INTERNATIONAL MENTORING ASSOCIATION

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Doctoral Advisors and Their Protégés: Does Mentoring Matter?

Introduction

The advisor-student relationship is at the heart of doctoral education in America. Significant resources and organizational efforts are devoted to promoting it. For example, the Council on Graduate Schools lists mentoring as one of six factors leading to PhD completion (Council of Graduate Schools, 2007). Hundreds of millions of dollars are spent on programs, such as the McNair Scholars (US Department of Education, 2007), which foster faculty-student mentoring. The National Science Foundation considers mentoring important enough to confer annually a Presidential Award for Excellence in Science, Mathematics and Engineering Mentoring with a $10,000 grant (National Science Foundation, 2007).

This study examines doctoral education mentoring using a large-scale survey conducted at two major American research universities. It explores specific doctoral supervisory behaviors and the influence of those behaviors on doctoral student outcomes. This is important for two reasons. First, it tests directly whether there is a measurable relationship between mentor behaviors and important student outcomes. Second, it examines conditions that promote or weaken the effects of mentor behaviors on student outcomes. The results suggest two important findings. First, mentoring is more complex than previously reported in the literature. There are different types of mentoring and each has a distinct path and outcomes. Second, mentoring involves networks. Most doctoral students have a network of supportive and helpful relationships. A clearer understanding of the mentoring relationship should include an appreciation of this network and its operation.

Theoretical Framework

A variety of theoretical approaches are found in the mentoring literature. A resiliency approach (Garmezy, 1985) is the basis for mentoring research on children and youth (Rhodes, 2002) while social exchange (Ensher, Thomas, and Murphy, 2001) and developmental approaches (Green and Bauer, 1995) characterize the research on adult mentoring relationships. Mentoring researchers have proposed that there may be a variety of mentoring networks, including the traditional one-on-one relationship, which may better describe individuals mentoring relationships (Higgins and Kram, 2001). To complicate matters further, most research on doctoral education considers mentoring as one of many factors that influence student retention, rather than an area of independent focus (Council of Graduate Schools, 2004).

A psychosocial, developmental approach is used here because it provides insight into why an individual may be receptive to being mentored and why someone might engage in mentoring. Psychosocial development theory provided the framework for the early work on mentoring (Kram, 1985; Levinson, 1979; Valliant, 1977) and is the basis for most mentoring inventories, including the one used in this study. There is a developmental window in young adulthood, during the stage of identity development, when individuals most benefit from having a mentor (Erikson, 1968). Individuals must have a need, which can be met by a more experienced person, to want or to benefit from a mentor (Levinson, 1979; Valliant, 1977). This notion of a developmental window comes from identity development theory. Identity development proceeds along two dimensions, commitment (high or low), and exploration (high or low), which yield four identity statuses (Marcia, 1966; Marcia, Waterman, Matteson, Archer, and Orlofsky, 1993). Identity commitment may be an important condition for mentoring receptivity.

Previous Studies

Mentoring is comprised of two functions: 1) career, e.g. sponsorship, coaching, protection, and providing challenging assignments, and 2) psychosocial, e.g. role modeling, acceptance, counseling, and friendship (Kram, 1985). These functions exist across disciplines (Ferrer de Valero, 2005; Green and Bauer, 1995), year in graduate school (Clark, Harden, and Johnson, 2000; Kahn, 2000; Rose, 2003; Schlosser and Gelso, 2001; Tenenbaum, Crosby, and Gliner, 2001), and for men and women (Tenenbaum et al., 2001; Zhao, Golde, and McCormick, 2005). Role modeling (Schlosser, Knox, Moskovitz, and Hill, 2003) or networking (Ortiz-Walters and Gilson, 2005; Tenenbaum et al., 2001) is a third function in a few studies. However, Kram's (1985) definition places these functions in psychosocial and career support respectively. This remainder of this section reviews the findings related to departments and discipline; frequency; who is considered a mentor; race, gender, and citizenship; outcomes; and conditional effects.

