

# **Doctoral Advisors' Perspectives on Career Advising and Professional Preparation in the Sciences**

*Heather L. Thiry, Sandra L. Laursen, University of Colorado Boulder*

*Heidi G. Loshbaugh, Community College of Denver*

## **Abstract**

Recently, calls for reform in science graduate education identify a mismatch between students' doctoral training and the knowledge and skills needed in the 21<sup>st</sup> century scientific workforce. We initiated this ethnographic study of doctoral education in the sciences to explore professional socialization and career decision-making processes. We conducted 95 interviews in three chemistry departments with doctoral students, faculty advisors, departmental staff, and university administrators. We identify three distinct orientations of advisors towards students' career development. Students' professional preparation and career commitment appears to be linked to their advisors' orientation toward career advising. Implications for policy and practice are discussed.

## **Study Objectives**

Concerned about a lackluster economy and increasing global competition, policymakers look to scientific, technological, engineering, and mathematics (STEM) fields to drive innovation and spur job creation (NRC, 2012). Graduate education may be the linchpin in realizing these national goals. However, doctoral education in the U.S. has been criticized for the mismatch between the narrow preparation of students and the broad range of skills required in postdoctoral careers, particularly non-academic careers (American Association of Universities (AAU), 1998; Golde & Dore, 2001; Nyquist, 2002; Nerad, Rudd, Morrison & Homer, 2006; Nyquist & Woodford, 2000; Smith, Pederson-Gallegos & Riegle-Crumb, 2002; Taylor, 2006; Wendler et al, 2012).

Exacerbating the importance of this gap in STEM doctoral preparation, students themselves are increasingly less interested in tenure-track positions and more interested in so-called "alternative" careers in industry, government, entrepreneurship, education, policy, or law (Sauermann & Roach, 2012). With such a broad array of possible career paths, STEM Ph.D. students need knowledge, resources, and transferable skills to prepare for future careers. First, however, they need information about doctoral career choices, so they can select a career path that fits their professional training, interests and skills, lifestyle, and temperament.

Doctoral advisors can play a crucial role in students' career knowledge, preparation, socialization and success. Indeed, good doctoral advising has been linked to desirable student outcomes, including research productivity (Tenenbaum, Crosby, & Gliner, 2001; Nettles &

Millet, 2006; Paglis, Green & Bauer, 2006), disciplinary learning (Wrench & Punyanunt, 2004), professional socialization (Boyle & Boice, 1998) and improved time-to-degree and persistence (Barnes, 2010; Ferrer de Valero, 2011; Girves & Wemmerus, 1998; Lovitts, 2001; Nettles & Millett, 2006). Doctoral advisors support students' professional development in many ways, including career advising and preparation. Career advising is linked to overall doctoral student satisfaction (DeWelde & Laursen, 2008; Schlosser et al., 2003; Zhao, Golde, & McCormick, 2010), although several studies have found that adequate career preparation and guidance is sorely lacking in most doctoral advising relationships (Austin, 2002; Schlosser et al, 2003; Waldeck et al, 1997). However, it is less clear how doctoral advisors view their role as career advisors, or how students and doctoral advisors compensate for the lack of career socialization often found in doctoral advising relationships.

While the majority of studies have examined doctoral advising from the perspectives of students, several recent studies have explored advisors' perspectives (Barnes & Austin, 2009; Knox et al., 2006; Lee, 2008). These studies address important domains, such as advising relationships, professional socialization, and psychosocial support, yet they only touch upon career advising. Clearly, though, the quality of doctoral career advising in STEM affects not only individual student success, but also broader societal and workforce goals. Thus, it is important to understand advisors' perspectives on their role in providing career guidance and support for their students. Because individual student decisions collectively affect the distribution of scientific talent across work sectors, the career exposure and preparation that STEM Ph.D. students receive is critical to the future of their discipline and the nation's economic vitality. In this paper, we focus on doctoral advisors' perspectives on career advising, and the ways in which they do, or do not, provide career information and guidance to students.

