 = 72.68, 9, p < .001 \))

mathematics, with students in mathematics having significantly lower odds of publishing than engineering students. Discipline significantly moderates the relationship between Apprenticeship and Rapport, and number of publications. A box plot showed that Engineering students publish more than students in other
disciplines, which makes Engineering the logical choice for the referent in the dummy coding. The significant interactions were graphed, with each conditional on the other. The graphs that make the most sense to interpret are Rapport, conditional on discipline (see Figure 2) and Apprenticeship, conditional on discipline (see Figure 3). Engineering is graphed for comparison, as it is the referent in the dummy coding.

Humanities students who report more psychosocial advisor support are more likely to publish less. The odds are 30% greater that students in Humanities will have a one-unit decrease in number of publications for a one-unit increase in Rapport. The odds are 17% greater that students in the Social Sciences will have a one-unit decrease in number publications for a one-unit increase in Rapport. The interaction is stronger for students in the Social Sciences since the slope is steeper, as shown in Figure 2. Clearly, students do not have a negative number of publications; these numbers are artifacts of the predictive model. This finding is in contrast with students in Engineering, who are predicted to have more publications as they receive more Rapport support from their advisor.

Apprenticeship support has the converse effect on number of publications reported. Receiving more Apprenticeship support from an advisor results in greater odds of publications for students in Social Sciences (odds are about 7 1/2 times greater), Humanities (odds are about 2 1/2 times greater), and Education (odds are about 3 1/2 times greater). The amount of Apprenticeship students in Engineering receive does not seem to affect the number of publications (see Figure 3).

The same analytic strategy used for predicting number of publications was used to predict number of presentations. There are no moderators of mentoring on
Figure 2. Effect of Rapport, Conditional on Discipline, on Number of Publications.

Figure 3. Effect of Apprenticeship, Conditional on Discipline, on Number of Publications.
number of presentations. The regression is significant, model pseudo $R^2 = .03$ ($X^2 = 73, 9, p < .001$); refer to Table 16 for the statistics. The model did not predict more variance, as measured by the pseudo $R^2$, than the model estimated in hypothesis one. The covariate, number of semesters since beginning the program, is significant. Number of semesters of undergraduate research is also significantly related to number of presentations. For a one-semester increase in Semesters of Undergraduate Research, the odds of presenting at a conference increase 15%. Apprenticeship is a significant main effect in the model. Doctoral students in mathematics have less odds of presenting than students in engineering.

In summary, discipline moderates mentoring and scholarly productivity when publications are considered. This finding provides support for hypothesis two. However, there are no moderators of mentoring on scholarly productivity as measured by number of presentations. Thus, there is not support for hypothesis two when presentations are the scholarly product.

Progress

Ordinary least squares multiple regression was estimated to analyze the interactions of Rapport, Discipline, Citizenship, and Identity on the relationship between mentoring and degree progress (see Table 17). The covariate, number of semesters in the program, was not considered in this analysis since it is confounded with this dependent measure. There were no significant interactions. Identity status was not significantly related to degree progress and citizenship was significant until discipline was included. Thus, identity status and citizenship were not included in the final model. Apprenticeship ceased to be significantly related to degree progress.
after discipline was included. Students majoring in science made significantly more progress toward degree than students in Engineering. Students with more undergraduate research experience made faster degree progress than students with less undergraduate research experience. The final model is significant, $R^2 = .09$, $F(8, 468)$, $p < .001$. Mentoring, as measured by Rapport and Apprenticeship, is not a significant predictor of progress toward degree.

Table 17.

**Unstandardized Regression Coefficients and Beta Weights for Predicting Progress, No Significant Moderators**

<table>
<thead>
<tr>
<th>Variable</th>
<th>B</th>
<th>β</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rapport</td>
<td>.08</td>
<td>.04</td>
<td>.542</td>
</tr>
<tr>
<td>Apprenticeship</td>
<td>.15</td>
<td>.08</td>
<td>.213</td>
</tr>
<tr>
<td>Undergrad Research</td>
<td>.07 *</td>
<td>.09</td>
<td>.042</td>
</tr>
<tr>
<td>Social Science</td>
<td>-.19</td>
<td>-.03</td>
<td>.537</td>
</tr>
<tr>
<td>Humanities</td>
<td>.16</td>
<td>.03</td>
<td>.580</td>
</tr>
<tr>
<td>Math</td>
<td>.37</td>
<td>.05</td>
<td>.312</td>
</tr>
<tr>
<td>Education</td>
<td>-.47</td>
<td>-.11</td>
<td>.068</td>
</tr>
<tr>
<td>Science</td>
<td>.54 *</td>
<td>.16</td>
<td>.019</td>
</tr>
</tbody>
</table>

$R^2 = .09$

*p<.05, **p<.01, ***p<.001

**Exploratory Analysis**

The results suggest that ex post facto analyses might reveal other variables that are related to mentoring and student outcomes. Thus, additional analyses were conducted to explore the effects of a mentoring network, discipline, career aspirations, and specific mentoring behaviors on mentoring outcomes. The results are presented here.
The majority of graduate students received mentor-like support from individuals other than their advisor. What types of support do students report receiving, from whom, and is it related to the doctoral outcomes examined here? The survey included several questions to determine mentoring that students might receive from other individuals.

Emotional support and career support are established factors of mentoring. In addition, networking has been found to be important in some studies. Thus, students reported on the extent to which another faculty member, a graduate student, a family member, or a friend outside the program provided emotional, career, and network support. Responses were on a five-item Likert scale. These responses were summed to create three variables measuring the sum of emotional, career, and network support from people other than their advisor. Career, emotional, and network support are significantly correlated with each other (see Appendix B). In addition these three types of support are significantly correlated with the AWAI-r Apprenticeship factor. However, emotional support is not significantly correlated with the AWAI-r Rapport factor. Individuals who considered their advisor to be a mentor were significantly more likely to also report receiving career, network, and emotional support from others (see Appendix B).

