Article

Tipping Points: Doctoral Students and Consideration of Departure

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Abstract

This exploratory mixed-methods study examines factors contributing to doctoral students' consideration of departure from their graduate programs with comparisons made by sex and affiliation with Science, Technology, Engineering, and Mathematics (STEM) programs. Logistic regression and qualitative analyses point to the importance of strong relationships with advisors and faculty, collegiality, and preparation for students' desired careers. Yet, results also suggest that women in STEM may be less satisfied than their male peers with the advising and career preparation received. The findings propose that university administrators and faculty should foster better faculty–student relationships and help students make more informed decisions prior to entering doctoral study.

Keywords

doctoral students, graduate education, attrition, sex, STEM

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Introduction

Graduate education remains a critical priority in the United States, as a well-educated population of advanced degree recipients is necessary to maintain global competitiveness, innovation, and knowledge generation (Council of Graduate Schools, 2013). In Science, Technology, Engineering, and Mathematics (STEM) fields, graduate education provides advanced technical and research training to students, enabling them to move on to the professoriate, find employment in advanced STEM positions, and contribute to a growing knowledge economy.

Yet, graduate enrollments have declined in recent years, and attrition continues to be a major concern. In light of this decline, due in part to significant changes in the U.S. economy (Gonzales, Allum, & Sowell, 2013), researchers and policy makers have a renewed interest in understanding the factors influencing persistence in graduate programs. These issues are far from novel. Concerns about U.S. graduate student attrition rates have been present for over 50 years (Crede & Borrego, 2014), and the average 10-year doctoral completion rate from 1992 to 2002 was only 57% (Council of Graduate Schools, 2008). Given the critical need to generate advanced degree holders in STEM and other fields (Holdren, 2013), understanding the causes of doctoral attrition is a growing national imperative.

Another pressing concern is the considerable workforce gap that exists between men and women in STEM employment, as "despite making up nearly half of the U.S. workforce and half of the college-educated workforce . . . [women] hold less than 25 percent of STEM jobs" (Beede et al., 2011, p. 1). While the proportion of female doctorate recipients has risen in the past decade, women still "earn less than 30% of the doctorates awarded in both physical sciences and engineering" (National Science Foundation, National Center for Science and Engineering Statistics, 2012, p. 4). A primary cause of gender imbalance in STEM fields is pipeline issues, as "there is considerable loss of women candidates between the bachelor's and doctoral degrees" (Gillen & Tanenbaum, 2014, p. 12). This disparity creates an already-diminished proportion of females entering doctoral programs in STEM disciplines and creates a critical gender gap within the STEM workforce, STEM faculty, and scholarship (Xu, 2008). Given the already low representation of women in STEM at the doctoral level, further research is needed to explore sex differences in satisfaction and retention, in order to identify policies and procedures that can address the gap.

Much of the extant research on graduate student attrition focuses on already-departed students' retrospective recall of factors contributing to their departure *after* leaving their programs, with most studies focusing on a relatively small sample of students or students within a single field. Researchers have yet to examine the reasons why students *consider leaving* while they are in their

programs, which might identify factors that bring students to "tipping points" in which negative or positive experiences may influence departure. In response, the current study explores doctoral students' satisfaction with their programs and reasons they *consider leaving*, investigating possible differences by sex and STEM or non-STEM programs.

Drawing on both quantitative and qualitative survey data from doctoral students at a large, public, research university, our study explores the questions:

1. What proportion of doctoral students at the university considers leaving their program? Does this proportion vary by sex or STEM or non-STEM major?
2. Why do doctoral students consider leaving their program? Do factors differ by sex, or STEM or non-STEM major?

Literature Review

According to prior studies, students tend to leave their doctoral programs for program-based or personal reasons, which are discussed in detail later. Key program-based factors include issues related to advising, program involvement, academics, and finances. Personal factors include family responsibilities, perceived academic lifestyle imbalance, and feelings of isolation.

Program-Based Factors

Finances and career options. Previous studies have found that the specific type and amount of financial support graduate students receive impacts their persistence. Using data on all entering PhD students across four programs (economics, English, physics, and mathematics) during a 25-year period at one institution, Ehrenberg and Mavros (1995) found that students with fellowships and research assistantships had higher completion rates than individuals with teaching assistantships. Ampaw and Jaeger (2012) used data from 2,068 doctoral students at one institution and similarly found that students with research assistantships are more likely to complete all stages of their doctoral programs than individuals with any other kind of financial support. Using a nationally representative sample of 1.2 million students, Strayhorn (2010) found that graduate students with a research assistantship were 2 times more likely to persist in their programs, while students with a tuition reduction were 1.6 times more likely to persist than individuals without either type of financial support. Although these studies involved large samples, their correlations could be confounded by other factors and so ultimately shed little light on underlying reasons that compel students to depart.