### **Theoretical Framework**

Professional socialization is one of the key outcomes of the doctoral advising relationship. Socialization theory emphasizes the enculturation of newcomers into the culture, norms, and beliefs of a profession (Antony, 2002; Austin, 2002; Tierney & Rhoads, 1994; Weidman, Twale & Stein, 2001). Organizational processes or practices, such as departmental requirements or doctoral advising, may either facilitate or impede the socialization process (Van Maanen & Schein, 1979). Weidman and Stein (2003) highlight three loci of graduate student socialization: "interaction with others, integration into or sense of fit with the expectations of faculty and peers, and learning of knowledge and skills necessary for effective professional practice" (p. 643). Doctoral advisors play a central role in all three aspects of graduate student socialization by conveying professional and disciplinary expectations to students, and imparting knowledge, skills, norms and beliefs.

However, the "traditional" notion of an advisor socializing a doctoral student into a strictly bounded discipline is an outmoded view of graduate socialization. While the role of the advisor cannot be discounted, the nature of academic disciplines and STEM professions are rapidly changing. Professional socialization must come from a variety of sources, and prepare

students to solve broad problems and work in emerging fields (Antony, 2002). Thus, it is also important to explore advisors' perspectives on appropriate sources of professional socialization and career preparation for students.

### **Research Methods and Data Sources**

This study consisted of two phases, an initial mapping study (Loshbaugh, Laursen, & Thiry, 2011), followed by in-depth case studies of three chemistry departments. The research design is qualitative, consisting of semi-structured interviews with faculty, doctoral students, administrators, and staff involved with doctoral education. Our overarching research question was:

*What are the elements and processes of professional socialization—both manifest and latent—by which science graduate students come to understand their profession and their own fit within it, and how do these shape their career selection and progress?*

Subsidiary questions relevant to this paper include:

*What are the factors that shape and influence these ideas, especially the role of the advisor, research group and department, and what is the interaction of these local factors with external representations of the discipline, such as journals and professional societies?*

*What faculty behaviors, departmental or institutional structures support career preparation and selection, and what additional unmet needs are reported?*

The discipline of chemistry was chosen to study socialization in STEM disciplines because many of the general concerns in doctoral education have been well documented in chemistry (American Chemical Society (ACS), 2002; Caserio et al., 2004; Kwiram, 2006). Despite the economic downturn, chemists have experienced low unemployment (ACS, 2010), although job growth in the coming decade is projected to slow (Bureau of Labor Statistics (BLS), 2012). Additionally, two-thirds of chemists work outside academe (ACS, 2010), and chemistry doctoral students are less interested in academic work than scientists in other disciplines (Sauermann & Roach, 2012).

Three departments were chosen as study sites based on a number of factors, including student and faculty diversity, interdisciplinary research focus, positive departmental climate, and prior engagement with doctoral reform. We sought departments that had attempted to address some of the gaps in students' professional socialization that have been identified in the research literature. Two of the study sites were public universities and one was private. The sites were geographically dispersed in the Midwest and East.

In the summer and fall of 2009, teams of two researchers conducted week-long site visits to each department to conduct semi-structured interviews with participants. Such interviews seek to understand complex behaviors, interactions, and social processes that are relatively uninvestigated (Fontana and Frey, 2000). Interview protocols addressed advising practices and philosophies, knowledge of doctoral career options, sources of professional learning, and

professional development opportunities available in the department, on campus, and elsewhere. Stratified samples of students and faculty were drawn from departmental records to achieve a representative sample of sub-disciplines, advisors, gender, race/ethnicity, and career rank. Women and underrepresented minorities were over-sampled to ensure that their perspectives would be included in the study. Interview participants represented a range of faculty career ranks, administrative positions, and doctoral stages.

During the three site visits, 95 interviews were conducted with 104 participants, including 32 late-stage students, 25 early-stage students, 34 tenure-track faculty, 3 non-tenure-track faculty, 3 departmental chairs, 2 university administrators, and 5 departmental staff. Of faculty interview participants, eight were assistant professors, nine were associate professors, 17 were full professors, and three in non-tenure-track positions worked directly with graduate students (e.g. TA supervisor, director of instrumentation). Ten of the tenure-track faculty interviewees were women: 50% of these at the assistant professor level. The gender and career rank distribution of the faculty sample was reflective of the overall distribution of faculty within the three departments.