Are protégés likely to have multiple mentors or do students look for other mentors only if their advisor does not provide such support? The data suggest the former explanation. An overwhelming majority of the sample reported having multiple mentors. Only 66 (14%) of the 477 respondents reported no other faculty
member or individuals outside of the faculty as a mentor (refer to the arrow in Table 18). Of these, 16 (refer to the two arrows in Table 18) did not consider their advisor a mentor, i.e. they either disagreed or strongly disagreed with that statement.

Table 18.

Mentor Network: Extent Advisor Considered a Mentor by Number of Additional Mentors

<table>
<thead>
<tr>
<th>Advisor Considered A Mentor</th>
<th>Number of Mentors Other Than Advisor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency Column %</td>
<td>0</td>
</tr>
<tr>
<td>Strongly Disagree</td>
<td>5</td>
</tr>
<tr>
<td>Strongly Disagree</td>
<td>7.58</td>
</tr>
<tr>
<td>Agree</td>
<td>11</td>
</tr>
<tr>
<td>Agree</td>
<td>13</td>
</tr>
<tr>
<td>Agree</td>
<td>19.70</td>
</tr>
<tr>
<td>Agree</td>
<td>25</td>
</tr>
<tr>
<td>Agree</td>
<td>37.88</td>
</tr>
<tr>
<td>Strongly Agree</td>
<td>12</td>
</tr>
<tr>
<td>Strongly Agree</td>
<td>18.18</td>
</tr>
<tr>
<td>Column Totals</td>
<td>66</td>
</tr>
<tr>
<td>Totals</td>
<td>13.84</td>
</tr>
</tbody>
</table>

A majority of the students appear to have a network of mentors, and this network's influence on doctoral student outcomes was explored. Two-thirds of the respondents report having a faculty member, other than their advisor, whom they consider to be a mentor (see Table 19). Two-thirds of the sample also reported having a non-faculty member whom they consider to be a mentor. Thus, the number
of other faculty mentors, the number of mentors (who are not faculty), and the emotional, network, and career support (received from people other than the advisor) were included in each of the five, final regression models used to test hypothesis two. The inclusion of these variables did not significantly increase the effect size. The number of faculty, who were not advisors, and career support (received from people other than the advisor) were significant variables in the negative binominal regression predicting presentations.

**Discipline**

Discipline was significantly related some of the dependent variables. Thus, it was examined more closely to determine if students in some disciplines might be more likely to consider their advisor a mentor or report a network of mentors (see Table 19). Students reported the number of faculty, other than their advisor, who were mentors to them. The number of other faculty mentors was dichotomized into a variable with 0 and 1 or more. Discipline did not affect the number of faculty mentors students reported, \( \chi^2 = 8.21, \text{df} = 5, p = .144 \). Students were also asked about the number of non-faculty mentors they had. The number of non-faculty mentors was also dichotomized into a variable of 0 and 1 or more. Discipline was not significantly related to the number of non-faculty mentors a student had, \( \chi^2 = 4.71, \text{df} = 5, p = .4518 \). Discipline is not significantly related to a student’s satisfaction with advisor, extent to which they consider their advisor a mentor, or the number of other mentors an individual reports.
Table 19.

Mentoring by Discipline

<table>
<thead>
<tr>
<th>Discipline</th>
<th>Advisor is a Mentor*</th>
<th>Faculty Mentors</th>
<th>Other Mentors</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>None # (%)</td>
<td>1 or more # (%)</td>
</tr>
<tr>
<td>Education</td>
<td>3.28</td>
<td>24 (26)</td>
<td>69 (74)</td>
</tr>
<tr>
<td>Engineering</td>
<td>3.67</td>
<td>27 (39)</td>
<td>42 (61)</td>
</tr>
<tr>
<td>Humanities</td>
<td>3.52</td>
<td>20 (33)</td>
<td>41 (67)</td>
</tr>
<tr>
<td>Mathematics</td>
<td>3.48</td>
<td>9 (33)</td>
<td>18 (67)</td>
</tr>
<tr>
<td>Science</td>
<td>3.61</td>
<td>42 (23)</td>
<td>141 (77)</td>
</tr>
<tr>
<td>Social Science</td>
<td>3.56</td>
<td>10 (23)</td>
<td>33 (77)</td>
</tr>
<tr>
<td>All Disciplines</td>
<td>3.53</td>
<td>132 (28)**</td>
<td>344 (72)</td>
</tr>
</tbody>
</table>

*Scale is from 1 (low) – 5 (high). **1 missing

Table 20.

Mentoring by Desired Organization of Employment Post-Graduation

<table>
<thead>
<tr>
<th>Organization</th>
<th>Advisor is A Mentor*</th>
<th>Faculty Mentors</th>
<th>Other Mentors</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>None # (%)</td>
<td>1 or more # (%)</td>
</tr>
<tr>
<td>Non-profit</td>
<td>4.44</td>
<td>1 (11)</td>
<td>8 (89)</td>
</tr>
<tr>
<td>Acad admins.</td>
<td>2.94</td>
<td>11 (32)</td>
<td>23 (68)</td>
</tr>
<tr>
<td>Acad research</td>
<td>3.69</td>
<td>10 (32)</td>
<td>21 (68)</td>
</tr>
<tr>
<td>FT faculty</td>
<td>3.66</td>
<td>58 (26)</td>
<td>254 (74)</td>
</tr>
<tr>
<td>Gov’t/Ind/Corp</td>
<td>3.46</td>
<td>38 (30)</td>
<td>89 (70)</td>
</tr>
<tr>
<td>Part-time fac.</td>
<td>3.62</td>
<td>6 (46)</td>
<td>7 (54)</td>
</tr>
<tr>
<td>Other</td>
<td>3.00</td>
<td>8 (24)</td>
<td>25 (76)</td>
</tr>
<tr>
<td>All Organizations</td>
<td>3.53</td>
<td>132 (28)**</td>
<td>344 (72)</td>
</tr>
</tbody>
</table>

*Scale is from 1 (low) – 5 (high). **1 missing

**Career Aspirations**

It is possible that the career aspirations a student has might affect their need for mentors. Thus, the relationship of what organization a student hoped to work in was examined relative to their satisfaction with their advisor and their mentoring network (see Table 20). The organization students aspired to work in after
graduation was not significantly related to the extent to which they considered their advisor to be a mentor, \( (X^2 = 35.14, df = 24, p = .06) \) at the .05 level. Their desired organization in which to work was also not significantly related to the number of faculty mentors they had, \( (X^2 = 5.502, df = 6, p = .48) \), or to the number of other mentors they reported, \( (X^2 = 10.2, df = 6, p = .12) \).