Perceptions and expectations of future employability and potential career earnings can contribute to persistence. Herzig (2004b), in a meta-analysis of studies examining causes of departure among mathematics doctoral students, found that

students may consider departure if they are not well educated regarding career options upon graduation. Utilizing data from more than 35,000 doctoral students in various programs across 10 universities, Bowen and Rudenstine (1992) found that doctoral completion rates decrease when the academic job market is scarce due to the economy. Additionally, Ampaw and Jaeger (2012) found that doctoral students in the research stage of their program were motivated to complete their degrees due to the expectation of higher earnings upon graduation. Finally, a doctoral student interviewed by Golde (1998) left his PhD program after realizing that the job market would have very few openings for his field.

Advising. Prior studies point to the importance of the student–advisor relationship. Although completed nearly 20 years prior, a key finding from a synthesis of 118 research studies conducted between 1970 and 1998 on doctoral student persistence was that "[t]he degree and quality of the relationship between doctoral student and advisor or faculty has a strong, positive relationship to successful completion of the doctorate" (Bair & Haworth, 1999, p. 13). In-depth interviews with three doctoral students who left their programs of study similarly revealed a problematic advising relationship as contributing to their attrition (Golde, 2000). Eighteen doctoral students in geology, history, biology, and English interviewed by Golde (1998) cited a mismatch with their advisor, characterized by different working styles and incompatible communication styles, as a reason for leaving their doctoral program. Interviews with six female doctoral students in a mathematics department revealed that a perceived lack of care from faculty contributed to students' consideration of departure (Herzig, 2004a).

Program involvement. The extent to which graduate students feel involved in their program or department can contribute to attrition. Survey results from 948 graduate students across 42 departments demonstrated that graduate student involvement in their department had the strongest direct effect on degree progress (Girves & Wemmerus, 1988). A review of 24 qualitative studies using interviews found that doctoral students who had opportunities to become involved in their departments were more likely to persist (Herzig, 2004b). Similarly, Bair and Haworth (1999) found that student involvement at the program, department, and institutional levels positively contributed to retention.

Academic factors. Student attrition is also connected to quality of teaching, dissertation difficulties, and program structure, which we collectively refer to here as academic factors. In Herzig's (2004a) study, some female mathematics doctoral students described wanting better teaching from their professors instead of inadequate feedback and incomprehensible lectures. Additionally, Bair and Haworth (1999) found that difficulty with various factors related to the dissertation stage can lead to doctoral student attrition. Specifically, individuals who changed their dissertation topic multiple times, struggled to narrow their focus,

or selected an inaccessible topic were less likely to persist than their peers who did not encounter the same difficulties. In addition, well-structured programs that provide more supervision tend to have lower attrition rates, while higher attrition rates were found in programs that required students to complete a master's degree before getting a PhD and had infrequent evaluations between students and faculty (Herzig, 2004b).

Personal Factors

Graduate attrition may also be influenced by personal factors. Students who perceive an imbalance between work and family responsibilities (Herzig, 2004b) or realize the life of a graduate student or professor in academia is not something they want are more likely to depart (Golde, 1998). Bair and Haworth (1999) found that graduate students who cultivate relationships with their peers are more likely to persist in comparison to isolated individuals. Through personal experience, observations, and interactions, Gay (2004) found that graduate students of color often times feel isolated in their programs as they may not have academic peers or professors who share their same ethnic or racial backgrounds.

Utilizing survey data from 574 graduate students across 18 departments at one university, Litzler, Lange, and Grainard (2005) found sex differences overall and within the science and engineering departments. Specifically, they found that "women are more likely than men to feel isolated, that the pace is quicker, and the workload is greater" (p. 13). Women also reported experiencing more instances of sex discrimination than men, indicating a less friendly climate for women in STEM departments.

Limitations of the Literature

The existing literature is limited in a number of ways. The studies are primarily based on data from small student samples (Gay, 2004; Golde, 1998, 2000; Herzig, 2004a, 2004b; Litzler et al., 2005) or from students within only a few units or departments (Cooke, Sims, & Peyrefitte, 1995; Ehrenberg & Mavros; 1995; Golde, 1998, 2000; Herzig, 2004a, 2004b), limiting the generalizability of the findings. The larger scaled studies primarily focus on correlations between assistantship support and retention (Ampaw & Jaeger, 2012; Ehrenberg & Mavros, 1995; Strayhorn, 2010). Only three of the studies we found on doctoral departure have been published in the last decade, raising concerns about the timeliness of the findings. The base of literature focusing on personal factors is also limited, with only four of the studies identifying personal factors as contributing to graduate student attrition (Bair & Haworth, 1999; Herzig, 2004b; Litzler et al., 2005). A number of the studies focus on a single or small number of factors affecting attrition, raising questions of how prevalent a wider set of factors may be in relation to one another. Lastly, our review suggests little

empirical support for a widely used theory of doctoral departure, resulting in a need to further conceptualize graduate students' experiences and outcomes.