All interviews were conducted individually, with the exception of five focus groups held with early-stage doctoral students. The digitally recorded interviews were 45-75 minutes long and each was transcribed verbatim to provide an accurate record for textual analysis. All transcribed interviews were submitted to *NVIVO 9* qualitative software for analysis.

To develop the coding framework, each transcript was searched for information bearing upon the research questions. Three researchers reviewed transcripts, met regularly to discuss themes in the data, and developed the codebook in an iterative process. Groups of codes that cluster around particular concepts were grouped within domains, such as *career choices and decisions*, *professional development needs*, *departmental support*, and *institutional support* (Spradley 1980). Ongoing discussions of the coding scheme ensured content validity of codes. Comparison of coded transcripts, including discussion and resolution of coding discrepancies, enhanced inter-rater reliability.

## **Results**

Traditionally, research advisors have been the locus of career advising and information for doctoral students. Many advisors in our study were quite thoughtful and reflective about how to best develop students' scientific expertise, yet this thoughtfulness did not always translate into well-informed career advising or explicit professional preparation. We identified three distinct career advising orientations, outlined in Table 1.

Table 1. Distribution of career advising orientations among tenure-track faculty (n=34)

Advising orientation	Number of faculty	Percentage of faculty	Description
Proactive	12	35%	Explicitly talked to students about careers and tried to inform them about various options. Tailored advising practices to match the students' goals or interests. Supported non-academic choices. Provided explicit skill development and drew on outside resources to assist students.
Supportive	12	35%	Did not provide explicit career education, but supported students' career decisions, including non-academic careers. Used personal networks or knowledge of outside resources to help students achieve their goals.
Hands-off	10	29%	Felt that students would figure out careers "on their own." Took few, if any, steps to help students navigate their career path. Did not support or were neutral about non-academic careers.

Advisors were evenly distributed across types, but women and early-career faculty were more likely to be "supportive" or "proactive." For instance, 89% of female advisors (8 of 9 interviewees) and 75% of assistant professors (6 of 8 interviewees) were classified as "supportive" or "proactive" advisors. Early-career faculty may be better able to reflect on their own, recent graduate education and how career advising, or the lack thereof, influenced their own career path. Therefore, early-career faculty may be better placed than more experienced faculty to try to address students' career development needs. Women faculty may also be more focused on career advising because many of them have had to overcome gender barriers in STEM, and thus, they may recognize the importance of proactive career advising for doctoral students. However, further research is needed to test these hypotheses.

The majority of advisors—of all types—felt that they did not have enough knowledge about non-academic career paths to adequately advise or prepare students for the realities of those careers. Due to this lack of information, some "hands-off" advisors did not feel that providing career guidance or support, particularly for non-academic careers, was part of their role. Thus their students ended up "on their own" to educate themselves about future careers and to acquire the non-scientific skills that they may need in the future, thereby missing out on one important pathway toward career knowledge and professional socialization. In this manner, "hands-off" advisors impeded their students' socialization processes and students, by necessity,

had to turn elsewhere for essential information about future career preparation and possibilities. As an example of the “hands-off” career advising orientation, a full professor stated:

*Things like scientific consulting, things like this that don't have a direct interaction with our department, and I don't know anything about—that's a tougher game. It's been on an ad hoc basis that some student gets an interest in an unusual area like that. Then they kind of have been on their own to learn about those kinds of things.*

Some faculty felt that career advising was not part of their role because students may not use the career advice they are given, or because advisors felt that current students already have more information than they did on which to base their career decisions. These beliefs led faculty to absolve themselves of responsibility for providing career guidance or information. A full professor reflected both of these beliefs in the following comment:

