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The Pathway to Loneliness: When Institutional Support Really Matters for STEM Graduate
Students

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Introduction

The Council of Graduate Schools (CGS) underscores the importance improving completion rates for doctoral students as vital to meeting our nation's present and future workforce needs (CGS, 2010). There has been a tremendous focus on increasing the number STEM graduate degrees awarded to domestic students, given its importance to maintaining national economic competitiveness in a globalized economy (Hira, 2010). While most efforts have focused on recruitment of more graduate students into the STEM fields and particularly domestic students from underrepresented groups, of much concern is the low doctoral completion rates, which are consistently estimated to reflect that only 40 to 50% of doctoral students complete the Ph.D (Denecke & Frasier, 2005; Lovitts, 2001; NRC, 1996). Attrition rates vary among disciplines and the CGS's PhD Completion Project found mathematics and the physical sciences to have the highest attrition rates of any field (Gravois, 2007). In order to fully meet national objectives in the sciences, we not only need to recruit graduate students, but also need to create environments that are conducive to engagement, satisfaction, and professional development to be able to retain these students and bolster degree completion rates.

Prior research has examined many areas in attempting to outline the causes of doctoral attrition and have identified factors related to insufficient funding, personal issues, personality factors, motivational factors, family demands, poor advising and mentoring, a lack of department, disciplinary integration, and feelings of isolation (Burnett, 1999; Gardner 2009; Lovitts 2001; Wright and Cochrane, 2000). Inherent to these factors is the issue of student's satisfaction with their doctoral experience. Gurr (2001) found that at least 25% of doctoral students were dissatisfied with the doctoral support they received. A strong link to this

dissatisfaction is the isolating nature of the doctoral process particularly after the completion of coursework. Faculty in doctoral programs have generally held onto the notion that doctoral students should work in isolation (Calvert & Casey, 2004) as the milestones of the qualifying exam, dissertation proposal and defense are venues for the student demonstrate individual competency (Lovitts, 2005) .

This period of time when students become more isolated as they delve into their specific area of research often contributes to the extended length in time towards degree completion (Golde, 2005). Shockingly, an estimated one third of all doctoral students who completed their course requirements fail to complete the dissertation (Maher, Ford, & Thompson, 2004). Given the prior research on influential relationships and their positive impact on doctoral degree completion (Gervis & Wemmerus 1988; Lovitts 2004), we examine the ways in which institutional agents enact direct support for students both inclusively and exclusively throughout their graduate school experience. Utilizing student voices we further establish the doctoral degree journey going from social to isolating, and the remaining peer, lab, post-doc, faculty and advisor relationships that either sustain students, or limit their opportunities for support.

Theoretical Perspectives

Graduate Student Socialization

To better understand the graduate experience we look to Tinto's (1993) framework illuminating the graduate student socialization process. Disciplinary cultures contain academic identities that shape the experiences of graduate students as new initiates (Becher, 1989), who must be socialized into adapting the norms, practices, and habits of interaction that are most valued and recognized (Wortham, 2004) within specific STEM fields. Doctoral programs have specific models for how individuals should act and what it means to be a student or researcher,

(Zhao, Golde, & McCormick, 2007). Effective adaptation to the role of a graduate student and then as a researcher requires doctoral students to negotiate new identities as science experts (Carlone & Johnson, 2007) and re-conceptualize themselves as professionals (Golde, 1998).

Tinto (1993) describes graduate education as a developmental process consisting of three distinct stages of doctoral persistence: transition and adjustment, attaining candidacy, and completing the dissertation. The transition stage consists of the first year of doctoral training during which the student's task is to establish membership in the social and academic communities of the university by developing personal affiliations with other students and faculty within the department. The second stage involves the development of competencies and the acquisition of knowledge necessary for doctoral research and includes the time until comprehensive exams and the attainment of candidacy, where community membership is of secondary importance. Tinto's final stage begins with attainment of candidacy and ends with the defense of the dissertation. He finds that persistence throughout the dissertation process reflects the nature of individual abilities and the specific relationship between student and primary advisor or committee. In the final stage of graduate school, "it is the faculty-mentor relationship that is most likely to shape completion" (Tinto, p. 241).