Disciplinary and departmental characteristics affect the type and amount of mentoring students report. Students in research psychology programs are more likely to have a mentor than students in applied programs (Clark et al., 2000). Students in departments with shorter times to degree and higher completion rates are more likely to have a mentor than students in departments with longer times to degree and lower completion rates (Ferrer de Valero, 2005). Students in humanities and social sciences are more likely to receive psychosocial support (defined as academic advising and personal touch behaviors) and less career support from their mentors than students in the physical or biological sciences (Zhao et al., 2005).

The frequency of mentoring varies by method used to study it. Survey-based studies report 50-75% of doctoral students have a mentor (Clark et al., 2000; Cronan-Hillix, Gensheimer, Cronan-Hillix, and Davidson, 1986; Nettles and Millett, 2006). In contrast, mentoring is rare when assessed with in-person interviews (Kram, 1985; Levinson, 1979; Valliant, 1977). Half of mentored students report having more than one mentor (Clark et al., 2000). Higgins and Kram's (2001) theoretical work on developmental networks suggests this finding may not be unique.

There is no consistency in who serves as a mentor for graduate students. Several studies define the advisor as the mentor (Green and Bauer, 1995; Schlosser and Gelso, 2001; Tenenbaum et al., 2001; Zhao, 2005). Clark et al (2000) broaden this definition to include any faculty member, while Kahn (2000) placed no limits on who could be considered a mentor. One researcher asked respondents to imagine an ideal mentor and answer the survey questions with that person in mind (Rose, 2003).

There are limited studies on race and gender and they have reported equivocal findings. Students of color, who have mentors of color, report significantly more psychosocial and career support as well as more comfort with the relationship (Ortiz-Walters and Gilson, 2005). However, having shared values, regardless of mentor race, was significantly related to these same outcomes. Women are slightly more likely to have female dissertation chairs than is to be expected by chance (Neumark and Gardecki, 1998) and female doctoral students graduate faster if there are more females on the faculty. However, female students with female dissertation chairs take longer to graduate than female students with male dissertation chairs. In contrast, Tenenbaum et al. (2001) find male and female students are more likely to have male mentors. Citizenship has not been considered in mentoring studies, even though a sizeable percentage of doctoral studies in programs in the U.S. are international students (Redd, 2006).

The few studies that link mentoring with protégé outcomes usually report positive outcomes. Outcomes have been defined as satisfaction with program or mentor; scholarly products such as publications or presentations; research interest; and time to degree. Graduate students who report psychosocial support from a mentor are significantly more likely, than those who receive less support, to be satisfied with their program or mentor (Tenenbaum et al., 2001; Zhao et al., 2005). Graduate students who have mentors are significantly more likely to have scholarly products, such as published articles or conference presentations, (Cronan-Hillix et al., 1986; Nettles and Millett, 2006; Tenenbaum et al., 2001), or interest in research (Kahn, 2000), than students without mentors. Tenenbaum et al. (2001) reports the sole negative outcome; receiving more psychosocial support is significantly, negatively correlated with student productivity (number of presentations and publications).

Mentoring research has identified significant, but small, effects. This suggests the presence of interactions or conditional effects (Frazier, Tix, and Barron, 2004). Theoretically, identity commitment may be an important variable to consider. The literature has identified two types of mentoring but it is not clear how the types influence one another. Education researchers point to the importance of disciplinary characteristics and citizenship when studying graduate students.

Research Questions

The overarching research question is does mentoring influence graduate student outcomes, and if so, do certain conditions strengthen or weaken that relationship? Two hypotheses are tested here. In addition, the data is explored to assess the presence of mentoring networks and specific mentor behaviors that might have the most influence on outcomes.

Hypothesis 1. Students who report more mentoring, i.e. psychosocial and career support, from their advisor will report higher satisfaction with advisor; more intellectual property events, publications, presentations; and more progress on degree milestones.

Hypothesis 2. Significant relationships in hypothesis one will be influenced by the interaction of the two mentor functions with each other and with student discipline, citizenship, and identity commitment.

Methods

This section describes the sample, survey design, and administration. Individuals from two, public research-intensive institutions (U1 and U2), who began their doctoral program between August 2000 and January 2003, participated in an online survey during April 2006. Students had time to develop a relationship with their advisor and to produce scholarly work. The universities are located in the southeast and southwest of the United States and were selected because of their sizable doctoral student populations and for convenience. Twelve U1 departments are participating in a study on doctoral completion and are excluded from the sample at the institution's request. The number of students in the sample is 2,004 (1,073 from U1 and 931 from U2).