Finally, the AWAI-r items were explored to determine which of the mentor-like behaviors were related to the five dependent variables of interest. The appropriate regression equations were estimated for each of the five dependent variables, using the 14 individual AWAI-r items as the independent variables. Logistic regression was computed for satisfaction with advisor and intellectual property events, with the covariate number of semesters since beginning the program. Negative binomial multiple regression was computed for number of publications and number of presentations, with the covariate number of semesters since beginning the program. Multiple linear regression was calculated for progress without the covariate, number of semesters since beginning the program, as it is correlated with progress. The estimates for the significant items are listed in Table 21.

This analysis revealed which of the apprenticeship and rapport behaviors were most frequently related to the student outcomes. Collaboration is the apprenticeship behavior that is significantly related to four of the dependent variables at the .05 level and is related to all five variables at the less conservative .10 level. Introduction to professional activities and offering improvement ideas were two other apprenticeship behaviors significantly related to three of the dependent variables.
variables. Feeling respected is the rapport behavior that is most frequently associated with student outcomes.

Table 21.

**Significant AWAI-r Items by Dependent Variable**

<table>
<thead>
<tr>
<th>Dependent Variable</th>
<th>Apprenticeship Behaviors</th>
<th>Rapport Behaviors</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Professional Activities</td>
<td>Like (R)</td>
</tr>
<tr>
<td></td>
<td>Plan for Work</td>
<td>Welcomes Input (R)</td>
</tr>
<tr>
<td></td>
<td>Collaboration</td>
<td>Encourage Input (R)</td>
</tr>
<tr>
<td></td>
<td>Time Table</td>
<td>Kind (R)</td>
</tr>
<tr>
<td></td>
<td>Productive Meetings (R)</td>
<td>Respected (R)</td>
</tr>
<tr>
<td></td>
<td>Networking</td>
<td>Offers Encouragement</td>
</tr>
<tr>
<td></td>
<td>Improve</td>
<td>Believe in Me (R)</td>
</tr>
</tbody>
</table>

Coefficients listed only for significant items at p<.05. Items with (R) are reverse coded from the questions below.

**Apprenticeship Behaviors**
1. Professional Activities – My advisor introduces me to professional activities (e.g., conferences, submitting articles for journal publication).
2. Plan for Work – My advisor helps me conduct my work within a plan.
3. Collaboration – My advisor has invited me to be a responsible collaborator in his/her own work.
4. Time Table – My advisor helps me establish a timetable for the tasks of my graduate training.
5. Unproductive Meetings – Meetings with my advisor are unproductive.
6. Networking – My advisor facilitates my professional development through networking.
7. Improve – My advisor helps me recognize areas where I can improve.

**Rapport Behaviors**
Advisor Not Like – I get the feeling that my advisor does NOT like me very much.
Welcomes Input – My advisor welcomes my input into our discussions.
Not Encourages Input – My advisor does NOT encourage my input into our discussions.
Not Kind – My advisor is NOT kind when commenting about my work.
Not Respected – I do NOT feel respected by my advisor in our work together.
Offers Encouragement – My advisor offers me encouragement for my accomplishments.
Not Believed – I do NOT think that my advisor believes in me.
However, not all of the behaviors have positive effects on student outcomes. Collaboration and professional activities have positive influences on student outcomes. Receiving feedback about how to improve is positively related to increased student satisfaction with advisor but negatively related to having more publications or presentations. Feeling respected is positively related to satisfaction with advisor and intellectual property events, but negatively related to having presentations.
DISCUSSION

For young scientists as talented as these destined laureates, great advantages accrue from being apprenticed to elite masters. Once internalized, standards of performance and scientific taste, unlike material facilities, do not generally depreciate with use. (Zuckerman, 1977, p. 131)

A mentoring relationship is at the heart of American doctoral education and knowledge creation, as Zuckerman found (1977) in her study of Nobel Laureates. Yet, remarkably little is known about mentoring. We do not know what constitutes a mentoring relationship; whether mentoring is responsible for protégé success; and what protégé or mentor outcomes should be expected. Graduate students provided an ideal sample to investigate some of these questions since mentoring is central to doctoral education.

This study set out to consider three research questions. First, does mentoring influence doctoral student outcomes such as satisfaction with advisor, scholarly productivity, and degree progress? Second, what is the relationship between the two types of mentor support (psychosocial and career) and three specific student variables—citizenship, discipline, and identity status—on student doctoral outcomes? Finally, is mentoring a stand-alone phenomenon or does it involve networks of support through which outcomes are achieved?

In examining these three questions, at least four conclusions are evident. First, mentoring has an effect, but only in certain contexts, such as some disciplines, and on certain outcomes, such as satisfaction with advisor, publications, and presentations. Second, the use of more sophisticated mentoring measures than have been previously used contributed to a greater understanding of the process.
Third, certain practical implications emerge regarding what behaviors affect more outcomes. Overarching all of these conclusions is the issue of a more rigorous definition of mentoring. Previous literature treats mentoring rather vaguely, and these findings suggest that the situation (discipline), type of mentoring (career), and specific behaviors (collaboration, developing professional networks, and feeling respected) interact to affect protégé outcomes. The discussion will cover these topics in turn, with a review of the study limitations presented before the section on implications.