Tinto's (1993) framework and more recent scholarly pieces (Golde, 2000; Lovitts, 2001, Weidman, et al., 2001) draw attention to the educational communities that shape the experience of doctoral students. Weidman et al. (2001) emphasizes that faculty and mentors have the most influence over the core elements of the socialization process. Students' networks of relationships within the academic community are important mentorship opportunities that can promote persistence and professional success. Most researchers define mentorship as a one-on-one relationship between an experienced, person and a junior, inexperienced person (Allen, Eby,

Poteet, Lentz, & Lima, 2004; Ehrich, Hansford, & Tennent, 2004). Mentorship opportunities within academia can be formal or informal in nature. Mentoring relationships in academia are often developed from intentional and assigned formalized arrangements (Schlosser & Gelso, 2001), such as, an assigned faculty advisor or peer mentorship through a structured formalized cohort model. Informal mentorship is not predetermined or managed but occurs more often as reciprocal, spontaneous, and gradually developed relationships. While these informal partnerships are more conducive opportunities for relationships of mutual understanding, respect, and trust (Johnson & Riley, 2004) with a more interpersonal bond (Mullen, 2005), formally assigned mentorships have the potential to grow and offer the same relational intensity (Johnson, 2007). We approach this study through a lens that acknowledges the benefits of formal and informal relationships among several academic circles, such as those with faculty advisors, department faculty, post-doctoral researchers, lab-mates, upper classmen, and cohort members, which are critical to student's development and socialization as doctoral researchers.

Institutional Agents

Stanton-Salazar's (2010) Institutional Agents Framework is useful for understanding the roles of influential relationships during the doctoral process as it acknowledges the "influence of significant others" in the academic socialization processes. These institutional agents are defined through a social capital perspective. Social capital is a form of capital gained and transmitted through social and personal networks which advantages those who are more attuned to the dominate culture (Bourdieu, 1986; Coleman, 1988; Portes, 1998). The framework defines institutional agents as individuals of "relatively high status, either within a society or in an insitution" (Staton-Salazar, 2010, p. 10). In the context of STEM graduate programs, these high-status individuals can be faculty members, post-doctoral researchers, and/or upper classmen who

have the capacity and commitment to provide institutional resources and opportunities that can impact a student's successful navigation of the educational system. The framework posits that the forms of capital associated with the dominant class (i.e. upper and middle classes) are what is highly valued in society and explicates the ways that students privileged by class, race, and gender achieve success through a support system of agents who act on their behalf (Stanton-Salazar, 2010); therefore, generally have an advantage over their peers with lower levels of social capital (McDonough, 1998). Within these societal and institutional forms of inclusion and exclusion, high-status individuals can perpetuate social inequities by "uncritically adhere to the social structure and stratification system of the institution" (Stanton-Salazar, 2010, p. 12) as "gate-keeper agents" or serve as institutional agents to support students from disadvantaged backgrounds in navigating STEM graduate programs.

Stanton-Salazar (2010) outlines direct support as characterized by an institutional agent's enactment of his or her roles as a resource agent, knowledge agent, advisor, or networking coach. In this context, given their knowledge of the doctoral process, faculty members, post-doctoral researchers, lab-mates, and upper classmen can serve as resource agents in providing personal and institutional resources that facilitate a student's success. They may also work as a knowledge agent and advisor through academic counseling and by informally transmitting knowledge about the educational system and the student's program requirements. Success in navigating the challenging pathway to becoming a STEM researcher, who is recognized in the field, is often dependent on student's ability to network by building relationships with influential people in the scientific community. As networking coaches, institutional agents, can help students learn to network and faculty in particular, can provide opportunities for developing and modeling appropriate networking skills. Institutional agents often enact more than one of these roles

simultaneously, potentially being combinations of knowledge agents, advisors, and networking coaches, resource agents, and advocates all at the same time. When individual relationships involve multiple roles or functions, they are termed “multistranded” (Stanton-Salazar, 2010, p. 14). Considering that doctoral students often have limited opportunities to interact with faculty and other influential individuals after coursework is complete, highlights the need to better understand the value and impact of these interactions as they can promote student completion.

Literature Review

Isolation

Students’ feelings of isolation during the doctoral process have been linked to attrition (Burnett, 1999; Golde, 2005) and is particularly relevant to our examination of the relationships fostered during graduate school as a lack of these supportive networks can contribute to isolation. Burnett (1999) acknowledges feelings of isolation as being among one of the variety of reasons that doctoral students do not complete their degrees. Successful completion of a dissertation requires rigorous collaboration and frequent interaction between students and their dissertation chair (Styles & Radloff, 2001); therefore, infrequent and inadequate advisement can lead to isolation and student’s dissatisfaction with their doctoral programs (Johnson et al., 2000).

Golde’s (2005) elaboration on students’ experiences of isolation from the broader institutional and departmental community and showed that students experience distancing, not only from faculty, but also from the absence of collegial and supportive relationships of peers. This isolation is perpetuated through the programmatic features that characterize doctoral programs during this critical transition from ‘dependence to independence’ (Lovitts, 2005) where student are expected to demonstrate individual competence through independent research and

completion of their dissertation. Golde (2005) elucidates structural isolation as occurring when students were situated in small labs with few peers that were located away from the departmental center or were put in fieldwork settings alone. Additionally, students in small subfields that only had a few students and faculty members restricted their opportunities for social and intellectual support (Golde). The potential negative impact of this isolation highlights the need for a better understanding of the supportive relationships that can engage students more fully in their doctoral experience.