*I think students have access to more information than was available when I was a student, you know, fifteen or twenty years ago. I don't know how good they are necessarily at really interpreting it even if they have it. I guess it's better that they have it and hear it, but it doesn't guarantee they'll digest it—not that I was any different necessarily. I think most of the students that are gonna be good Ph.D.'s are also pretty stubborn probably, or they wouldn't have the persistence to get through. They're probably fairly independent and kinda like to do things a little their own way, or they wouldn't kind of be creative enough and have this sense of wanting to kind of do things on their own. So, you're sort of self-selecting for people that are sometimes hard to steer that way.*

In contrast, “supportive” professors tried to informally talk to students about career options and preparation. These advisors supported their students' career decisions, including non-academic choices. When they did not know about a career, they drew on their networks or their knowledge of supplemental resources (e.g., professional associations, internship opportunities, etc.) to help students gain more information or prepare for the profession. Supportive advisors thereby provided alternative pathways to enhance students' professional socialization. A full professor noted:

*[I talk to students] directly, never trying to tell them what they should do, but what they could do. And especially when I'm not very good about it, like industrial careers, having never worked in industry, [I'm] trying to get information from people that know.*

Non-tenure-track faculty members, themselves in a type of “alternative” job, tried to educate students about various alternatives to higher education and industry careers. A non-tenure-track faculty member, who worked closely with graduate students, commented:

*I've tried to make students aware at times of some of the distinctions that faculty members don't seem to be keeping on the, forefront of their minds. 'Cause some of them seem to, reflect the kind of big pharm, or big business industry, big government, or big university, or small university. That's kind of their paradigm. And so, I try to tell students*

*well, there's other paradigms. And, because I've got some contacts, and I've maintained some contacts over the years, I've actually tried to hook up students with some of the other possibilities.*

Some advisors proactively tried to educate their students about career paths, and deliberately developed their students' non-scientific skills so they would be prepared for any career they might choose. Advisors who used multiple strategies to inform students about career options were more successful in fostering greater career awareness and preparation in their students. These advisors also strongly encouraged their students to take advantage of supplemental opportunities, such as trainings and professional development workshops, to bolster their career knowledge and professional skills. In the following comment, a proactive advisor described the various formal and informal methods he used to engage students in thinking about their career choices.

*The only thing that I try to do is provide to them a broad perspective of opportunities for a Ph.D. chemist. And we do that through several venues. One is through weekly group meetings, and I talk about what Ph.D. chemists do. I'm a director of a center and we hold professional development workshops. And we provide students with opportunities to learn about post-graduation, what is out there. And I do it through informal mechanisms by talking to students about postdocs, commercial private sector jobs, things like that.*

Proactive advisors were also aware that students' professional socialization and career education needed to start early in their graduate experience. A proactive faculty member who had just become Director of Graduate Studies in his department described his efforts to develop a career seminar series that would inform early-stage students about career options and help them to develop career-related, professional skills. He stated that the seminar series would:

*...give the new students, a much broader perspective on science. To start thinking about bigger questions, and to help them to be thinking about where they want to go and where they can go. One is to give them the opportunities of what could be available to them, and then thinking about what they have or do not have that they will need to get. And if you're a first year [student], you can be thinking about these.*

He continued to state that some advisors see a conflict of interest in encouraging their students' broad, professional development because they primarily view doctoral students as supporting faculty research needs. He described the beliefs of these "hands-off" advisors and how they can work against students' professional socialization:

*There is a conflict with some faculty views, [that] the students are their employees, to get them into the lab as fast as possible. And that is wrong. That's an employer relationship, you need to do what's best for the student, and that may be to tell them, you should go work somewhere else. So that should be the model, if you are always thinking what's best for the student, then you'll never go wrong.*

In this respect, proactive advisors resembled the “ideal type” advisor identified by DeWilde & Laursen (2008) as well as the exemplary advisors described by Barnes & Austin (2009). Similarly, almost all students in our study with proactive advisors reported that they had specific knowledge of scientific careers beyond academe or industry. In contrast, many students of “hands-off” advisors reported that they had inadequate knowledge of the landscape of career options. Proactive advisors provided alternative, and explicit, pathways to enable their students’ professional socialization, and students benefited from the willingness of their advisors to enhance their professional socialization and career development.