To address these limitations, the current exploratory study draws on a relatively large dataset to examine the prevalence of various reasons why doctoral students consider leaving their program. This mixed-methods study combines survey data from over 2,000 doctoral students and compares quantitative analyses of factors related to students' consideration of departure with written explanations given by nearly 500 students who considered departure. As the data were obtained from a large, public university featuring 93 doctoral programs, we also utilize the data to compare students' responses by sex and STEM or non-STEM fields to investigate whether either of those factors, or an interaction between the two, contributes to consideration of departure.

Guiding Framework

Data for this study were drawn from an existing survey of doctoral students that a university recently initiated to help assess and provide feedback to its doctoral programs. Hence, the survey was not designed to test a specific theory of doctoral departure, and the researchers were limited to the questions posed on that survey. Still, existing literature and Tinto's (1993) doctoral departure model were used to help ground and interpret the results.

Tinto is best known for his theory of undergraduate persistence, but he briefly addressed the question of doctoral departure in an appendix to the second edition of *Leaving College* (Tinto, 1993). He posed a longitudinal model of doctoral persistence outlining various stages of students' experiences (Figure 1). At the center of his model are social and academic systems, and Tinto hypothesized

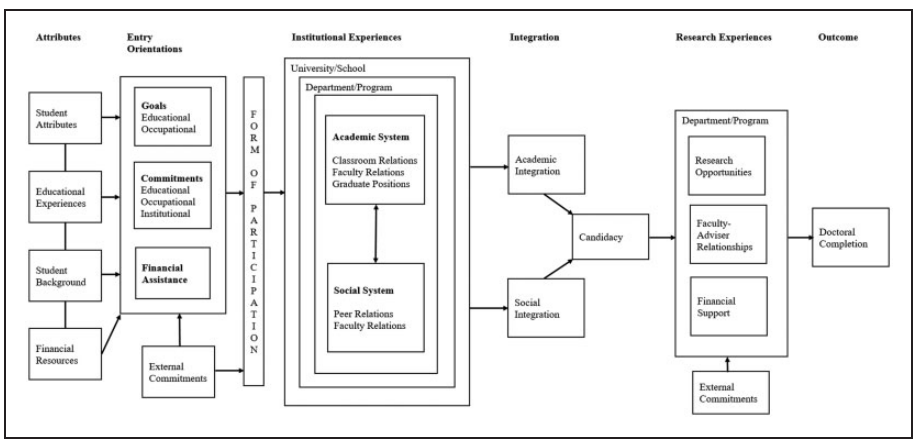

Figure 1. Tinto's (1993) longitudinal model of doctoral persistence.

that when students feel less integrated into these two systems, they are more likely to depart.

Still, Tinto's model may reflect outdated graduate education practices. Specifically, according to the model, students progress to research experiences only after experiencing academic and social integration and achieving doctoral candidacy. However, today's doctoral students often engage in research early in their programs. For instance, doctoral students in the biomedical sciences at some institutions are introduced to research laboratories in their first year of study (Fuhrmann, Halme, O'Sullivan, & Lindstaedt, 2011). Similar patterns of early research experiences (including undergraduate research) can be found at other institutions, particularly in the sciences, with some institutions emphasizing applied research, encouraging students to connect real-world solutions to real-world problems throughout their programs (Wendler et al., 2010).

Despite the model's limitations, it does point to factors that may be important in shaping doctoral students' persistence and departure patterns. Still, Tinto (1993) noted that his model is "merely informed speculation" (p. 241), and additional research is needed to explore its validity (Andrade, 2008). Although this study does not utilize the staged aspect of Tinto's model, it does examine which factors are more or less prevalent for doctoral students at a large public research institution.

To cast the net broadly and identify the themes most important to the students, as opposed to being constrained by the specifics in Tinto's model, his model did not serve as a starting point to frame data analysis. However, we return to his model in the discussion, considering the extent to which this study's results map onto Tinto's academic and social factors.

This current study is therefore exploratory and grounded, taking into account the full scope of data available, forming conclusions based on inductive analyses of the data to the extent possible, and interpreting findings within the context of Tinto's model and existing literature.

Method

Data Collection

Surveys were administered to approximately 5,000 doctoral students at a large, public, Research I university, yielding 2,070 responses during 1 year of administration (2013–2014). The survey consisted of several items pertaining to doctoral program experiences, such as program collegiality, advising, and other aspects. A summary of respondents' demographics is provided in Table 1. Overall, 545 doctoral students (26% of respondents) responded "yes" when asked whether they ever considered leaving their program, with 454 (83% of "yes" respondents) providing written details regarding why.

Table 1. Survey Sample Sizes by STEM and Sex.