Faculty Advisors as Key Supports

Styles and Radloff (2001) purported that both faculty and students regarded the quality of supervisory interaction as fundamental to the doctoral experience. Numerous functions and benefits of student-faculty mentoring have been documented by scholars who agree that the mentoring relationship between a doctoral student and her or his mentor is an essential and important element in doctoral education (Clark, Harden, & Johnson, 2000; Dixon-Reeves, 2003; Johnson & Nelson, 1999; Schlosser et al., 2003; Tenenbaum, et al., 2001; Walker, Golde, Jones, Bueschel, & Hutchins, 2008). Functions of these student-faculty relationships can be described as either career focused or psychosocial supports (Kram, 1969). Career functions include direct training, advisement, sponsorship, and instruction (Dixon-Reeves, 2003), while psychosocial support encompasses role modeling, acceptance and confirmation (Clark, et al. 2000), emotional support and counseling, and genuine collegiality (Dixon-Reeves, 2003; Johnson & Nelson, 1999). Positive relationships can be characterized by good advisee-advisor rapport (Schlosser & Gelso, 2001), in addition to students feeling supported, respected, and valued by their advisor (Schlosser et al., 2003). Formal faculty advisor roles may simply aim at developing, supporting, guiding and managing doctoral students towards successfully completing their dissertation.

However, the enduring mentoring relationships that may form from these assignments can lead to more influential outcomes. Benefits and outcomes of good faculty- student mentoring include professional skill development (Schlosser, Knx, Moskovitz, & Hill, 2003; Ward, Johnson, & Campbell, 2005), professional confidence (Clark, Harden, & Johnson. 2000), scholarly productivity (Hollingsworth & Fassinger, 2002; Tenenbaum, Crosby, & Gliner, 2001), networking connections (Dixon-Reeves, 2003; Tenenbaum, et al., 2001) and satisfaction with their graduate program and institution (Clark, et al.. 2000; Tenenbaum, et al., 2001; Walker, Golde, Jones, Bueschel, & Hutchins, 2008).

Many doctoral students note the relationship with their dissertation advisor as the "most important aspect" of their doctoral program (Ignash, 2007, p. 217). Luna & Cullen (1998) surveyed 109 graduate students at a large comprehensive university and found that 90% of the students felt that having a mentor was not only important, but considered their relationship with faculty to be the most important determinant of quality in their graduate program. Furthermore, prior research points to degree completion as related to students' overall doctoral satisfaction (Gervis and Wemmerus 1988; Lovitts 2004) and a growing body of research suggests problems or dissatisfaction with one's advisor can contribute to doctoral student attrition (Barnes et al. 2010; Golde 2005; Lovitts 2001; Minor 2003).

Student satisfaction with faculty relationships is particularly important in the sciences considering that Golde's (2005) examination of doctoral students in science departments found that incompatible advising relationships, marked by a lack of interaction, trust, and intellectual support, led to attrition. Zhao, Golde, & McCormick's (2007) findings also indicate that doctoral students in biological sciences were less satisfied with their advising relationships and students in the physical and biological sciences report higher levels of exploitative advisor behavior

relative to their counterparts in the humanities. Advising relationships are critical within the context of science doctoral education as it is generally characterized by the direct link of the faculty advisor as the principal investigator of a central research project where research funding, career sponsorship, and publications are all tied to the advisor with the student's advancement being dependent on the advising relationship to support their development.

Mentoring relationships for underrepresented populations. Mentoring of students of color and women has been a concern expressed in mentoring research (e.g., MacLachlan, 2006; Sax, 2001). Several researchers have noted the importance of college mentors for students of color (Girves, Zepeda, & Gwathmey, 2005; Schultz, Colton, & Colton, 2001) particularly in graduate training (Dixon-Reeves, 2003; Nettles, 1990; Reid & Wilson, 1993). For students of color, research suggests that student-faculty relationships are infrequent do not always forge naturally (Allen, Epps, & Hanniff, 1991; Reid & Wilson, 1993). Many mentor programs seeking to make these connections specifically for underrepresented students because these students generally have less access to critical informal networks (Coppola, 2001; Schultz, Colton, & Colton, 2001), which can impact their ability to navigate the STEM pathways (Gasiewski, Tran, Herrera, Garcia, & Newman, 2010). Therefore, many studies examine mentoring relationships among students of color, through a social capital lens (Smith, 2007).