Mentoring and Doctoral Outcomes

This section first discusses the prevalence of mentoring and the evidence for mentoring networks. The important covariates are then reviewed, followed by a discussion of the dependent and independent variables. The covariate undergraduate research, which could be considered a mentoring activity, had a surprisingly robust effect on doctoral outcomes. Some of the independent variables did not display the expected influence on mentoring.

*Mentoring Prevalence and Networks*

Mentoring is a common experience that students deem important. In addition, most students received mentor-like support from a number of individuals. Over half of the sample considered their advisor to be a mentor. Eight-six percent of the individuals had one or more mentor(s), in addition to their advisor. Two-thirds of the sample indicated that mentoring contributed to their success as a graduate student.

Most students appeared embedded in a network of mentor-like relationships. They reported receiving emotional, career, and networking support from family, other
students in the program, and friends outside their program. As previously mentioned, most students had more than one mentor, and over 1/3 of the sample reported having three or more mentors in addition to their advisor. Most mentoring research focuses on one mentor-protégé relationship, yet doctoral students appear engaged in several such relationships at a time.

Despite the prevalence of mentoring, twenty percent of the students did not consider their advisor to be a mentor, which is surprising given the importance of the advisor relationship in completing a PhD. However, most of these students found mentors elsewhere. There were remarkably few students, 16 out of 477, who did not consider their advisor to be a mentor and had no other mentor. One wonders if these students might be among those likely to not complete their program.

What could not be investigated was the mentoring experience of students who were on leave or who dropped out of their program. Despite efforts to locate them, only 20 of these students participated in the study. This number was insufficient for meaningful statistical analysis. Further study is needed to investigate the relationship of mentoring support and doctoral student attrition.

Covariates

There were two significant covariate relationships: time in the program and undergraduate research. The study controlled for number of semesters since beginning the program, which was significantly related to number of presentations, but not to the other scholarly productivity outcomes. It is not clear why length of time in school would influence number of presentations but not number of publications or having an intellectual property event. This covariate was not included in the analysis.
of the dependent variable progress toward degree because it is confounded with this dependent variable.

The findings on the second covariate, number of semesters of undergraduate research, warrant more attention. Individuals who reported more semesters of undergraduate research reported significantly more intellectual property events, more conference presentations and faster degree progress; but they reported significantly less satisfaction with their advisor. This last relationship is unexpected. However, it might be that doctoral students with more exposure to faculty, through undergraduate research, might have higher expectations of faculty and are therefore not as satisfied as students with less undergraduate research experience. Undergraduate research experience was related to publications until discipline was considered, which suggests students in some disciplines might engage in more undergraduate research. In any case, this was a rather crude measure of an activity that could be considered a type of mentoring, that occurred years ago, and which had robust effects on doctoral outcomes. This study provides evidence that undergraduate research contributes to graduate student success.

Dependent Variables

Satisfaction with advisor and two types of scholarly productivity, publications and presentations, were influenced by mentoring support. The introduction of discipline eliminated the influence of mentoring on the other dependent variables.

Satisfaction with Advisor

The results indicate that mentoring affects how satisfied students are with their advisor, but it is a synergistic effect. Psychosocial support (rapport)
significantly, positively moderated the effect of career support (apprenticeship) on satisfaction with advisor. The interaction was strongest at high levels of psychosocial and career support. This addition of the interaction term did not explain more variance in satisfaction with advisor but may more accurately reflect the mentoring process. It makes sense that a student would be more satisfied if he or she received more career and psychosocial support. The variables explain a large amount of the variance in ratings of satisfaction with advisor (pseudo $R^2 = .43$). This finding makes an important contribution because previous literature had not examined the interaction between psychosocial support and career support on protégé outcomes. Discipline was not related to student satisfaction with their advisor.

There is some evidence that identity matters. Students with higher scores on the Identity Achieved status, a high commitment status, had greater odds of reporting higher satisfaction with their advisor. This finding is in the expected direction since students who are have an established sense of self, including their career goals, might be more likely to cultivate a good relationship with their advisor since that relationship is needed to achieve their career goals.

*Intellectual Property Events*

At a simple level of analysis career support is significantly related to intellectual property events. However, the introduction of discipline eliminated the influence of mentoring on intellectual property events. Non-engineering students had significantly lower odds of having an intellectual property event than engineering students. Thus, it is possible that having an intellectual property event was not the best outcome measure to use for students in all disciplines. The amount of variance
explained for intellectual property events (pseudo $R^2 = .16$) is in the medium effect size range, but discipline appeared responsible for the effect.

**Publications**

Discipline matters. Studies of mentoring need to take this variable into account, as it might explain the small effects and contradictory findings that characterize mentoring research. Discipline significantly moderated mentoring and the number of publications, one of the scholarly products. However, the two types of mentoring support displayed different patterns of influence. Students in the social sciences and humanities, who received more psychosocial support, published less than engineers, who received more psychosocial support. This counter-intuitive finding replicates Tenenbaum et al.'s (2001) findings that graduate students who received more psychosocial support were significantly less productive. It might be that students having trouble need, and therefore receive, more psychosocial support from faculty in certain disciplines.

Conversely, individuals in social sciences, humanities, and education who received more career support were found to publish more, whereas apprenticeship appeared to have no influence on the publication rate of engineering students. The structure of these disciplines might explain this finding. It might be the case that apprenticeship support is built into the engineering doctoral experience in some way. If this were true, then career support from an advisor might not yield the same benefits to engineering students as it might for students in other disciplines. Students in mathematics reported significantly fewer publications than individuals in engineering. It is difficult to produce original research in mathematics, and therefore
presentations and publications are not the best outcome measures for students in this discipline. The amount of variance explained for publications \((\text{pseudo } R^2 = .12)\) is in the small to medium range for effect sizes.