	Non-STEM	STEM	Total
Male	367 (40.9%)	838 (71.5%)	1205 (58.2%)
Female	531 (59.1%)	334 (28.5%)	865 (41.8%)
Total	898	1172	2070

STEM = Science, Technology, Engineering, and Mathematics.

Programs were assigned as STEM or non-STEM according to the U.S. Department of Homeland Security's (2012) STEM Designated Degree List.[1] Gender representation within STEM designated fields was similar to other studies' findings (National Science Foundation, National Center for Science and Engineering Statistics, 2012), with a significantly lower percentage of females represented in STEM fields as opposed to non-STEM fields (Table 1). Specifically, while 59% of non-STEM students were female, only 29% of STEM students were female.

The survey instrument included nine items pertaining to specific aspects of program satisfaction, each using a 5-point scale. Exploratory factor analysis suggested that six of these items could be condensed into two composite scales (created by using the means of grouped items). Three single items were sufficiently independent of other items to merit treating individually. Hence, subsequent quantitative analyses focused on five "satisfaction variables" (we use the term "satisfaction variable" throughout the text for consistency): The two composites, Faculty or Advising and Knowledge of Program Requirements, and the individual items, Sufficiency of Financial Support, Collegiality, and Career Preparation (Table 2).

Data Analysis

This study employs a mixed-methods approach using a concurrent analytical procedure (Creswell, 2013; Creswell & Clark, 2007), in which the quantitative and qualitative analyses inform one another.

First, *t* tests were used to compare male and female means for each of the five satisfaction variables. These analyses revealed whether males or females had a more positive perception of key components (e.g., advising quality or financial aid) of their doctoral experiences. Means for male and female students within STEM and non-STEM fields were compared.

Subsequent analyses involved binary logistic regression. With consideration of departure as the dependent variable, various combinations of independent variables were used in subsequent models: a base model, and then models adding sex, STEM or non-STEM, and the five survey satisfaction variables. Significant

Table 2. Survey Items and Composites.

Item/construct	Mean	*SD*
Quality of Advising	4.09	0.82
How satisfied are you with the advising you have received from your doctoral program?	3.83	1.08
How often do or did you receive guidance or feedback from your primary faculty advisor?	4.36	0.94
How satisfied are you with the quality of the relationship between you and your advisor?	4.02	1.05
Knowledge of Requirements	3.55	0.76
How well do you understand the formal requirements for successful completion of your doctoral program?	3.85	0.83
How well do you understand the informal or unspoken expectations for successful completion of your doctoral program?	3.26	0.96
Sufficiency of Financial Support	2.68	0.82
Is/was the financial support you are receiving for your doctoral studies sufficient to meet your basic living expenses?		
Collegiality	3.78	1.00
How collegial (collaborative, friendly) is or was the environment in your doctoral program?		
Career Preparation	3.80	0.88
How well do you think your doctoral program is preparing or prepared you to begin a career in your discipline?		

Note. All item responses were on a 5-point scale, which varied slightly depending on the wording of the question. For example, the responses for collegiality were *not at all collegial*, *slightly collegial*, *moderately collegial*, *very collegial*, and *extremely collegial*.

predictor variables and their odds ratios were noted, to explain how much each variable predicted students' consideration of departure. Interactions between sex and STEM were included to investigate whether males or females were particularly likely to consider departure within STEM or non-STEM fields. The results of these quantitative analyses were ultimately compared with those from qualitative analyses to check for consistency in results.

Qualitative analyses involved coding the 454 open-ended responses students wrote when asked to explain why they had considered departure. One research member conducted comprehensive coding, developing categories informed by the initial quantitative analyses, existing literature, and suggested through repetition in the responses. The authors met several times to discuss, develop, and refine these codes. Once the 16 codes were finalized, the team employed a code by committee approach whereby two members met to code all of the open-ended responses (Saldaña, 2012), with more than one code used per response as

necessary. Coded responses were counted within various groups and included in basic descriptive analyses, comparing male and female responses within the STEM or non-STEM categories. Lastly, we compared our findings with Tinto's (1993) doctoral departure model to determine how well the prominent predictors of departure from this study relate to the social and academic pillars.

Results

Quantitative Results

The rates at which students considered departing differed by sex and STEM or non-STEM fields (Table 3). There was a higher overall rate of considering departure from non-STEM programs (32%) than STEM programs (24%). Additionally, although males (36%) were more likely than females (29%) to report that they considered leaving their non-STEM programs, STEM females (27%) were more like than STEM males (22%) to consider leaving.

As an initial exploration of survey satisfaction variables, students were grouped into STEM and non-STEM categories, with male and female means on each of the five variables compared using *t* tests (Table 4). While no differences between variable means existed by sex for the non-STEM group, STEM males indicated slightly higher satisfaction with advising ($d = .18$), preparation ($d = .17$), and knowledge of requirements ($d = .16$) than their female counterparts. Females in STEM indicated slightly higher satisfaction with their financial support than STEM males ($d = .12$).