Beyond access, research suggests that mentoring experiences are different for those in socially privileged groups (Pope-Davis, Stone, & Nelson, 1997; Smith, 2007). While some studies found no significant differences in how student-faculty interaction affects student educational outcomes for minority versus non-minority students (Eimers & Pike, 1997; Eimers, 2001), these studies did not separate racial groupings. In contrast, Lundber and Schreiner (2004) found that there are significant differences in the effects of student-faculty interaction on student

learning gains. African American and American Indian students reported more frequent contact with faculty, yet received fewer benefits from their interaction. Thus, access to faculty mentors is not the only challenge to consider for students of color, but the quality of these interactions and the benefits that they receive from these relationships is also an important.

Difficulties in access mentors has been noted for students of color (Allen, Epps, & Hanniff, 1991; MacLachlan, 2006; Reid & Wilson, 1993), while some research has found no significant gender differences in terms of women finding and maintaining mentoring relations (Clark, Harden, & Johnson, 2000) However in STEM fields specifically, limited access to faculty role models and mentors has been noted in the research both for minority students (MacLachlan, 2006) and women (Sax, 2001). Finding same-race and same-gender mentors may be particularly challenging in STEM fields where the proportional percentage of minority and female is small and the numbers of female faculty and faculty of color is often low. Underrepresented students in STEM may have to look to other networks of support to find the mentorship needed to be successful in these disciplines.

Peers In Science

A number of studies explore the socialization process of graduate students into doctoral programs and then professionally as future scholars, shedding light on the role of peers in the cohort, in the laboratory, and outside the department (Austin, 2002, Weidman et al., 2001). Formal and informal relationships with peers in science can offer various rewards, facilitate socialization and increase retention in graduate programs. However, for students who are underrepresented in graduate education, especially in STEM fields, interaction with peers in science can be negative, hinder integration in to the department or lab group, and ultimately be

one of the key reasons students choose to leave without obtaining a doctoral degree. Despite the importance of peers, few studies examine their role more closely (Mwenda, 2010).

The role of faculty mentors and advisors has been widely explored in graduate education, but little is known about formal peer mentorship relationships in graduate education. In their notable study, Grant-Vallone and Ensher (2000) surveyed mentors and protégés in a formal peer mentorship program pairing new students in a psychology graduate program with advanced students. They found that peer mentors provide proteges with increased levels of psychosocial (e.g. emotional support, socializing) and instrumental support (e.g., advice for working with advisor, information on campus programs). While traditional mentors may provide more instrumental support to proteges, peer mentors provided greater levels of psychosocial support.

Informal peer support is also key to guide new students through their programs. In Gardner's (2007) study examining socialization processes in history and chemistry, she found that peer support was mentioned by students much more often than faculty support. Peers supported each other academically and provided friendship; advanced students were also key sources of knowledge about navigating graduate education. Although the students in these programs were not formally paired up, they still looked to each other as mentors. Students in the chemistry department found advice from advanced students crucial in choosing a lab as they were the most aware of the lab atmosphere and progress on projects.

The importance of peers in doctoral students' socialization was echoed in other studies. Weidman and Stein (2003) found that graduate students' most commonly engaged in scholarly activities were with peers. Graduate students most frequently reported critiquing other students' work and vice versa. While the students in this study did engage academically, most of their interactions were social in nature.

First generation students relied on peers for important knowledge about navigating doctoral programs (Gardner & Holley, 2011). These students recognized that their peers, some who had parents with doctoral degrees, were a wealth of information. Minority doctoral students in STEM reported that peer academic support, such as forming study groups, academic advice and feedback were all important to their success in graduate school (Mwenda, 2010; Williams et al, 2005). Peers also offered minority students social support in the form of social interaction within the program or department, informal mentoring pairing advanced students with new students, and universitywide support programs targeted to minority students. For black women in graduate education, peer support often replaced faculty support. Women of color find few mentors from the same background in their department and they may have to look for non-traditional sources of support outside the academy (Patton & Harper, 2003). Black women cited peer mentoring as an important alternative to mentoring from faculty, but often found these sources of support with students from other departments or institutions. For instance, some students found support from same-race faculty involved in national professional organizations.

For some students relationships and interactions with peers can be negative and present a challenge to advancement and integration in to the graduate environment. In a mixed methods study, Ferreira (2003) studied the role of contextual factors such as social climate on the attrition rate of men and women in biology and chemistry at a research university. The social climate, as defined by peers in the classroom and laboratory as well as advisors and other faculty, play an important role in graduate student success due to the inordinate amount of time spent in the research laboratory. Results showed significant differences in perceptions of social climate between men and women. The women in chemistry, a department without any female faculty, did not feel comfortable asking for assistance from male peers. In addition they discussed

science and socialized with male peers less often. Moreover, in interviews, the women further described the laboratory environment in chemistry as competitive and isolated. For instance, each lab was described as "a little island." Women felt uncomfortable with crude talk and did not feel welcome. Rather than play an important role in socialization, advanced male graduate students ridiculed women and "used their power to limit... access to membership in that community." This competitive and aggressive social climate led most women to leave the program before earning a PhD.