### **Scholarly Significance of the Research**

Lack of career information and exposure may interfere with the professional socialization process and prevent students from acquiring the knowledge and skills they need to select and prepare for an appropriate career. Most doctoral advisors in this study lacked understanding of non-academic careers, yet they differed in whether or how they compensated for this shortcoming. Variability in advising practices gave rise to inequities in students’ professional preparation, as students of “hands-off” advisors reported worse outcomes, and less career awareness, than those of “proactive” advisors. Our findings affirm Antony’s (2002) admonition that doctoral advisors should not be the sole locus of career information and socialization for students.

Our findings have implications regarding the nature of the doctoral student-advisor relationship. Students and advisors must both recognize that advisors may be limited in their ability to provide career information to students. Since this aspect of professional socialization will have to be augmented through other sources, students must be proactive in seeking career information and professional preparation opportunities, and advisors should support students in doing so. Advisors may also wish to enhance their own knowledge about doctoral careers to better understand the broad array of skills required in the doctoral workplace and thus help their students develop these skills. To gain such knowledge, doctoral advisors could attend professional development workshops themselves, peruse job postings, and network with non-academic colleagues and alumni. While faculty are often aware of their own past advisees’ career moves, departments might share information about all alumni to broaden general faculty awareness of possible career paths and of alumni who might assist current students explore non-academic careers.

Additionally, our finding that early-career advisors are more likely to be proactive or supportive of their students’ career socialization raises interesting questions concerning the future of doctoral advising. Is the nature of doctoral advising changing, as novice advisors are more likely to view career advising as part of their role? Or do overly burdened faculty gradually change their orientation toward career advising as they progress in their careers and gain greater departmental responsibilities and more distance from their own graduate experiences? Because this study was not longitudinal, it cannot shed light on these questions but the finding does highlight topics for future investigation.



Yet, our findings affirm that departments also clearly hold some responsibility for students' socialization into professional behaviors, knowledge, and skills, as well as their preparation for future careers. Departments can offer discipline-specific career development opportunities, such as alumni panels, disciplinary communication workshops, and speakers from industry and other non-academic careers. Most importantly, students need to be encouraged to attend these offerings. Many "hands-off" advisors in this study impeded their students' socialization processes by discouraging their participation in such supplemental professional development opportunities. Yet these are the very students most in need of additional pathways of professional socialization. Departmental leadership can work to instill a culture in which career exploration is supported and encouraged.

Institutions also bear responsibility for providing resources, trainings, and information for doctoral students, though these offerings are less likely to be discipline-specific. For example, graduate schools can provide professional development workshops to help students acquire a host of "soft skills" that may not be acquired through their technical training alone. Graduate career centers can offer academic and non-academic career workshops to present students with a range of career possibilities, along with advice for applying and interviewing for these positions. Thus, institutions can fill gaps left by advisors' incomplete knowledge and abilities. Further, institutions can also hold workshops for faculty members to help them improve their doctoral advising practices, including career advising strategies. Faculty development is just as important as student development in the area of career advising.

Employers are the often overlooked part of doctoral students' career socialization. Yet employers hold the most knowledge about specific careers and the desired skills, traits, attitudes, and capacities within these careers. Thus, employers should play a larger role in doctoral students' socialization and preparation. At present, university-industry partnerships can be highly productive and beneficial, yet they are fraught with challenges as higher education infrastructure often does not readily facilitate these collaborations (Malfroy, 2011). For students interested in careers other than academe, the growth in professional doctorates may provide greater access to future employers for students, and may help to establish the infrastructure and support needed to develop and maintain these critical university-industry partnerships.

Improved career development, then, will depend on the actions of graduate students, faculty, departments, institutions, and employers alike. Doctoral students' professional socialization and career preparation must come from a variety of sources, and both students and faculty should view career exploration as a necessary and important part of graduate education. Encouragingly, many early-career faculty in our study did view these responsibilities as central to their advising role. Following the behaviors of the "proactive" advisors in this study, faculty should encourage students to begin the exploratory process early. They can also deploy their networks to assist with career exposure and preparation, not just job acquisition.