In logistic regression models (Table 5), increases in the survey satisfaction variables of quality of advising, collegiality, and career preparation significantly predicted a lower likelihood of considering departure. Odds ratios of 0.55, 0.65, and 0.63, respectively, indicate that, for each factor, a one-point increase in satisfaction correlated with a decrease in intent to depart by nearly half. When adding dummy control variables for sex (male = 1) and STEM (STEM = 1) to the regression model (Model 2), the three variables retained

Table 3. Considering Departure Rate, by Sex and STEM.

		Non-STEM ($n = 898$)			STEM ($n = 1{,}172$)		
		Male ($n = 367$)	Female ($n = 531$)	Total	Male ($n = 838$)	Female ($n = 334$)	Total
Considered	No	63.7%	70.7%	67.8%	77.7%	73.0%	76.4%
Departure	Yes	36.3%	29.3%	32.2%	22.3%	27.0%	23.6%

STEM = Science, Technology, Engineering, and Mathematics.

significance. This suggests that when student satisfaction with finances, advising, and the other variables are held constant, there is no significant gender difference overall in terms of consideration of departure.

In a third model, an interaction term between sex and STEM was added and found to be significant. This seems consistent with Table 3, which indicates that females in the sample were more likely than males to consider leaving STEM programs, while the reverse was true in non-STEM programs. However, this could be due to differences in male and female satisfaction with key program aspects (as revealed in Table 4), and these aspects were taken into account in the logistic regression models.

Table 4. *T* Tests of Composites, Males, and Females by STEM.

	Non-STEM ($n = 898$)			STEM ($n = 1,172$)		
	Male ($n = 367$)	Female ($n = 531$)	*t* test Sig.	Male ($n = 838$)	Female ($n = 334$)	*t* test Sig.
Financial Support	2.34	2.39	0.38	2.89	2.99	0.03
Quality of Advising	3.96	4.01	0.45	4.21	4.06	0.00
Collegiality	3.71	3.62	0.20	3.89	3.82	0.21
Career Preparation	3.76	3.73	0.62	3.88	3.73	0.00
Knowledge of Requirements	3.56	3.51	0.43	3.61	3.49	0.04

STEM = Science, Technology, Engineering, and Mathematics.

Table 5. Logistic Regression Models, Considering Departure as Dependent Variable.

	Model 1 Composites		Model 2 + Male and STEM		Model 3 + Sex × STEM	
	Exp(B)	Sig.	Exp(B)	Sig.	Exp(B)	Sig.
Constant	239.42	0.00	230.79	0.00	196.01	0.00
Financial Support	0.87	0.10	0.91	0.31	0.91	0.32
Quality of Advising	0.55	0.00	0.56	0.00	0.57	0.00
Collegiality	0.65	0.00	0.65	0.00	0.65	0.00
Career Preparation	0.63	0.00	0.62	0.00	0.62	0.00
Knowledge of Requirements	0.86	0.14	0.85	0.11	0.86	0.15
Male			1.09	0.53	1.51	0.04
STEM			0.75	0.06	1.06	0.83
STEM × Male					0.53	0.03

STEM = Science, Technology, Engineering, and Mathematics.

Table 6. Calculated Probability of Considering Departure (Composites Constant at = 3).

Non-STEM	STEM
0.63	0.49
0.53	0.54

STEM = Science, Technology, Engineering, and Mathematics.

Because the interacted terms are dichotomous, a simple 2×2 matrix with calculation of expected terms, with all satisfaction variables held constant, was used to interpret the interaction (Table 6). First, the probabilities of considering departure with variables held at 3 (the midpoint of the 5-point scale) were calculated for each of the four gender or STEM groups. Females were less likely than males to consider leaving non-STEM programs, and the reverse was true for STEM programs. In fact, the most striking difference was between males in non-STEM versus STEM programs, with males substantially more likely to consider leaving non-STEM programs (.63) than STEM programs (.49). Analysis of difference in differences of marginal effects was significant between males and females in non-STEM fields only, and between males in STEM versus non-STEM fields.

Again, these differences are significant when values of survey satisfaction variables are held constant. In other words, when men and women respondents in STEM and non-STEM fields were equally satisfied with key components of their programs, men were particularly likely to consider leaving non-STEM programs, but there was no significant difference between male and female consideration of departure from STEM programs. However, STEM females reported less satisfaction than did STEM males on two of the three satisfaction variables (quality of advising and career preparation) that, according to the logistic regression results, were significant predictors of considering departure. Hence, these results point toward possible reasons why women may be more likely than males to leave STEM doctoral programs.

Qualitative Results

As noted earlier, although the vast majority (74%) of students reported that they had never considered departing from their programs, those students who said they considered leaving were asked to explain why. These open-ended responses were analyzed, and comparisons were made between male and female students within STEM and non-STEM fields. Overall, the qualitative findings are consistent with the quantitative findings in emphasizing the importance of advising

or mentorship relationships, collegiality, and career preparation in retaining doctoral students.