The results provide some evidence for the importance of identity and mentoring. Individuals with a one-unit increase in their higher moratorium score, a low commitment status, had 4% lower odds of having a publication. This finding is in the expected direction since it was posited that students with low identity commitment might produce fewer scholarly products. However, students who scored one unit higher on the diffusion score, another low commitment status, had less odds of having one more publication. The Diffusion scale had low reliabilities in this study and might explain why this last finding was not in the expected direction.

**Presentations**

Mentoring matters when conference presentation rates for doctoral students are considered. Students who receive more career support have increased odds of presenting at conferences, even after discipline is considered. However, the effect size is quite small \((R^2 = .03)\). Clearly, there are additional variables to be considered that influence presenting at conferences.

**Degree Progress**

Mentoring had a similar influence on progress toward degree as it did on intellectual property events. At a basic level of analysis students who receive more career support make faster progress on degree milestones. However, the introduction of discipline eliminated the influence of mentoring on degree progress. Discipline significantly influenced progress toward degree. Students in the sciences
made significantly more progress toward degree milestones than students in engineering. Having more semesters of undergraduate research was also positively, significantly correlated with degree progress. Overall, the amount of variance explained for progress (pseudo $R^2 = .25$) is in the medium effect size range, but, again, discipline appears to be responsible for this effect.

*Independent Variables*

Two of the independent variables, citizenship and identity status, did not have significant interactions with mentoring but are worthy of mention. Mentoring effects did not disappear even when talent, measured by GPA and semesters of undergraduate research, was taken into account.

*Citizenship*

The analysis did not reveal citizenship to be significantly related to the doctoral student outcomes. However, a review of the data suggests citizenship and discipline are confounded. Over 60% of the engineering students in this study were international students. Foreign students are estimated to comprise from 25 – 40% of doctoral students in American programs. Most mentoring research on doctoral students does not mention the citizenship of students, so it is difficult to know its effect. More study is needed in disciplines with large numbers of international students to tease out mentoring effects on protégés who are foreign-born. This is important because mentoring efforts targeted in disciplines with significant foreign-born populations may not have the same efficacy for U.S. versus international citizens.
Identity Status

Identity status, or how committed and motivated a person is to develop his or her sense of self, did not prove to be an important moderator in this study. This might have been because of the low-reliabilities for two subscales of the instrument used in this study. Having a higher commitment status, Identity Achieved, was related to being more satisfied with an advisor, and having a lower commitment status, Moratorium, was related to publishing less. Both of these findings were in the expected direction. Psychosocial theory, upon which most mentoring research is based, suggests that identity is an important factor in being receptive to mentoring relationships. More work is needed in this area.

Talent

This study considered whether talent might affect the mentoring relationship since one study (Green & Bauer, 1995) found that more talented students were more likely to have mentors. Self-reported data were collected on three proxy variables for talent: undergraduate GPA, Graduate Record Exam (GRE) scores, and the number of semesters of undergraduate research. (GPA and GRE scores were not requested from the institutions in order to ensure the anonymity.) Only two of the variables could be used because the GRE data was insufficient due to changes in the examination. The hypothesis that mentoring is important, even after talent is considered, was supported. It seems reasonable to expect that talent might affect mentoring outcomes even though the proxy measures used in this study did not support this position. A subset of exceptionally talented graduate students might
need to be studied to understand better the relationship between talent and mentoring.

Summary

Mentoring matters when satisfaction, publications, and presentations are considered. This study investigated the possibility that the small effect sizes reported in the literature (Underhill, 2006) are related to the existence of moderators. The findings provide some evidence for this position.

Career support, also known as apprenticeship, makes a difference, even if it is a small one in some cases, on doctoral student outcomes. Students who received more career support were significantly more satisfied with their advisor and produced more scholarly products, as measured by number of publications and presentations, than students who received less career support. The introduction of discipline reduced the influence of career support on some of the dependent variables, which suggests it is an important variable to consider when examining mentoring.

Satisfaction with advisor and publications were the only outcomes significantly affected by psychosocial support (or rapport). Psychosocial support interacted with career support to increase satisfaction with advisor. However, psychosocial support was negatively related to having publications in some disciplines.

The results suggest that intellectual property events and presentations might not be the best outcome measures for all disciplines. Engineering students had the majority of the intellectual property events. Mathematics students do not appear to
present at conferences very often. More work is needed to identify appropriate outcomes for students in all disciplines.

Measures of the Mentoring Construct and Outcomes

Mentoring is complicated. There continues to be lack of agreement about what constitutes mentoring and who might provide it. This vague definition might account for differences in findings. This study employed a multiple measure approach that seemed useful. Questions included specific behaviors as well as number and types of people who provide emotional, networking, or career support. This allowed for an analysis of which specific types of behaviors might be responsible for mentoring outcomes. In addition, the presence of a mentor network could be detected.

Previous studies have not assessed whether individuals valued mentoring. Thus, respondents were asked about several factors that contributed to their success in graduate school. Respondents endorsed mentoring as the second most valued factor, behind financial support. This seems to establish that students believe mentoring is important to them and are attentive to opportunities for mentoring.

Many studies determine mentoring by asking if a person has a mentor (Clark et al., 2000, Cronan-Hillix et al., 1986, Maher et al., 2004). In contrast, this study asked individuals to indicate the extent to which they considered their advisor to be a mentor. Almost 20% of the respondents provided a neutral answer (n=123), indicating neither strong agreement nor strong disagreement. It is unclear how these individuals would have answered a yes/no question about having a mentor.
Individuals were also asked to rate their advisor on 14 mentor-like behaviors. Factor analysis showed that these 14 behaviors represented two factors of mentoring, emotional support and career support, which have been found in previous research. Collaboration and encouragement of professional activities were significantly, positively related to at least three of the five outcome measures. Some of the behaviors, such as recognizing areas of improvement, welcoming input, and establishing a timetable, appeared to have a negative impact. Feeling respected was positively related to two satisfaction with advisor and intellectual property events, but was negatively associated with presentations. This study provides a first step toward identifying the specific mentor-like behaviors that influence protégé outcomes. Identification of these behaviors might assist mentoring programs to target relevant behaviors.

