Mind the Gap:
The Mismatch between Career Decision-Making Needs and Opportunities for Science Ph.D. Students

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Abstract

Through an interview study of Ph.D. students and faculty in three chemistry departments, we are uncovering processes—both explicit and tacit—by which graduate students develop ideas about their profession and make choices about careers. Of particular interest is a gap between students' career development needs and the opportunities they have. Faculty feel most prepared to offer (some) help in securing a job in a chosen field, while graduate students fail to make such choices because they lack information about careers and cannot assess their fit to various career options. We interpret this gap as a failure of professional socialization by which graduate students would become involved in their future career and mentally invested in it.

Study objectives

Recent calls for reform of graduate education in the sciences recommend that Ph.D. education foster a wider array of skills that prepare graduates to meet 21st-century workforce needs and to adapt professionally to new careers in emerging fields (COSEPUP 1995, 2007; Greene, Hardy & Smith, 1996; Golde & Walker, 2006; AAS, 1997; CPSMA, 2000). Yet these calls often emphasize the importance of skills that recent doctorates say they lack, in areas such as interdisciplinary work, management, and leadership (Golde & Dore, 2001; Nyquist, 2002; Smith, Pedersen-Gallegos & Riegle-Crumb, 2002; Stacy, 2006; Mitchell-Kernan, 2005).

In addition to providing career-relevant skills, graduate school is a time when students form ideas about which career they will pursue and why. These individual decisions can have an important cumulative impact. For example, young women in particular reject careers in academic science and engineering based not on disinterest, but on their perceptions of difficulties in balancing family life against a tenure-track job (Thiry, Laursen & Liston, 2007; Mason & Goulden, 2002; de Welde & Laursen, 2011). These perceptions contribute to low representation of women among faculty ranks, despite women's growing presence among Ph.D. graduates (Handelsman et al., 2005). Thus it is important to understand what information, beliefs and attitudes influence each student's career decisions. Because individual decisions collectively affect the distribution of scientific talent across work sectors, the career exposure and preparation that Ph.D. students receive is critical to the future of their discipline as a whole.

We cast our overarching research question in terms of the professional socialization of scientists in their graduate program:

> *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?*

To study these issues, we chose the discipline of chemistry. Most chemistry Ph.D.s pursue non-academic careers (Golde & Walker, 2006), and chemistry departments have been involved in several national initiatives to improve graduate education (CGS, 2004; Pruitt-Logan, Gaff & Jentoft, 2002; Woodrow Wilson Foundation, 2005; Walker, Golde, Jones, Bueschel & Hutchings, 2008). Thus students' need for socialization into a range of careers should be salient in this field, and a useful example to other disciplines.

Our study takes a two-level approach to the research question. First, we conducted a "mapping" study to understand the broad landscape of career preparation in chemistry graduate education. By examining documents and interviewing department leaders, we learned how departments were preparing Ph.D. students for their future professions. We were particularly interested in whether and how departments were responding to calls for change in graduate education, but we also uncovered other economic and demographic forces driving change (Loshbaugh, Laursen & Thiry, 2011).

Guided by these findings, we pursued in-depth interviews with Ph.D. students and faculty in three departments. These interviews reveal some of the processes—both explicit and tacit—by which science graduate students develop ideas about their profession and use them to select or reject careers. Moreover, by treating each department as a case study for comparison, we hope to uncover the role of cultural values and beliefs in professional preparation, in addition to the skills and knowledge that are more programmatically emphasized. Ultimately, the study seeks to provide an empirical basis that educators can use to enrich professional socialization in all its dimensions.