Participants took 10-20 minutes to complete an online survey, which had four sections. The first section asks about enrollment, completion of program milestones, and factors affecting degree progress, which were adapted from the Survey on Doctoral Education and Career Preparation (Golde and Dore, 2001). Mentoring behaviors received from the advisor and the number of mentors are the focus of the second section. The third section asks about scholarly productivity using questions developed for a similar population (Schneider, 2007). The fourth section includes the 24-item Objective Measure of Ego Identity Status (OMEIS) (Adams, 1998), demographic, and career questions. Individuals were invited by email to complete an anonymous, online survey. Two reminder emails were sent seven days apart and participants were given the opportunity to enter an incentive drawing for $100 gift certificates. About 25% of the individuals (n= 505) could not be contacted because their email was returned as undelivered, 258 from U1 and 247 from U2. Thus, 1,499 individuals were contacted.

Independent Variables

Mentoring. Mentoring is measured by two factors computed from fourteen behaviors. The factors represent the psychosocial and career functions of mentoring relationships. These behaviors are taken from the Advisor Working Alliance Inventory (AWAI) (Schlosser and Gelso, 2001). The authors refer to the factors as Rapport and Apprenticeship, however the theoretical constructs psychosocial and career are used in this paper to avoid confusion. The AWAI was selected because it is the only instrument with established validity and reliability for graduate students (Schlosser and Gelso, 2001). The AWAI was modified in two ways. First, the identification-individuation factor, composed of five questions, was eliminated. There has been limited support for a third mentoring factor and the three-factor model was empirically derived. Second, eleven items were eliminated from the psychosocial (four) and career (seven) factor. These items had low factor loadings and were not theoretically consistent. The items in the AWAI-revised (AWAI-r) scale are presented in Table 1. Confirmatory Factor Analysis (CFA) is estimated for the AWAI-r ($\square$ = .84) and is satisfactory. Responses are on a 5-response Likert scale from 1 (strongly disagree) to 5 (strongly agree). Some items are reversed coded. Respondents also rated the extent to which they consider their advisor a mentor, how much and what type of mentoring they receive from others, and how many people they consider a mentor.

Table 1
AWAI: Psychosocial (P) and Career (C) Factor Loadings by Item

Factor Loadings		Item
P	C	
.72		I get the feeling that my advisor does NOT like me very much.
.80		I do NOT think that my advisor believes in me.
.65		My advisor does NOT encourage my input into our discussions.
.71		My advisor is NOT kind when commenting about my work.
.82		I do NOT feel respected by my advisor in our work together.

.76		My advisor offers me encouragement for my accomplishments.
.62		My advisor welcomes my input into our discussions.
	.74	My advisor introduces me to professional activities (e.g., conferences, submitting articles for journal publication).
	.82	My advisor helps me conduct my work within a plan.
	.68	My advisor has invited me to be a responsible collaborator in his/her own work.
	.88	My advisor helps me establish a timetable for the tasks of my graduate training.
	.72	Meetings with my advisor are unproductive.
	.64	My advisor helps me recognize areas where I can improve.
	.84	My advisor facilitates my professional development through networking.

Identity Commitment. The short version of the Objective Measure of Ego Identity (OMEIS) was selected to measure identity status because of its established validity and reliability (Adams, 1998). There are 24 questions; six items for each of the four identity statuses, which cover three domains: occupation, politics, and religion. Subjects respond using a scale from 1 (strongly disagree) to 6 (strongly agree). There were not enough respondents in the two high commitment identity statuses (achievement and foreclosure). Thus, the original categorical scoring plan was abandoned in favor of using the respondents scores on the four, continuous identity sub scales: diffusion (M = 16.05, standard error = .25, □ = .59), foreclosure (M = 9.93, standard error = .19, □ = .78), moratorium (M = 12.48, standard error = .22, □ = .74), and identity achievement (M = 24.5, standard error = .22, □ = .59). The OMEIS has been used on samples of college students and young adults (Adams, 1998), although no studies were found with a doctoral student population.