These findings provide support for the Higgins & Kram (2001) theory of a mentoring network. With the exception of the Clark et al. (2000) study, previous empirical research implied that individuals have only one mentor. This study found that most individuals have more than one mentor and receive mentor-like support from other graduate students, family members, faculty members, and friends. Perhaps the mentoring construct should be modified to include the possibility of receiving mentor-like support from more than one person.

This study highlights areas for improvement in measurement in mentoring outcomes. There is a need to develop appropriate discipline-specific outcomes. For example, receiving grants or a Fulbright award may be important doctoral outcomes that are influenced by mentoring. The treatment of doctoral student outcomes needs
to be investigated more closely. This study found that mentoring affected presentations and publications differently. Previous research has combined these variables, which might obscure findings.

Limitations

There are three limitations of this study: construct validity, external validity, and time latency concerns. The cross-sectional study design is also subject to memory inaccuracies since respondents reported on activities that occurred over several years.

There are construct validity concerns for two independent variables, mentoring and identity. Psychosocial support and career support, two mentoring variables, were measured with the AWAI-r. This measure was chosen because it has established reliability and validity for doctoral students. However, the measure does not encompass all of the behaviors that characterize mentoring relationships in graduate school. For example, introducing a student to a new literature is an item, but is also an important professional, mentoring behavior. Thus, the measure might not have fully assessed mentoring. The OMEIS was used to measure identity status, another independent variable. There were low Cronbach Alphas for two factors, and about 10% of the respondents did not answer enough OMEIS items to compute a factor score. These non-completers did not appear to be different on demographic characteristics from those who did complete enough items, but they may differ on items such as personality that might affect mentoring outcomes, which were not measured in this study.
There are external validity concerns regarding generalizability. Currently enrolled or graduated students were included in this study. However, between 30-50% of doctoral students do not complete their program. Thus, these findings may not be applicable to students who do not complete their program. A related concern is the lower response rate from international students, which might make the findings less applicable to all international doctoral students in U.S. programs. It is also unknown whether foreign-born students interpreted the survey questions the same way as U.S. citizens.

Finally, it is unclear what the best outcome measures are to assess mentoring. This study used proximal measures that occur during doctoral education. However, mentoring might have a lag effect. It might take several years or even decades for the effects of professional networks and collaboration to come to full fruition. There may be more appropriate, distal outcomes that should be considered. More work is needed in this area.

Implications and Future Research

The implications for this study fall into two areas, mentoring theory and practical considerations. Each will be considered in turn below.

**Mentoring Theory**

First, from a practical perspective, the findings provided more information about specific mentoring behaviors that influence the development of talent in graduate students. Advisors who collaborate with their students and who engage their students in professional activities are more likely to have more satisfied and productive students.
Second, mentoring is more complex than previously suggested, and mentoring does not always have a positive influence. At a minimum, the type of mentoring support and possible interactions of contextual factors such as discipline are important to consider. Psychosocial support and career support influence how satisfied students are with their advisor. However, receiving too much psychosocial support might indicate a student in difficulty. Career support, specifically collaboration and encouragement of professional activities, is related to having more publications in some disciplines. These findings have implications for how mentoring should be encouraged. The psychosocial or “friend” aspect of mentoring is often mentioned in training materials such as Advisor, teacher, role model, friend: On being a mentor to students in Science and Engineering (National Academy Press, 1997), but perhaps emphasis also needs to be given to career support behaviors.

Third, a reconceptualization of the mentoring construct might be useful. While this research did not demonstrate the effect of having multiple mentors on protégé outcomes, it did provide evidence of a mentoring network. It appears that doctoral students are embedded in a network of people who provide mentor-like support. Future research might explore the effects of these networks on protégé outcomes.

Fourth, the findings suggest that mentoring theory should include some consideration of the context of mentoring and data about the mentoring dyad. Discipline was found to be an important interaction with mentoring. This study collected data from the protégé perspective, but more data is needed from the mentor perspective as well. The findings raise the question of directionality with regard to who initiates the mentoring relationship – the mentor or the protégé. There
may be a personality trait that causes a person to report (and attract) more mentors, since considering the advisor a mentor was significantly correlated with having more than one mentor. Yet, most studies imply that the mentor initiates mentor relationships, not the protégé. This study collected data only from the protégé. Future research might focus on the context, and the dyadic nature of the relationship.

Practical Considerations

There are four practical implications of this research on mentoring and talent development. First, there is some evidence that doctoral students benefit from career support emphasizing collaboration and the building of professional networks. Graduate deans might wish to encourage those advising behaviors. Second, the findings suggest that career support, not psychosocial support, has the greatest positive effect on student productivity. This finding is supported by case studies on exceptional talent that found career and professional guidance to be more important than emotional support (Sand, 2000; Zuckerman, 1977). Emotional support was found to be negatively related to number of publications for students in some disciplines. Thus, greater emphasis by graduate programs on career support might be warranted. Third, the findings suggest there should be more support of undergraduate research. This study provided evidence that undergraduate research was positively related to intellectual property events, presentations at conferences, and progress toward degree. Fourth, mentoring is considered to be an important factor in research on doctoral completion. Yet more work is needed to understand the relationship of mentoring on doctoral outcomes, including attrition rates. This
study assessed proximal outcomes, but longer-term dependent variables might be more appropriate. More work is needed to assess the time latency of mentoring effects on doctoral outcomes. It is unclear if the high attrition rate is related to mentoring, selection, or other factors. Attrition has not been examined carefully in part because of a sense that some attrition is ‘good’ or perhaps inevitable. However, an attrition rate as high as 50% would seem to be an inefficient use of scarce resources.