Conceptual framework

As theoretical underpinning, we draw on the work of Weidman, Twale and Stein (2001) on graduate student socialization, based on Thornton and Nardi's framework for role acquisition (1975). Professional socialization includes development of the knowledge, skills, beliefs, and values that prepare new Ph.D.s to enter the profession (Weidman et al., 2001). Individuals learn the formal policies and rules of their profession, but also the informal expectations and norms that are shared by participants (Schutz, 1970). Thus professional socialization is a "ritualized process that involves the transmission of culture" (Tierney & Rhoads, 1993, p. 21); a two-way, adaptive process by which both individuals and the profession are influenced.

Through socialization processes, science graduate students are enculturated into their disciplines, the values shared by their specific fields and academic work at large, and the broader values of science, all of which influence their persistence, success, and career outcomes. Weidman and

colleagues (2001; Weidman & Stein, 2003) describe three core elements of graduate socialization: acquisition of knowledge and skills, involvement in the professional role as a practicing novice, and investment, which includes commitment to the role, adoption of its expectations, and professional sponsorship. Cognitive elements—knowledge and skills—may be transmitted through formal instruction and are often explicit in departmental goals, while affective and integrative elements are more implicit and transmitted through informal processes such as interpersonal interactions and general climate.

Weidman, Twale and Stein's (2001) socialization framework grows out of several decades of work by these researchers (Weidman, 1979; Stein & Weidman, 1989; Weidman & Stein, 2003) and continues to be used by leading scholars of higher education (e.g. Austin & McDaniels, 2006; Gardner, 2010; Millett & Nettles, 2006). Antony (2003) offers an important critique of socialization theory based on its assumption that, to succeed, an individual must adopt the profession's norms and values—perhaps replacing her own. He argues that compliance with a narrow set of professional norms is not required for socialization to benefit the individual and the profession. While offering the possibility of a middle way in which students may navigate the field without co-opting their own values, this critique does not negate the importance of other elements of socialization, including knowledge and skill acquisition, involvement in the professional role, and professional sponsorship, as influences on a novice professional's preparation, sense of belonging, and success.

Study methods

Our qualitative methods of data collection and analysis are ethnographic, rooted in theoretical work and methodological traditions from sociology, anthropology and social psychology (Berger & Luckman, 1967; Blumer, 1969; Garfinkel, 1967; Mead, 1934; Schutz & Luckman, 1974). Classically, qualitative studies uncover and explore issues that shape informants' thinking and actions, providing information necessary for generating hypotheses to test or survey questions to ask. Ethnographic approaches also highlight interactions and processes, which are foci of this study.

Data sources

The interview data come from 100 interviews with 106 individuals at three campuses: 58 graduate students, 40 faculty, 2 senior administrators, and 6 staff members who worked with graduate students in some capacity. Late-stage (within 1-2 years of graduation) students were interviewed individually so that their individual career aspirations and ideas could be explored, while early-stage graduate students were interviewed in small, same-sex focus groups. Most of the interviews were gathered in person during campus site visits; they lasted 50-70 minutes and were digitally recorded and transcribed verbatim for coding.

Our interview coding scheme incorporated both theoretical considerations and empirical observations from the study sites. It was designed to organize the data to answer our research questions and to confirm or refute several particular hypotheses that we have developed along

the way. Thematic coding captured patterns across interviews, and frequent research team meetings helped to ensure consistency and establish shared understanding of analytical themes. Early and late-stage graduate students, faculty, and staff do not perceive professional socialization, disciplinary enculturation, and career decisions uniformly, so we triangulate their reports to recognize common phenomena as seen from different perspectives.

Results

Graduate students' professional socialization was best developed with respect to the element of knowledge and skills (Weidman et al., 2001). Graduate students recognized their acquisition of disciplinary knowledge and research skills, and could to some extent anticipate how those skills would be useful in a future career. However, many students were ill-informed about the characteristics and expectations of potential work settings. With little understanding of what skills were needed in various jobs, most were unable to self-assess their own fit to various work roles. Consistent with the literature, they tended to emphasize their specific disciplinary and technical knowledge and downplay "soft skills" that research indicates are often lacking.