Citizenship. Citizenship is assigned from the respondent's choice from these options: U.S. Citizen, Permanent Resident, or Non U.S. Citizen. Citizenship is dummy coded with U.S. Citizen as the referent.

Discipline. The respondents report their field of study, which were collapsed into six disciplines: education, engineering, humanities, mathematics, science, and social science. Discipline is dummy coded with engineering as the referent.

Dependent Variables

Satisfaction with advisor. Satisfaction with advisor is computed from responses to one, 5-level Likert scale question; a 5 indicates more satisfaction. This variable is treated as an ordered, categorical variable because it is comprised of one item.

Student productivity. Intellectual Property Events is a categorical yes/no variable. An intellectual property event includes any of the following: invention disclosures, patent applications, copyrights, patents granted/derived, and licensing agreements. Number of publications is a continuous variable estimated by summing the number of publications (including in-press) the individual reports having with faculty as co-authors, in refereed journals, and in published proceedings. Number of presentations is a continuous variable calculated by summing the number of national, international, and local conferences the person reports.

Degree progress. Progress toward degree is calculated from respondents' answers to eight questions about common degree milestones. There is a short time to the graduation milestone after a dissertation defense, thus these two milestones are collapsed. Respondents indicate if the milestone is a program requirement and if they have completed it. A modified Guttman scale is used to calculate this variable. If certain milestones are completed it indicates the candidate has completed all the previous steps, e.g. advancement to candidacy. These scores are assigned as follows: 7 - graduated or orally defended their dissertation; 6 - orally defended their proposal; 5 - written dissertation proposal; and 4 - advancement to candidacy. The remaining respondents receive a 1, 2, or 3 depending on the sum of these milestones: classes, master's degree, and comprehensive exams. If the milestone is not a program requirement then the person receives credit for completing it. The range is 1 7.

Covariates

There were two covariates in the analysis, number of semesters since beginning their doctoral program and number of semesters of undergraduate research.

Results

Sample Characteristics

The sample is 53% female, 66% European American, 73% U.S. citizens, and 82% are enrolled at the time of the survey (see Table 2). About half of the respondents study engineering (14%) or science (38%). Two-thirds (63%) of the advisors are full professors. Two-thirds of the respondents are married or partnered. Fewer individuals responded in Engineering, however this is confounded with international status because the majority of engineering students are international students. Significantly more women than men from U2 responded, $F(1, 474) = 7.06$, $p > .01$. This may be a result of the elimination of 12 U1 departments, two of which were humanities and social science departments, which have high female enrollment. There are no significant differences in the number of white

students and students of color from the Universities. U1 has more part-time student respondents. Twenty respondents have complete data, but are on leave or had withdrawn. These cases are excluded from the analysis because the small number does not allow for statistical comparisons. The response rate is 45% (N=677) if all responses are considered. However, missing and excluded data reduces the sample to 477 complete cases, a response rate of 32%.

Hypothesis Testing

Different regression equations are computed for the five outcomes because four dependent variables are not normally distributed. Logistic regression, computed for satisfaction with advisor and having an intellectual property event, is used to predict a discrete outcome (Tabachnick and Fidell, 2001) from a set of variables. The probability of the outcome is computed and odds ratios are provided to make this assessment. A goodness of fit measure is computed to assess the extent to which the model fits the data.

Computing the appropriate regression, to examine if the two mentoring functions are significantly related to the five doctoral student outcomes, tests the first hypothesis. Number of semesters since beginning the program is entered as a covariate. Number of semesters of undergraduate research and undergraduate grade point average are entered as controls for talent. Undergraduate grade point average is not significant and is dropped from the analyses. Number of semesters of undergraduate research is significant and remains in the analyses. The psychosocial mentoring function is positively, significantly related to satisfaction with advisor and the career mentoring function is positively, significantly related to all five outcomes. Thus, there is partial support for the hypothesis one (see Table 2).