Faculty or advising. The most prevalent code for all males (30%) and females (39%) in the sample was Faculty or Advising (see Table 7). These respondents either described the nature of the relationship with or the quality of guidance provided by the advisor or faculty member as a reason for considering departure. Some students described an incompatible, negative, or abusive relationship with their advisor or faculty member(s). Males described their advisors or faculty in the following ways: ''unethical and abusive,'' ''absolute lack of professionalism,'' ''extremely controlling and not easy to work with,'' ''overbearing,'' ''harsh treatment from my adviser in the form of discouraging or inappropriate language,'' ''demeaning comments by advisor and unwillingness of other faculty to improve the situation,'' and ''I was made to feel like a bonded labor (sic).'' Two STEM males even compared the experience of working with their advisor to hell: ''It was hell'' and ''Life was pure HELL.'' Some females characterized the relationship as ''difficult,'' ''bad,'' or ''poor.'' One non-STEM female described faculty as ''unsupportive, distant, degrading, and disrespectful.'' One STEM female said, ''I was constantly berated and praised causing me to not know what was going on,'' while another stated, ''The primary reason I considered leaving was due to my advisor . . . who was borderline abusive.''

Doctoral students also expressed disappointment in the quality of advising received. Males cited an absence of guidance: ''an appalling lack of academic advising,'' ''complete lack of guidance and mentoring,'' ''the students are provided with very little support or guidance throughout the process . . . our advisors never reach out to their students.'' Females also cited a general lack of support, saying ''no support from advisor,'' or the absence of guidance, noting ''my original research advisor clearly lacked the ability to provide the infrastructure and guidance needed for me to complete a dissertation.'' One female student commented, ''I have had a very difficult experience working with senior faculty . . . I ended up wasting two years in my career without any research and have not received any feedback or advise (sic) on the project . . . I feel miserable to have ended up in such a situation.''

Mismatch of interests and goals. The second most prevalent response for both males (23%) and females (25%) was Mismatch of Interests and Goals. Some students described how their research interests did not match up with those of faculty in their department, providing comments such as ''there will be only one professor whose research interest is the same as mine'' and ''the course work required does not necessarily tally up with research interest.'' Regarding the mismatch of goals, some students indicated that the program was not going to lead to the type of career they desired. One STEM male had ''thoughts that an MBA would be more appropriate for my career goals'' while another non-STEM male

Table 7. Qualitative Coding.

		All		Non-STEM		STEM	
	All (454)	Male (263)	Female (191)	Male (116)	Female (127)	Male (147)	Female (64)
Faculty or Advising	134 (33%)	69 (30%)	65 (39%)	38(37%)	46 (43%)	31 (24%)	19 (32%)
Mismatch of Interests and Goals	96 (24%)	54(23%)	42 (25%)	23 (22%)	29 (27%)	31 (24%)	13 (22%)
Collegiality or Climate	66 (16%)	34 (15%)	32 (19%)	19 (18%)	28 (26%)	15 (12%)	4 (7%)
Career Preparation	64 (16%)	44(19%)	20 (12%)	18 (17%)	14 (13%)	26 (20%)	6 (10%)
Program Structure	64 (16%)	40 (17%)	24 (14%)	23 (22%)	16 (15%)	17 (13%)	8 (13%)
Finances	59 (15%)	33 (14%)	26 (16%)	22 (21%)	21 (19%)	11 (9%)	5 (8%)
Administrative Issues	52 (13%)	31 (13%)	21 (13%)	22 (21%)	18 (17%)	9 (7%)	3 (5%)
Other (Specific)	37 (9%)	23 (10%)	14 (8%)	6 (6%)	9 (8%)	17 (13%)	5 (8%)
Personal Reasons	25 (6%)	16 (7%)	9 (5%)	8 (8%)	4 (4%)	8 (6%)	5 (8%)
Prestige or Ranking of Institution	25 (6%)	20 (9%)	5 (3%)	11 (11%)	3 (3%)	9 (7%)	2 (3%)
Advisor or Faculty are Leaving	22 (6%)	8 (3%)	14 (8%)	6 (6%)	12 (11%)	2 (2%)	2 (3%)
Understanding Formal or Informal Requirements	14 (4%)	7 (3%)	7 (4%)	4 (4%)	6 (6%)	3 (2%)	1 (2%)
Discrimination or Representation	14 (4%)	3 (1%)	11 (7%)	3 (3%)	8 (7%)	0 (0%)	3 (5%)
Geography	10 (3%)	7 (3%)	3 (2%)	1 (1%)	0 (0%)	6 (5%)	3 (5%)
"Is it worth it?" "Is it for me?"	7 (2%)	4 (2%)	3 (2%)	1 (1%)	2 (2%)	3 (2%)	1 (2%)
Tired or Stressed	4 (1%)	2 (1%)	2 (1%)	0 (0%)	1 (1%)	2 (2%)	1 (2%)
	693	395	298	205	217	190	81

STEM = Science, Technology, Engineering, and Mathematics.

mentioned that "I was not sure about pursuing a research/teaching career in the future. Therefore, I was not sure if a PhD was the best suited program for me."