The onus of career advising fell on faculty. While, understandably, faculty could best give advice about academic career paths like their own (de Welde & Laursen, 2008), most claimed to be open to their advisees' pursuit of a variety of career paths. They offered examples of their career discussions with advisees or helped them pursue non-normative career paths such as patent lawyer or forensic scientist, often by drawing upon their collegial and alumni networks. While not all graduate advisors were personally equipped to help students navigate the range of careers available to doctoral chemists, most were sincerely willing to assist, stating, as several did, that "If a student knows what he wants, I will help him achieve it."

Students, however, did not generally hold well-formed understandings of their career options. Their naïve notions were based on information gathered by hearsay or chance. Academic careers were one exception to this lack of knowledge, as students had observed in some detail the careers and lives of their advisor and other faculty. For some, this confirmed or clarified interest in a faculty career, but others rejected this career path and were left with no well-understood alternatives. This student's lack of awareness of non-academic career options was typical:

> [Career options are] something I'm growing more and more aware of as I go through. So, of course there's academia, you're in that, you see that's a path that's very well set for you, because that's what everybody you're learning from has done…. Beyond that I've kind of picked up a little bit more on industry—there's always this other broad term "industry," right? And well, no one's ever really said what is it—what industry is. Even today I still haven't had anybody sit down and say what "industry" for a chemist is. They just say "It's that other thing that chemists do besides going into academia."

Moreover, the time was never right to explore career options. At first students were busy learning their research field, mastering research skills, and juggling lab work with course work and exams; embarking upon a career was distant to the point of irrelevance. Later on, immersed

in research, they focused on progress toward the degree—and now, investigating career options seemed only to delay the degree itself. This was true even when departments offered opportunities for career exposure. For example, one study site hosted a regular seminar series that portrayed careers for chemists; students who attended reported this seminar to be quite helpful, but a surprising number did not attend.

Thus students often appeared to become stuck at the point of determining what career they wanted, while faculty expected students to make a career choice before they could or would assist. This resulted in a mismatch between where students needed help in career planning, and where faculty felt prepared to be of help. Neither group generally recognized this mismatch, but both expressed some frustration at what appeared to students to be little help offered, and to faculty as little uptake of their offers of help.

In the Weidman et al. (2001) framework, this mismatch signals a failure of socialization in two respects. Chemistry Ph.D. students may develop needed knowledge and skills, but by not actively choosing a career path (as we commonly observed), they have little chance for *involvement* in such work as a practicing novice. They do not learn how their work as academic chemists (as student members of a research group) may be like or unlike that of a research chemist in industry or government, or how their advisor's job in a research university differs from that of, say, faculty in a liberal arts college. They also have little chance for *investment*, or mentally committing to a particular professional role and learning its expectations. Acquiring these elements of socialization is thus largely delayed until their first job—or beyond. Indeed, many interviewees opted for a postdoctoral research position as their first career goal post-Ph.D. Though some pursued a postdoc as an expected step toward the faculty position they sought, others took this default option because they didn't know what else to do—thus further delaying their career decision and the involvement and investment phases.

Scholarly significance of the work

Our data help to explain gaps between graduate preparation and professional skill needs that have been documented by other researchers. Lack of career information and exposure may pose a bottleneck that prevents students from acquiring the professional socialization needed for graceful transition into an appropriate career. But remedies for this mismatch are also within reach. Our findings suggest that improved career socialization will depend on the actions of graduate students, faculty and departments alike. Students must view career exploration as a necessary and important part of their graduate education, and they should be able to rely on support or least permission from their faculty advisors to spend time doing this (Laursen, Thiry & Liston, 2012). Faculty can proactively prod students to begin the career exploration process, and can deploy their networks to assist with career exposure, not just job acquisition. And departments should consider mechanisms such as career seminars and internships that can provide students opportunities to investigate a wide range of career paths. These lessons should apply widely across science and other disciplines.

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