Table 2

The Main Effects Model: Significant Regression Results for Hypothesis One

	Dependent Variables				
Independent Variables	Satisfaction w/ Advisor (Odds Ratios)	Intellectual Property Events (Odds Ratios)	Publications (Odds Ratios)	Presentations (Odds Ratios)	Progress (Beta Weights)
Psychosocial Support	7.61				
Career Support	9.97	2.78	1.79	1.40	.15
Undergraduate Research	0.90			1.07	.13
Semesters Since Beginning the Program				1.09	n/a
Pseudo R^2 or R^2	.42	.06	.02	.02	.04

Hypothesis two is tested in two steps. First, the mentoring functions are entered, followed by the conditional variable, e.g. discipline, and finally the interaction terms, e.g. discipline*psychosocial support and discipline*career support. A final regression is computed by entering only the significant independent variables and significant interactions in order to control for Type 1 error (Frazier et al., 2004). These results are presented next (see Table 3).

Satisfaction with Advisor. Logistic regression shows the two mentoring functions significantly, positively interact to influence satisfaction with advisor, $\square 2$ (9, N=477) = 581, $p < .001$; pseudo $R^2 = .43$. The interaction between career and psychosocial support is significant and positive. There is a significant, negative main effect of number of semesters of undergraduate research on satisfaction with advisor. The odds are 10 percent lower that an individual will have a one-unit decrease in satisfaction with their advisor for one more semester of undergraduate research. For a one-unit increase in Identity Achievement the odds of being more satisfied with the advisor are 5% higher. The interaction of the mentoring variables provide partial support for hypothesis two.

Intellectual Property Events. The two mentoring variables are not significantly related to having an intellectual property event, however the logistic regression equation is significant, $\square 2$ (11, N=477) = 41.58, $p < .001$; pseudo $R^2 = .16$. Discipline and number of semesters of undergraduate research are significant as main effects. Individuals who report more semesters of undergraduate research have odds of an intellectual property event 18% higher than those with one less semester of undergraduate research. Students in majors other than engineering have significantly less odds of reporting an intellectual property event (28% less for science/math; 16% less for social science/humanities; and 9% less for education). There is no support for hypothesis two for intellectual property events.

Publications. Discipline significantly interacts with the two mentoring variables to influence the number of publications students reported, model pseudo $R^2 = .11$ ($\square 2 = 177, 19, p < .001$). Receiving one-unit more of psychosocial support is significantly associated with lower odds of having a publication for students in the Humanities (30% less) and Social Sciences (17% less). Career support has the converse effect on publications. Receiving one-unit more of career support is significantly associated with greater odds of having an additional publication for students in social sciences (7 times greater), humanities (2 times greater), and education (3 times greater). Number of publications for engineering students is not affected by receiving more career support. The significant main effects are number of semesters since beginning the program, diffusion identity status and moratorium identity status. A one-unit increase in diffusion scores produces a modest change in the odds of publishing, only 6%. A one-unit increase in moratorium scores leads to slightly lower odds of publishing more, 4%. There is a significant main effect of mathematics, with students in mathematics being 11 times less likely to publish a paper than a student in engineering. There is partial support for hypothesis two for because discipline significantly interacts with career support to influence publications.

Presentations. Career support is significantly related to number of presentations, but there are no significant, conditional effects, model pseudo $R^2 = .03$ ($\square 2 = 73, 9, p < .001$); thus hypothesis two is not supported for presentations. Individuals are 40% more likely to have a presentation for each unit increase in career support. For a one-semester increase in having participated in undergraduate research, the odds of presenting at a conference increase 15%. Doctoral students in mathematics have lower odds (60%) of presenting than students in engineering.

Progress. The two mentoring variables are not significantly related to progress on degree milestones but the model is significant, $R^2 = .09$, $F(8, 468)$, $p < .001$, because of the main effect of discipline. There is no support for hypothesis two for progress on degree milestones. The covariate, number of semesters in the program, is omitted from this analysis because it is confounded with the dependent measure. Students majoring in science make significantly more progress toward degree than students in Engineering ($\square = .54$). Students with more undergraduate research experience report more progress on degree milestones than students with less undergraduate research experience ($\square = .07$).