Clearly, research has shown that the aforementioned social relationships are important factors in student success. Based upon student accounts, we interrogate the ways in which institutionally based relationships support students through their educational process.

Methods/Data Source

Participants

Forty-one focus groups were conducted over a five-month time span, from December 2009 to April 2010, with 150 participants from seven universities across the United States: three Hispanic serving institutions (HSI), one historically Black college/university (HBCU), and three predominantly White institutions (PWI). These institutions were selected based on their high rates of STEM degree completion among underrepresented racial minorities (URMs). The sample included 35% African Americans, 21% Whites, 25% Latino/as, 9% Asian Americans, and 5% who marked other; 50% were women. The average age was 27.5 with a range of 21-53 years old. Of the 150 students interviewed, the majority (n=71) were studying some form of chemistry or biology, while nearly one quarter (n=36) were studying engineering. To ensure racial diversity in the sample, we purposefully recruited a majority of the participants through structured programs specifically targeted at supporting URMs in STEM. We utilized purposeful

sampling in order to capture “information-rich cases that elicit an in-depth understanding of a particular phenomenon” (Jones, Torres, & Arminio, 2006, p. 65) and specifically to capture the experiences of URM students who had successfully navigated the scientific pipeline.

Solicitation emails were sent to directors of campus research programs and/or STEM faculty to obtain student contact information. An open invitation for participation was then emailed to these graduate students, who often referred their friends.

Focus Group Interviews

We were primarily interested in how student participants made meaning of their graduate school experiences, thus this study was based upon an interpretive and descriptive design. As such, our understanding of student experiences was mediated through ourselves as instruments of the research (Merriam, 2002), which necessitates continuous reflection upon our own positionality and the impact of our own complex gender, racial, SES, and educational identities on our interactions with students and interpretation of the resultant data.

We employed a semi-structured, in-depth interview technique, as this method of data collection involves a conversation between the interviewer and interviewee that requires both active asking and listening and yields exploratory, descriptive and explanatory data. This means of data collection was utilized for multiple reasons: its usefulness in a pre-arranged setting, the ease with which it allows the interview process to remain issue oriented and focused, and its ability to draw out “thick descriptions” of the lived experiences of participants (Hesse-Biber & Leavy, p. 119). Further, it allows the interviewers to respond “to the situation at hand, to the emerging worldview of the respondent, and to new ideas on the topic” (Merriam, 1998). We chose to conduct these interviews in a group setting, as focus groups offer the distinct advantage of being socially oriented, and this format has been shown to increase participants’

comfort level, while allowing them to reflect on their own ideas as they listen to those expressed by others (Krueger & Casey, 2009; Marshall & Rossman, 1994; Patton, 2002).

Procedure

Prior to the interviews, participants were asked to complete a brief biographical questionnaire, which gathered data on a range of relevant background characteristics (e.g., demographic information, educational attainment, and research experience). Once questionnaires were completed, the moderator explained the purpose of the study, and each interviewer introduced themselves, stating their name, program of study, and the pathway to their current educational status. Following these introductory activities, we began with a “grand tour” question where we asked the students to follow our example and describe the pathway to their current educational position, their year of study and major (Malone & Barabino, 2007). This descriptive question served to establish rapport and ground our later questions. We asked students a series of nine questions, under the headings of Pathways, Identity, Graduate Experience, and Career Planning, allowing student responses to dictate the order in which we asked the questions. These thematic headings were developed in order to cover a wide breath of student experience, while addressing the aims of our research questions.

Analysis

In order to develop the coding architecture utilized in NVivo, each transcript was open coded by examining the raw data and identifying salient themes supported by the text. This constant comparative approach followed an inductive process of narrowing from particular (text segments) to larger themes while using the constant comparative approach, “the researcher attempts to ‘saturate’ the categories—to look for instances that represent the category and to continue looking until the new information does not provide further insight into the category”

(Creswell, 2008, pp. 150-151). Our team of six researchers each read transcripts from two institutions, gathering and comparing themes across focus groups and institutions, while having different researchers reading and re-reading the same data set, enabled analytical triangulation (Patton, 2002). Once we felt that we had reached saturation in generating themes, we developed several iterations of coding schemes, wherein codes were created, expanded, defined, and refined. These categories/themes in the raw data were then labeled as “nodes.” Six researchers thematically coded three randomly-selected sections of text and inter-coder reliability ratings consistently ranged from between 80-85 percent (Miles & Huberman, 1994). Following inter-coder reliability exercises, the coding was re-validated and we were able to add new codes and sub-codes where necessary. Once the coding structure was finalized, we utilized 24 primary nodes, 111 secondary nodes, and 86 tertiary nodes in NVivo 8 to code the data by selecting relevant text segments representing each node, and dragging and dropping these selections into the free node section of the program. The data selected were stored there under the node and the link to the full record was maintained. Once these bins of relevant data were created, we re-read the data repeatedly, in order to ensure data based decision making regarding the significance of findings. Queries were run linking participant attributes with coding references.