## References

- American Association of Universities (AAU) (1998). AAU Committee on Graduate Education: Report and recommendations. Retrieved on 3/9/10 from [www.aau.edu/WorkArea/showcontent.aspx?id=6720](http://www.aau.edu/WorkArea/showcontent.aspx?id=6720)
- American Chemical Society (ACS) (2002). *Graduate education in chemistry. The ACS committee on professional training: Surveys of programs and participants*. American Chemical Society: Washington, D.C.
- American Chemical Society (ACS) (2010). Research brief: U.S. Chemistry Employment and Unemployment: Data, Implications, and Trends. American Chemical Society: Washington, D.C.
- Antony, J. S. (2002). Reexamining doctoral student socialization and professional development: Moving beyond the congruence and assimilation orientation. *Higher Education: Handbook of Theory and Research*, 17, 349–380.
- Austin, A. E. (2002). Preparing the next generation of faculty: Graduate school as socialization to the academic career. *The Journal of Higher Education*, 73(1), 94-122.
- Author (2008). *The Open Education Journal*.
- Author (2011). *Journal of Chemical Education*.
- Barnes, B.J. (2010). The nature of exemplary doctoral advisors' expectations and the ways they may influence doctoral persistence. *Journal of College Student Retention*, 11(3), 323-343.
- Barnes, B.J. & Austin, A.E. (2009). The role of doctoral advisors: A look at advising from the advisor's perspective. *Innovative Higher Education*, 33,297-315.
- Boyle, P. & Boice, B. (1998). Best practices for enculturation: Collegiality, mentoring, and structure. *New Directions for Higher Education*, 101, 87-94.
- Bureau of Labor Statistics (BLS) (2012).
- Caserio, M., Coppola, B.P., Lichter, R.L., Bentley, A.K., Bowman, M.D., Mangham, A.N., Metz, K.M., Pazicni, S., Phillips, M.F. & Seeman, J.I. (2004). Responses to changing needs in U.S. doctoral education. *Journal of Chemical Education*, 81, 1698-1703.
- Ferrer de Valero, Y. (2001). Departmental factors affecting time-to-degree and completion rates of doctoral students at one land-grant institution. *The Journal of Higher Education*, 72(3), 341-367.

- Fontana, A. & Frey, J.H. (2000). The interview: From structured questions to negotiated text. In N.K. Denzin & Y.S. Lincoln, (Eds.), *Handbook of Qualitative Research* (2<sup>nd</sup> ed.), 645-672. Thousand Oaks, CA: Sage Publications.
- Girves, J.E. & Wemmerus, V. (1998). Developing models of graduate student degree progress. *The Journal of Higher Education*, 59(2), 163-189.
- Golde, C. M., Dore, T. M. (2001). *At cross purposes: What the experiences of today's doctoral students reveal about doctoral education*; Report prepared for The Pew Charitable Trusts: Philadelphia, PA.
- Knox, S., Schlosser, L.Z., Pruitt, N.T., & Hill, C.E. (2006). A qualitative examination of graduate advising relationships: The advisor perspective. *The Counseling Psychologist*, 34(4), 489-518.
- Kwiram, A.L. (2006). Time for Reform?. In *Envisioning the Future of Doctoral Education: Preparing Stewards of the Discipline. Carnegie Essays on the Doctorate*. P. 141-166. Golde, C. M., Walker, G. E., (eds). San Francisco: Jossey-Bass.
- Lee, A. (2008). How are doctoral students supervised? Concepts of doctoral research supervision. *Studies in Higher Education*, 33(3), 267-281.
- Lovitts, B.E. (2001). Leaving the ivory tower: The causes and consequences of departure from doctoral study. Lanham, MD: Rowman & Littlefield Publishers.
- Loshbaugh, H.,
- National Research Council (NRC) (2012). Rising to the challenge: U.S. innovation policy for global economy. Washington, D.C.: The National Academies Press.
- Nerad, M., Rudd, E., Morrison, E., & Homer, L. (2006). Confronting common assumptions: designing future-oriented doctoral education. Conference proceedings, *Doctoral Education and the Faculty of the Future*, Cornell University, Ithaca, NY, October 8-9, 2006.
- Nettles, M.T. & Millett, C.M. (2006). Three magic letters: Getting to PhD. Baltimore: The Johns Hopkins University Press.
- Nyquist, J. (2002). The Ph.D.: A tapestry of change for the 21<sup>st</sup> century. *Change*, 34(6), 13-20.
- Nyquist, J.D. & Woodford, B.J. (2000). Re-envisioning the Ph.D.: What concerns do we have?. Paper commissioned by the Pew Charitable Trusts. Retrieved on July 24, 2007 from <http://depts.washington.edu/envision/resources/ConcernsBrief.pdf>