Table 3
Conditional Model: Significant Regression Results and Change in R^2

	Dependent Variables			
Conditions or Interactions	Satisfaction w/ Advisor (Odds Ratio)	Intellectual Property Events (Odds Ratio)	Publications (Odds Ratio)	Progress (Beta Weights)
Psychosocial*Career	1.73			
Discipline**		.09-.28	. 17-7.61	.16
Identity	1.05		.96 - 1.06	
Undergraduate Research	0.90	1.18		.09
Pseudo R^2 or R^2	.43	.16	.12	.09
Change in R^2	.01	.10	.10	.05

**Presents the range of the significant odds ratios because Discipline is dummy coded to represent six areas.

Exploratory Analysis

Most students consider mentoring to be important. Mentoring is the second most frequently endorsed item (by 2/3 of the sample) of seven factors contributing to graduate student success (financial support was first). Family support and social or peer support are the third and fourth most frequently endorsed items. Over half of the doctoral students agreed or strongly agreed with a statement that their advisor is a mentor, another 25% are neutral about their advisor being a mentor, and 18% did not agree that their advisor is a mentor. There are no significant differences by gender, discipline, race, marriage/partnership status, or citizenship for students who considered their advisor a mentor (strongly agreed or agreed) and those who did not consider their advisor a mentor (strongly disagreed or disagreed).

Mentoring studies use one item to assess mentoring. The validity of this type of measure is assessed using ordinary least squares regression. Regression significantly predicts the extent to which an advisor was considered to be a mentor from the AWAI-r, $R^2 = .62$, $F(2, 474) = 388$, $p < .001$. Individuals are thinking of similar constructs when rating specific mentor-like behaviors and when asked if they consider their advisor a mentor. Most individuals report multiple mentors, including their advisor. Two-thirds of

the respondents have a faculty mentor, other than their advisor. Two-thirds of the sample have a mentor outside of the faculty. Only 66 (14%) of the 477 respondents report no other mentors. Of these, only 16 do not consider their advisor a mentor, i.e. they either strongly disagreed or disagreed with that statement.

A post hoc analysis of the individual AWAI-r items with the dependent measures was conducted. This analysis reveals collaboration to be significantly related to four of the dependent variables at the .05 level and to all five variables at the less conservative .10 level. Introduction to professional activities, offering improvement ideas, and feeling respected are significantly related to three of the dependent variables. However, four behaviors (including feeling respected) are negatively related to outcomes. All mentor-like behaviors are not associated with positive outcomes.

Discussion

The results advance knowledge about mentoring in three areas by: providing evidence that mentoring is important but conditional on discipline and the type of mentoring; providing evidence of mentoring networks; and examining the behaviors that constitute mentoring relationships. In addition, the covariate undergraduate research, arguably a type of mentoring relationship, was unexpectedly related to doctoral student outcomes.

First, conditional relationships in mentoring research need to be considered. This study examined the influence of psychosocial and career mentoring functions on doctoral student outcomes. Psychosocial and career support were positively, significantly related to doctoral student outcomes in a main effects model. There was a large effect size for one dependent variable, satisfaction with advisor. However, the small, significant effect sizes found in previous research were found for presentations, publications, intellectual property events, and progress on degree milestones. Most studies stop at this point. This study went one step further by introducing conditional effects, which presented a different view of how the type of mentoring influences student outcomes. The conditional models explained more variance for four of the dependent variables. The exception was satisfaction with advisor; which already had a large effect size. Psychosocial and career support significantly, positively interacted to influence satisfaction with advisor. The interaction of these variables has not been investigated but these results suggest they are dependent on one another, at least for ratings of advisor satisfaction. The interaction did not explain more variance, but may represent what is actually happening. Having a personal relationship with an advisor might make a student more likely to take their career advice.

This study replicated Tenenbaum's et al (2001) findings of negative outcomes. Why would students in humanities or social sciences who receive more psychosocial support have less odds of publishing than students in engineering? Biglan (1973) suggests that work proceeds differently in pure versus soft disciplines. In the pure disciplines there is more structure, more collaboration and research is done a team, laboratory environment. Individual work characterizes humanities. Thus, a struggling student may have more support built in the pure disciplines and may be left to flounder in the softer ones. If there is less support in soft disciplines then the role of the mentor is more important and a student may need more psychosocial support. Similar findings have been reported in the youth mentoring literature (Rhodes, 2002).

The disciplinary characteristics may also explain why receipt of more career support is related to higher odds of publishing for students in the humanities, social sciences, and education. Career support may be built into the pure disciplines through laboratory teams. Thus, the influence of advisor career support may not be as important. However, career support from an advisor may make a big difference for the students working alone in the humanities.