Mentoring is a pervasive element of American education, yet there is a surprising paucity of empirical information about it and its consequences. It is hoped that this study helps advance the research into the nuances of mentoring relationships, the effect of mentoring networks, and refinement of mentoring outcomes.
References


Council of Graduate Schools. (2004b). *Ph.D. completion and attrition: Policy, numbers, leadership, and next steps*. Washington, DC.


Schneider, J. (2007). A Multivariate Study of Graduate Student Satisfaction and Other Outcomes within Cooperative Research Centers. NC State University, Raleigh.


APPENDIX A

DOCTORAL EDUCATION SURVEY

INSTRUCTIONS:
Your data will be completely anonymous. By taking this survey, you are giving us consent to use your data in our analysis. You may stop taking the survey at any time by closing your browser before you click the ‘Submit’ button at the end of the survey.

The survey takes about 15 minutes to complete and there are four sections.

If you have any questions, please contact me by email at laura_lunsford@ncsu.edu or call 919/515-9640.

Thank you again for your participation!

SECTION A: DESCRIPTION OF YOUR DOCTORAL PROGRAM AND DEPARTMENT
To start with, we would like to learn about where you are in your doctoral program.

1. I attend (drop down: NC State University, University of Arizona, Duke University, UNC-Chapel Hill).
2. What is your field of study? (drop down with departments listed).
3. During academic years I have primarily enrolled (select one): (drop down: part-time, full-time)
4. Please select your current status in your doctoral program (drop down: currently enrolled, withdrawn, on leave, graduated).

A doctoral program has many requirements that students must fulfill. Typical requirements are listed here. Please indicate how far along you are by indicating for each requirement if you completed it or if it is not a requirement of your program. (drop down responses: completed (coded 1), not completed (coded 2), not a requirement (coded 0)).

5. Classes and coursework.
6. Master's degree.
7. Comprehensive exam in the middle of the program (also known as qualifiers, comps, cumulative exams).
8. Advancement to candidacy (also known as achieving dissertator status).
9. Written proposal of planned dissertation work.

12. What have been the main factors that contributed to either your ability to make progress on your doctoral degree or your decision not to complete your doctoral degree?
(drop down: Financial support, Mentoring/advising, Family (non-financial) support, Social environment/peer group support, Program requirements, Program quality, Professional/career guidance, Other (please briefly explain): )
SECTION B. EXPERIENCE WITH ADVISOR

This section pertains to your perceptions about your relationship with your advisor. Advisor is the faculty member who guides you through your graduate program (e.g. advisor, major professor, committee chair, dissertation chair). If you have graduated or withdrawn please think about the person who served as your advisor.

13. Do you have co-advisors? (yes, no).
If yes, please answer the questions below in reference to the one with whom you work most closely.

Please select the appropriate response for each item below using the scale 1-5, with 1 = strongly disagree, 2 = disagree, 3 = neither agree or disagree, 4 = agree, 5 = strongly agree. (will be check boxes for 1 – 5; only one response per item allowed).

14. I get the feeling that my advisor does not like me very much.
15. My advisor introduces me to professional activities (e.g. conferences, submitting articles for journal publication).
16. I do not want to be like my advisor.
17. My advisor welcomes my input into our discussions.
18. My advisor helps me conduct my work within a plan.
19. I tend to see things differently from my advisor.
20. My advisor does not encourage my input into our discussions.
21. My advisor has invited me to be a responsible collaborator in his/her own work.
22. I do not want to feel similar to my advisor in the process of conducting work.
23. My advisor is not kind when commenting about my work.
24. My advisor helps me establish a timetable for the tasks of my graduate training.
25. My advisor and I have different interests.
26. I do not feel respected by my advisor in our work together.
27. My advisor is available when I need her/him.
28. I feel like my advisor expects too much from me.
29. My advisor offers me encouragement for my accomplishments.
30. Meetings with my advisor are unproductive.
31. I do not think that my advisor believes in me.
32. My advisor facilitates my professional development through networking.
33. My advisor takes my ideas seriously.
34. My advisor does not help me stay on track in our meetings.
35. I do not think that my advisor has my best interests in mind.
36. I learn from my advisor by watching her/him.
37. I feel uncomfortable working with my advisor.
38. I am an apprentice of my advisor.
39. I am often intellectually “lost” during my meetings with my advisor.
40. I consistently implement suggestions made by my advisor.
41. My advisor strives to make program requirements as rewarding as possible.
42. My advisor does not educate me about the process of graduate school.
43. My advisor helps me recognize areas where I can improve.
44. I am satisfied with the quality of my relationship with my advisor.
45. How long have you worked with your advisor? (___months, ___ years)?
46. My advisor is (drop down: male, female).
47. My advisor is (drop down: African American (coded 0); Native American – Alaska Native (coded 1); Asian American – Pacific Islander (coded 2); Caucasian (coded 3); Chicano/a – Hispanic – Latino/a (coded 4); Not sure; Other (coded 5). Specify: )
48. My advisor’s rank is: (drop down: assistant professor, associate professor, full professor, not sure).

Please tell us who meets your top needs relative to your work as a graduate student:

49. Emotional support (listening, builds confidence, etc). (drop down: my advisor, another faculty member, a graduate student, a family member, a friend outside of the program, other: ____)

50. Career support (what conferences to attend, research advice, etc). (drop down: my advisor, another faculty member, a graduate student, a family member, a friend outside of the program, other: ____)

51. Networking support (helps with professional contacts). (drop down: my advisor, another faculty member, a graduate student, a family member, a friend outside of the program, other: ____)

52. Other type of support (please describe: ____). (drop down: my advisor, another faculty member, a graduate student, a family member, a friend outside of the program, other: ____)

A mentor is someone who provides support and advice to a less experienced person. Please think of this definition when answering the next questions.

53. I consider my advisor to be a mentor.

54. Some students have more than one mentor. How many faculty members, other than your advisor, do you consider a mentor? (drop down one response allowed: 0, 1, 2, 3, 4 or more).