The multi-institutional analysis allows for validation of the findings across sites, whereas the multiple focus groups per school allows for cross-validation of findings within institutions.

Limitations

As with any study, there are some limitations that must be considered. Although focus groups enable more authentic discussion, the responses of each participant are not independent and some students may have felt hesitant to share their experiences. We must also acknowledge that the nature of semi-structured interviews privileges the importance of certain topics through

the use of prompts. Further, despite the fact that our sample is relatively large at 150 participants, across seven institutions, the study obviously cannot represent the views and experiences of every STEM graduate student. Finally, as all data are self reported, the possibilities to triangulate are limited.

Findings

Most students in the early stages of their graduate STEM studies describe being elated with the level of collaboration amongst peers and find them to be an excellent source of support and encouragement. However students further along in their program commonly describe a process akin to a ‘pathway to loneliness’, where their first year of graduate school is indeed spent collaborating with their peers in class, studying together, and socializing outside of class, but as they progress into their graduate studies they spend more and more time alone in their labs, working independently on their research. This is a true challenge for students, and many like Alexander and Sarah, expressed an extreme sense of isolation.

I remember when the first year started – because we do all of our course work the first year so we, my classmates, we would spend hours together every single day and on Saturday we would study together for like 12 hours so we got pretty close that first year but then once you get into your thesis lab it’s isolating. It’s almost inherent because we all moved to different labs and different spaces. The only people I really kept in touch with were the ones who were in my lab, which is in another building. That’s in a different ZIP code than everything over here so it’s like the only people I see are the ones in the lab. (Alexander, African American, PWI)

But I do think it’s very isolating, very isolating. You don’t come to grad school for a social life I guess because you don’t really see anybody ever. The first year I think it was pretty social. You did rotation. Kind of went to classes; you hung out. But once you’re in the lab I think it’s you don’t really see people too much unless they’re in your lab. And even if they are in your lab, I pretty much just talk to my bay mate so. (Sarah, Caucasian, PWI)

Indeed, as students enter their second, third, fourth, and fifth years of graduate study, what was once a social and collaborative peer learning environment is no more. It is during this

time that institutional agents become integral to students' success. Recall that an institutional agent is an "individual who occupies one or more hierarchical positions of relatively high status and authority" while "operating in the context of societal and institutional forms of inclusion and exclusion" (Stanton-Salazar, 2010 pp. 10-11). These institutional agents can play multiple roles simultaneously, being resource agents, knowledge agents, advisors, advocate, and networking coaches in different combinations at different times for different students, while operating in inclusive and exclusionary ways. Here Chloe student describes the complexity of this advisor-student relationship:

Well, we have a few different relationships. From a business side as my boss, we had regular one-on-ones. We had meetings as a lab group where somebody had to present on their research every week. There were milestones and lots of feedback. So, in that sense, but he was also a mentor in the sense that like I knew his family. I got to know his family, babysat his daughters, things like that. (African American, PWI)

In this context, Chloe's advisor acted as a knowledge agent by meeting with her one-on-one and in lab, as an advisor by giving her feedback on her research, and also being a resource agent by providing her with the personal resources of support and mentoring. Chloe's advisor inclusively enacted these elements of direct support.

It is these dual concepts of inclusion and exclusion that are key to our findings, as many students describe advisors, faculty members, lab mates, and peers supporting them in ways like Chloe's advisor, while many others site numerous instances of exclusion from the full benefits of direct support because of their racial, gender, SES or national identities. In the following sections we present exemplars of both inclusive and exclusionary practices in terms of institutional agents delivering direct support to students.

Institutional Agents' Inclusive Practices through Direct Support

Advisors as Resource Agents

Many students describe advisors who do more than just help them with course selection, or teach them how to use instruments, but who become their friends. These friendships are not limited to classes or research discussions, but extend into free time, with many students describing “hanging out” with their advisors, going to their houses for dinner or parties, and even babysitting their children. These students note these friendships as critically important to their success in graduate school, as Mason says:

I have a good relationship with my advisor. I think he’s part of the reason like the graduate program has been going well so far. We have a good advisor and student relationship and also as friends. So it’s been good so far. (Latino, HSI)

For other students, their advisors were less like friends and more like parents. These students perceived their advisors as truly caring about their well being and happiness, by making sure they are “doing okay” and expressing parental concern.