Second, most doctoral students are embedded in a network of mentors, providing evidence for Higgins and Kram's (2001) developmental network theory. Most students report multiple mentors and receive mentor-like support from a number of people, including fellow graduate students. Are certain individuals more likely to attract mentors? Perhaps there is a personality trait or mentoring personality causes a person to report (or attract) more mentors. The small effect sizes in previous studies might be partially explained by a failure to include mentoring received from more than one person.

Third, this study explored which mentor behaviors positively and negatively influence protégés' outcomes. For example, collaboration and engagement in professional activities are positively, significantly related to several doctoral outcomes. Other behaviors, such as recognizing areas of improvement, welcoming input, and establishing a timetable have a negative, significant relationship with the doctoral outcomes. Feeling respected is positively related to satisfaction with advisor and intellectual property events but is negatively associated with presentations.

The findings need to be considered with caution. The AWAI-r might not encompass all of the behaviors that characterize mentoring relationships in graduate school. For example, introducing a student to a new literature was not one of the AWAI-r items but is an important professional, mentoring behavior. The OMEIS was used to measure identity status but the low Cronbach alphas suggest it might not be the best measure. Only currently enrolled or graduated students were included in this study. Thus, these findings might not apply to students who are on leave or who have left their program. A related concern is the lower response rate

from international students, which means the findings might not apply to international students. Finally, it might take years for the effects of mentoring to be realized, which might not show up in the proximal measures used here.

Implications and Practical Considerations

This study has four implications for future research. First, more work is needed to understand how citizenship and identity may influence mentoring and student outcomes. The measures of citizenship (confounded with engineering) and identity commitment (low Cronbach alphas) were problematic. Research on engineering students might illuminate any relationship between citizenship and mentoring functions. Other measures of identity commitment, such as career commitment, might be more appropriate to discern the relationship between mentoring and this theoretically important concept. Second, future studies need to examine the influence of multiple mentors because so many students in this sample reported them; failure to consider multiple mentors may be why one reason for the small effect sizes found in the literature. Third, the findings highlight a need to develop discipline specific outcomes. For example, number of publications is not a good measure for students in math since so few math students publish. Fourth, few of these advanced or graduated students reported having no mentor but more work is needed to understand the relationship between mentoring and doctoral attrition. It is unclear if the high attrition rate is related to mentoring, selection, or other factors. Golde (2005) is one of the few researchers examining attrition. Many faculty believe some attrition is good or perhaps inevitable. However, an attrition rate as high as 50% seems to be an inefficient use of scarce resources.

The results provide two practical considerations for doctoral education. First, the friend aspect of mentoring is usually emphasized (National Academy of Sciences, 1997) but doctoral students might benefit if career support is also emphasized. Career support had a positive effect on doctoral student productivity and mirrors findings in case studies on the development of exceptional talent, which found career guidance to be important (Sand, 2000; Zuckerman, 1977). Furthermore, the specific career behaviors of collaboration and building of professional networks appeared to be responsible for the positive relationship with doctoral student outcomes. Thus, these types of activities might be highlighted more in graduate programs. Second, the findings suggest support of undergraduate research might be warranted because it was robustly related to several important doctoral student outcomes. The relationship between mentoring and outcomes disappears when talent is considered (Green and Bauer, 1995). Thus, this variable was included as a measure of talent. It was not found to be important as a talent variable but it was left in the analysis as a covariate because it was significantly related to the outcomes. Number of semesters of undergraduate research is a crude measure of an activity, arguably a mentoring activity, which occurred years prior to the data collection. However, it was significantly, positively related to having an intellectual property event, publications, and progress on degree milestones. It was negatively, significantly related to satisfaction with advisor. This last, surprising finding might be explained because these students might have had higher expectations of graduate advisors, given their prior research experience. Undergraduate research might be an important pipeline into doctoral education and was clearly related to doctoral outcomes.

Mentoring is a pervasive element of American education, yet there is a surprising paucity of empirical information about it and its consequences. This study made a small contribution towards advancing the research by examining the types of mentoring functions and their relationship to doctoral outcomes; how certain conditions influence mentoring relationships; and providing evidence of mentoring networks.

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