55. How many, if any, other individuals who are not faculty would you consider as a mentor? (drop down one response allowed: 0, 1, 2, 3, 4 or more)
SECTION C: PROFESSIONAL ACTIVITIES

We would like to know what types and amount of publications, presentations, and intellectual property events have resulted from your doctoral work. A) Please mark all of the different types of scholarly achievements in which you have been engaged. B) If you have marked a particular scholarly achievement, how many productions of that type were produced?

<table>
<thead>
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<th>A</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>My work in my doctoral program has resulted in this.</td>
<td>How many were...</td>
</tr>
</tbody>
</table>
| 48. Publications (in press) | ___ With faculty members as co-authors  
___ With students as co-authors  
___ In refereed journals  
___ In published proceedings  
___ Technical reports |
| 49. Presentations at national or international scientific or professional meetings (include poster presentations) | ___ Total |
| 50. Presentations at other scientific or professional meetings that were not national or international (include poster presentations) | ___ Total |
| 51. Intellectual Property events (you applied for or helped others apply for) | ___ Invention Disclosures  
___ Patent applications  
___ Copyrights  
___ Patents Granted/Derived  
___ Licensing Agreements |
SECTION D: CAREER PLANS & BACKGROUND INFORMATION

We are interested in your interests, your career plans and in learning more about you. Read each item below carefully and respond to the total item, not just a part of it. Using the range of responses from strongly agree to strongly disagree, indicate to what degree it fits your own impressions about yourself. You may begin by thinking about whether you agree or disagree. Then you can decide how strongly you feel about it. Respond using the scale 1-6, where 1 = strongly agree, 2 = moderately agree, 3= agree, 4 = disagree, 5 = moderately disagree, 6 = strongly disagree.

52. I haven’t really considered politics. They just don’t excite me much.
53. I might have thought about a lot of different things, but there’s never really been a decision since my parents said what they wanted.
54. When it comes to religion I just haven’t found any that I’m really into myself.
55. My parents had it decided a long time ago what I should go into and I’m following their plans.
56. There are so many different political parties and ideals. I can’t decide which to follow until I figure it all out.
57. I don’t give religion much thought and it doesn’t bother me one way or the other.
58. I guess I’m pretty much like my folks when it comes to politics. I follow what they do in terms of voting and such.
59. I haven’t chosen the occupation I really want to get into, but I’m working toward becoming a _____ until something better comes along.
60. A person’s faith is unique to each individual. I’ve considered and reconsidered it myself and know what I can believe.
61. It took me a long time to decide but now I know for sure what direction to move in for a career.
62. I really never was involved in politics enough to have to make a firm stand one way or the other.
63. I’m not so sure what religion means to me. I’d like to make up my mind but I’m not done looking yet.
64. I’ve thought my political beliefs through and realize I may or may not agree with many of my parent’s beliefs.
65. It took me a while to figure it out, but now I really know what I want from a career.
66. Religion is confusing to me right now. I keep changing my views on what is right and wrong for me.
67. I’m sure it will be pretty easy for me to change my occupational goals when something better comes along.
68. My folks have always had their own political and moral beliefs about issues like abortion and mercy killing and I’ve always gone along accepting what they have.
69. I’ve gone through a period of serious questioning about faith and can now say I understand what I believe in as an individual.
70. I’m not sure about my political beliefs, but I’m trying to figure out what I can truly believe in.
71. I just can’t decide how capable I am as a person and what jobs I’ll be right for.
72. I attend the same church as my family always attended. I’ve never really questioned why.
73. I just can’t decide what to do for an occupation. There are so many possibilities.
74. I’ve never really questioned my religion. If it’s right for my parents it must be right for me.
75. Politics are something that I can never be too sure about because things change so fast. But I do think it’s important to know what I can politically stand for and believe in.
Use the drop down boxes to select the appropriate answer for the questions below.

74. In which area do you anticipate working? (drop down: Full-time academic faculty; Part-time academic faculty; Academic non-faculty research; Academic administrative; Government; Industry/corporate; Non-profit; Other: ____)
75. I started my doctoral program in ____ (month) _____ (year).
76. I am (drop down: male (coded 0), female (coded 1))
77. I am (drop down: Single (coded 0), Married or partnered (coded 1))
78. I am a (drop down: US Citizen (coded 0); Permanent Resident (coded 1); Non-US Citizen (coded 2))
79. My ethnic background is (drop down: African American (coded 0); Native American – Alaska Native (coded 1); Asian American – Pacific Islander (coded 2); Caucasian (coded 3); Chicano/a – Hispanic – Latino/a (coded 4); Other (coded 5). Specify:
80. I was born in ____ (month), 19 _____ (year).
81. I received my bachelor’s degree in: ______ (year).
82. My undergraduate GPA was: ____.
83. I was involved in undergraduate research for (drop down: 1, 2, 3, 4, 5, 6, more than 6) semesters.
84. My GRE subscores were: math:_____, verbal: _____, quantitative: _____.

Here is the chance to share final thoughts.
85. Please use this space to elaborate on your answer to any question, or to tell us anything else you would like us to know about your doctoral education experience. (free response text box).

Thank you again for your help and thoughtful participation in this survey.

Please click on this email (link here) to send your email to be entered in the drawing for one of the ten $100 gift certificates to Amazon.com. Please include a statement certifying that you completed and submitted your survey answers. If you would like the results of the study you may include that in your email also.
## Appendix B

**Correlation of Independent and Dependent Variables, and Exploratory Variables**

The CORR Procedure

16 Variables: 
- RapF1
- AppF2
- AdvMen
- UR
- GPA
- SemProg
- SatisAdv
- DIPE
- PubSumNoS
- PresSum
- Progress
- NS_SumNA
- CS_SumNA
- ES_SumNA
- FacM_Num
- NFacM_Num

### Simple Statistics

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