Although the two most prevalent reasons for considering departure were the same for males and females, the magnitude of their responses differed. In comparison to males (30%), females' (39%) consideration was more strongly influenced by reasons relating to their advisors or faculty. The second most prevalent reason for both groups, Mismatch of Interests and Goals, appeared with approximately the same frequency for both males (23%) and females (25%).

Reasons students in STEM consider leaving. Faculty or Advising (24%) and Mismatch of Interests and Goals (24%) were the two most prevalent reasons influencing STEM males' consideration of departure. Career Preparation (20%) was the third most prevalent reason for STEM males as some students expressed concerns that they were not being adequately prepared for a career in their field, noting "little support or preparation for non-research jobs, at least in my subfield," "there were no opportunities to teach, design, or implement upper level undergraduate classes, so one is at a disadvantage in terms of teaching experience upon entering the job market," and "lack of industry-relevant training." Others stated that they would not be able to find a job upon graduation, with comments such as "I was worried about the future job market in my career" and "the job market . . . is pretty abysmal." Unlike other groups examined, there is a very narrow gap (approximately 4%) between the prevalence of issues surrounding Faculty or Advising, Mismatch of Interests and Goals, and Career Preparation for STEM males.

STEM females cited issues related to Faculty or Advising 32% of the time, which made it the most frequently mentioned reason impacting their consideration of departure, followed by Mismatch of Interests and Goals (22%). Career Preparation was mentioned by only 10% of STEM females, in contrast to 20% of STEM males. In contrast, collegiality in the program was mentioned by only 7% of STEM females, suggesting that relationships with faculty were more important than relationships with peers for this group.

Reasons non-STEM students consider leaving. Comparisons between males and females in non-STEM programs revealed some of the same trends as mentioned earlier. Faculty or Advising was the most prevalent reason given by both males (37%) and females (43%). Mismatch of Interests and Goals and Program Structure surfaced in 22% of males' responses. Student responses categorized into the latter code indicated concern about program structure or requirements, noting "I felt that the doctoral program lacks structure" and "requirements seemed too many, unclear, not suited to my needs." Concerns about these factors were a relatively strong influence of non-STEM males' consideration of departure compared with other populations. The second most prevalent reason given by non-STEM females was Mismatch of Interests and Goals

(27%). Overall, the trends comparing all males and females in the sample are maintained when comparing non-STEM males and females. There is, however, more consistency in the differences between the first and second most prevalent reasons for both groups.

In summary, the qualitative data help us better understand why doctoral students consider leaving their programs, but also which reasons matter the most to specific subgroups of interest. For all students in the sample, relationships with and quality of guidance received from advisors or faculty appear to be crucial, and having clear alignment of research interests between doctoral students and faculty and course offerings is also very important. Furthermore, STEM males were more concerned about career preparation than were STEM females.

Discussion

Our exploratory analyses revealed five patterns that merit further discussion. First, relationships with advisors appeared critical in retaining this sample's doctoral students, as indicated by both the logistic regression and the qualitative analyses. In fact, according to students' open-ended responses, concerns about advisors were the top reason students considered departure. The results confirm those of prior smaller scale studies (Golde, 1998, 2000; Herzig, 2004a, 2004b) that consistently highlight the need for quality mentorship of students. In considering how this critical factor maps onto Tinto's (1993) two pillars of academic integration, we see from students' comments that concerns about advising span both pillars. That is, students noted both the importance of having a strong social or emotional relationship with advisors, as well as needing high-quality academic and professional support. Indeed, this supports the notion that faculty and advisors fit into both social and academic roles as doctoral students seek respectful relationships as well as academic guidance.

Second, as measured by the survey satisfaction variables, STEM males reported more satisfaction with their advising, career preparation, and knowledge of formal and informal program requirements than did STEM females. Given the self-reported nature of our survey, the differences between males and females may indicate a difference in the actual constructs (e.g., STEM programs provided less support for females than for males), a difference in perception or rating of those constructs (e.g., females are less satisfied with support provided even when equivalent to the support provided for males), or a combination of both. In any case, the mean differences are generally small but notable, particularly given that satisfaction with advising and career preparation was linked to students' consideration of departure in the regression analyses, and given that no sex differences in the means of the five satisfaction variables existed among non-STEM students.