- Paglis, L.L., Green, S.G., & Bauer, T.N. (2006). Does adviser mentoring add value? A longitudinal study of mentoring and doctoral student outcomes. *Research in Higher Education*, 47(4), 451-476.
- Sauermann, H. & Roach, M. (2012). Science PhD career preferences: Levels, changes and advisor encouragement, PLoS ONE, 7(5): 36307. doi:10.1371/journal.pone0036307.
- Schlosser, L.Z., Knox, S., Moskowitz, A.R., & Hill, C.E. (2003). A qualitative examination of graduate advising relationships: The advisee perspective. *Journal of Counseling Psychology*, 50(2), 178-188.
- Smith, S. J., Pedersen-Gallegos, L., Riegle-Crumb, C. (2002). The training, careers, and work of Ph.D. physical scientists: Not simply academic. *Am. J. Physics*, 70, 1081-1092.
- Spradley, J.P. (1980). *Participant observation*. Fort Worth: Harcourt Brace College Publishers.
- Taylor, C. (2006). Heeding the voices of graduate students and postdocs. In *Envisioning the Future of Doctoral Education: Preparing Stewards of the Discipline. Carnegie Essays on the Doctorate*. P. 46-64. Golde, C. M., Walker, G. E., (eds). San Francisco: Jossey-Bass.
- Tenenbaum, H.R., Crosby, F.J., & Gliner, M.D. (2001). Mentoring relationships in graduate school. *Journal of Vocational Behavior*, 59, 326-341.
- Tierney, W.G. & Rhoads, R.A. (1994). Enhancing promotion, tenure and beyond: Faculty socialization as a cultural process. ASHE-ERIC Higher Education Report No. 6. Washington, D.C.P: The George Washington University School of Education and Human Development.
- Van Maanen, J. and Schein, E.H. (1979). Toward a theory of organizational socialization. In B. Staw (ed.), *Research in Organizational Behavior, Vol. 1*. Greenwich, Conn.: JAI Press, pp. 209-269.
- Waldeck, J.H., Orrego, V.O., Plax, T.G., Kearney, P. (1997). Graduate student/faculty mentoring relationships: Who gets mentored, how it happens, and to what end. Paper presented at the annual meeting of the National Communication Association. Nov 19-23, 1997, Chicago, IL.
- Weidman, J., Twale, D., Stein, E. (2001). *Socialization of graduate and professional students in higher education: A perilous passage?* (ASHE-ERIC Higher Education Research Report, Vol. 28(3). San Francisco: Jossey-Bass.
- Wendler, C., Bridgeman, B. Markle, R., Cline, F., Bell, N., McAllister, P. & Kent, J. (2012). *Pathways through graduate school and into careers*. Princeton, NJ: Educational Testing Service.

Wrench, J.S. & Punyanunt, N.M. (2004). Advisee-advisor communication: An exploratory study examining *interpersonal communication variables in the graduate advisor-advisee relationship*. *Communication Quarterly*, 52(3), 224-236.

Zhao, C-M., Golde, C.M., & McCormick, A. (2010). More than a signature: How advisor choice and advisor behaviour affect doctoral student satisfaction. *Journal of Further and Higher Education*, 31(3), 263-281.