It seems like almost like he wants to really get to know us and kind of just be our friend on a certain level. As well as like almost a parenting figure because he just kind of wants to make sure we’re doing okay. So he can definitely tell if something’s wrong. He comes in. ‘I haven’t talked to you for awhile. How are you doing? Like I’m just concerned. I just want to make sure everything is okay.’ And so it’s been really, really great for me. (Amelia, Native American, PWI)

Whether viewing their advisors as friends or parental figures, these students receive important emotional and social support from their advisors. In this way these advisors act as resource agents by acting as a resource themselves and providing this critical element of psychosocial support.

Advisors as Networking Coaches

Outside of these personal relationships and their resultant psychosocial benefits, many advisors may provide entrée into professional networks by utilizing their connections for their students' benefit. These potential opportunities range from post-docs within academia, to industrial connections, to entrepreneurial opportunities.

I think with my advisor it doesn't particularly matter if you tell her you want to do industry or a post-doc, but she kind of wants to know earlier so that when it comes to a point when you're selecting your fourth year, whether or not she can start thinking about why type of industrial connections does she have to try to get you a job or what type of people has she heard that want post-docs that you may be interested in so she can kind of prepare and be ready to make these recommendations or to put your name into somewhere when you want to do it. (Cooper, African American, PWI)

My professor's really supportive you know, he – the guy is a schmoozer, so he knows – you know, he knows every possible person you could ever need to know, and every possible thing you should probably need to do to look at it...And he's also had, like, a spinoff from some of the work we've done in our lab, so he also has some of the small kind of business start up in case, you know, you develop some entrepreneurial interests. So he could help you in trying to navigate that as well. (Sadie, African American, PWI)

These networking opportunities are especially important forms of support in that advisors are not only helping students to develop relationships with potential employers or make connections, but they are also modeling appropriate networking behavior, and teaching their students how to network themselves.

Advisors as Knowledge Agents

In describing their advisors, other students stress the value of being good teachers, as the majority of learning in STEM graduate programs seems to occur outside of the classroom. For these students, advisors are integrally involved in teaching them to be strong researchers. For example, Brianna's advisor is not only interested in his own research projects and bench science, but deeply interested in teaching his students as well.

At first I didn't really know him because he's kind of one of the new faculty. He was the only one I didn't know...But he has turned out to be fantastic just because – well I think he's a great teacher and I also think he's very – it might have something to do with being new, but he's very involved with his projects. So he's very into my thesis and very into my projects and very into my future. (Brianna, Latina, HSI)

For other students, advisors took a less involved approach, instructing their students, then stepping back and letting them work more independently. In these instances, students often described their advisors treating and teaching them more like peers.

We have a good relationship because he has a really good combination of teaching and instruction and giving the students that are independent sort of the same time, so he's – I wouldn't say he's like a micromanager...the rope is loose enough where I can kinda do my own thing and then talk to him when I need help, but when I came into the lab, he wanted to really stress and encourage the idea that at this point in time we were peers, so like I need to talk to him like he's another scientist and he'll talk to me like I'm another scientist. (Ella, African American, PWI)

Through a combination of hands on and more 'loose' approaches many advisors are imparting to their students not only technical research skills, factual knowledge, and interpersonal skills needed to relate to peers in research settings, but also modeling "how to become a scientist".

And I think that when you – when you're able to learn specifically from one person who's like a master in the field for an extended period of time that's such a valuable thing. And they teach you everything. Well, maybe not the technique stuff necessarily. Cause sometimes they've been at the lab for a while and there are other people in the lab who could tell you the techniques. But in terms of like the sort of thought process behind how you design experiments or the rationale behind why you're doing what you're doing. Or even like critically evaluating other people's work. Like that's, they are like your teacher in doing all of that. So I think it's very important. They teach you how to become a scientist. (Joshua, Caucasian, PWI)

Students repeatedly describe the importance of these intangible elements of scientific success, and the ways in which their advisors can and do serve as models.

Beyond providing the aforementioned elements of direct support, advisors also occasionally expose their students to professional development opportunities. When this occurs,

students recognize the rarity, and take advantage of the opportunity immediately. Here MacKenzie, Avery, and Sophia describe the grant writing, conference presentation, and publications that their advisors involved them in.

My PI's fantastic. And he has asked me to participate in all aspects of the science. Meaning going to the meetings, the budget meetings. And I have written grants. I helped him write a grant. And I'm the only one I know in my peer group that has done that. And I think it's invaluable, really invaluable. (MacKenzie, Caucasian, PWI)

He had me go to a conference right away. The second semester I went to a conference and we were there very late during my project. He would have me to my presentation over and over and over until I had it perfect. I felt like he was very proud at the end of my presentation. (Luke, White, HSI)

I think that's pretty important to the faculty members also because they want their grad students' names out there. They want them to be having publications so oftentimes if they'll get invited to write a book chapter they'll have their grad student work on it also and they're usually first or second author, the grad student. And there's not usually too much. Whatever project the grad student is working on it's assumed they're first author. (Sophia, Latina, PWI)

By involving their students in these activities, these advisors imbue their students with a skill set and knowledge base that will help them navigate and interact in the complex realm of research more effectively. In this way these advisors are acting as knowledge agents as STEM professionals need to know how to write grants, make presentations, and publish their work.