Third, in regression analyses, the interaction between sex and STEM indicated that non-STEM male students tended to have higher odds of considering

departure than other groups. However, when holding student satisfaction with key program aspects constant, STEM females were no more likely to consider departing than STEM males. Again, the issue is that the STEM women were, indeed, less satisfied with several key aspects of their program, including quality of advising, which was a strong predictor of consideration of departure. The interplay between STEM and sex is one that needs greater attention in future quantitative analysis to further understand the specific experiences of females in STEM and how those experiences relate to departure.

Fourth, one other prevalent theme for STEM males in both the quantitative and qualitative data was career preparation. This finding is consistent with Eccles, Wang, Tsai, and Banerjee (2014), who found that, although men and women both cared about choosing careers aligned with their interests, men placed higher emphasis on gaining money and status, while women balanced other commitments such as family considerations. Career preparation as a reason for considering doctoral departure is also supported by prior, small-scale studies (Ampaw & Jaeger, 2012; Golde, 1998; Herzig, 2004b).

Fifth, this study points to collegiality as a factor linked to doctoral students' consideration of departure but did not differ by sex or STEM affiliation. This is consistent with Tinto's focus on social integration and speaks to the importance of relationships in academic settings.

It is worth noting that in the open-ended responses, 72 respondents described why they decided to remain in their program, despite having considered departure. The most prevalent response, given by 28 students, referred to supportive advisors. As one student described, ''If it wasn't for my advisor, I would surely have left.'' These data give further support for the importance of relationships, specifically the student–advisor relationship, during doctoral programs.

Limitations

The most significant limitation of this study is that data were drawn from a single large, Midwestern university, thus limiting generalizability. For example, the apparent lack of importance of financial factors for the students in this sample might suggest that students at this university tend to have sufficient funding, as opposed to suggesting that finances are never important factors in student persistence. Although one strength of the single-university setting is that institutional differences are not confounding the patterns relating to sex or STEM affiliation found here, future research should utilize data from different types of doctoral-granting institutions representing a range of characteristics. A larger, cross-university sample could also support the inclusion of additional student characteristics, such as academic background, race or ethnicity, and social class.

The binary classification of STEM or non-STEM programs, using the Department of Homeland Security's list for guidance, does not reflect differences

between specific types of STEM (or non-STEM) programs and may mask important subprogram distinctions. Future analyses could further consider ways in which specific disciplinary characteristics (e.g., biological vs. physical sciences, shape departure decisions for men and women).

Finally, this study relies heavily upon a single, self-reported open-ended question asking the reason for considering departure. While informative, further insight into some of the observed differences, such as males in non-STEM fields compared with their peers, could be gained by conducting follow-up interviews or focus groups. Furthermore, while Faculty or Advising was certainly a prevalent theme, students' comments about advisors, advising, and general faculty mentoring were often interwoven. Future research could work to identify possible nuanced differences within some of the larger identified themes. Finally, additional, longitudinal studies could follow students over time, thereby allowing a more thorough testing and revision of Tinto's staged model of doctoral persistence.

Implications

Practitioners

The consistency of advising and collegiality as significant factors contributing to students' consideration of departure suggests that strong social integration is necessary to retain doctoral students. For practitioners at research-intensive universities, there are important implications for how faculty members are educated to become good mentors, as well as how advising—and even mentoring—are valued. Departments, colleges, and universities have much to gain by helping faculty improve their formal and informal mentoring and professional development of graduate students. The presence of significant mismatches between student goals and the reality of programs, in terms of focus, research areas, and program expectations, also suggests that instructors and program administrators should be more explicit about what the doctoral program entails. By improving advising and more explicitly addressing expectations and goals of the program, administrators may help limit the factors that bring students to a "tipping point," causing their departure.

Researchers

For researchers, we offer two implications. The first is the need to develop a comprehensive model of doctoral student departure that emphasizes how students' experiences during their program of study can lead to eventual departure. Even though our sample was limited within a single institution, our findings highlight the need to consider how academic and social spheres interact for doctoral students, as well as how student demographics, field of study, and career goal alignment with program may impact departure decisions.

The second implication is to leverage and expand upon doctoral program assessments occurring at various institutions. As these doctoral program assessment data used in this study are relatively new at the focal institution, our analysis opens doors to continued longitudinal analyses, and provides a test-bed for the development of larger scale, multiinstitution studies. Likewise, the instrument, itself, benefits from continued scrutiny and improvement in order to address the questions of highest importance to researchers and practitioners alike.

This study, while exploratory in nature, sheds light on the many factors doctoral students may consider when deciding to depart from (or persist in) their program of study. While the student–faculty relationship was highlighted as being the most important factor, the data also provide evidence that doctoral students have focused interests and goals, and that these may weigh heavily in students' consideration of departure. As programs and universities seek to increase retention rates, the factors highlighted here can help inform discussions about steps forward.

Authors' Note

Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the Institute or the U.S. Department of Education.

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Note

1. The list serves as a recruiting mechanism for the U.S. workforce in areas of high demand and represents one of only a few formal lists of STEM-designated programs.

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