Advisors as True Advisors

Enacting a final element of direct support, a rare advisor truly embraces the title and enacts the direct support that should be inherent to the role. These advisors help students assess problems and work collaboratively to find solutions, guide them through effective decision making, and help students make informed decisions.

My new advisor is amazing. He's really great. You don't just have to go up and talk to him about, 'Oh, I'm having trouble writing my thesis,' or, 'My project isn't going well.'

And my advisor will be like, 'Sure. Sit down. Let's talk about it.' So I love my new advisor. (Paige, Caucasian, HSI)

As far as giving feedback, my PI, or major professor, whatever you wanna call him, he has always been really good with that. So what he's done now is he's giving me feedback but it's a different type. It's more like he's coaching me on how to correct a lot of my own mistakes, or how to pick up on a lot of my own mistakes. (David, African American, HBCU)

Most of my interactions are mainly with my advisor. She's very good at letting me know what I should be taking. Ultimately, she left it up to me, which I thought was just great. But she was very encouraging telling me what classes. She really recommended what I think she thought would help me and be a good background. (Lauren, Latina, HSI)

As Paige, David, and Lauren's words illustrate, these individual advisors are providing an essential element of direct support, true advising. They are utilizing their expertise in science, effective teaching strategies, and knowledge of the system to guide students.

Faculty as Knowledge Agents

Beyond advisors, there are other faculty who provide direct support to STEM graduate students, acting as resource agents, knowledge agents, advisors and networking coaches as well. For students like Taylor, faculty members act as knowledge agents by providing direct instruction regarding particular subject matter or tasks.

But now as far as graduate, I think all the faculty is really supportive. Actually my doctoral seminar now teacher he's been very, very helpful in these five, six weeks that I've had that class. I think it's helping me tremendously for my dissertation and just the learning of how different journals work, what kind of requirements they have, how to actually go and try to write a publishable journal article. So it's really, really valuable to have something like that. (Taylor, Caucasian, HSI)

Other students indicate that faculty members are able to provide this element of direct support by simply being available and accessible to students who are not their own advisees. Students highly value the notion of being about to collaborate with a range of faculty members, appreciate faculty members' openness to this collaboration, and the resultant knowledge gained.

And then outside of my own advisors I've emailed a number of other professors in the department and said, 'Hey, I read a paper of yours recently,' or, 'I saw you give a talk recently. I really liked what was going on,' or, 'I have a problem with what was going on, can we talk?' And without fail I had no problem getting meetings with people. They almost all like to take advantage of the idea that if there's a grad student outside of my group that wants to do my work then I'll let him. So they want to cultivate that kind of interest and there really is a very collaborative department. (Jacob, Caucasian, PWI)

Faculty as Advisors

Students also indicate that they receive direct support from faculty members when the faculty member takes the time and initiative to sit down with students, get to know them, and make sure they are progressing along the graduate path, as Joshua explains below.

The grad group chair like sits down with us one on one like pretty regularly. I would say at least every six months. He really wants to know like 'how are you doing?'. Like he wants to make sure that he like knows where everyone's at and like what exactly we're doing and like what our future plans are. And like you can – and it's sort of like a time where you don't have to necessarily like go solicit someone. There is someone like right there who is very interested. I feel like he's really trying to help us get to the next step, whatever that is. (Joshua, Caucasian, PWI)

This faculty member interacting with Joshua has taken an interest in his individual progress through the program and takes the initiative to meet with him. Many other students described similar faculty members taking a keen interest in their progress and overall satisfaction within their graduate programs. Through this discussion, Joshua feels that this faculty member is trying to dialogue with him about any potential programs and invested in helping him to 'get to the next step.' Other students, like Megan, describe advising to be a critical element of faculty members' direct support as well.

I met the director of the joint program and public policy and econ political science and sociology. She's amazing. She's – I was paired with the wrong advisor when I first came here, and on paper we looked great together. He wasn't – he didn't really seem like he'd be – he'd go to battle for me if need be. And there's always a time in the PhD program when someone needs to have that support. Even if you have the best experience you're going to need that. And I kind of told her, like, I don't want to step on his toes. She was, like, 'oh, they paired you up with him? Why'd they do that? No, drop him.

You should go with this person or that person. I'll send them an email to let them know that you're considering. Don't worry about it.' And I was kind of politely – and I was how do I tell him I don't want to work with him anymore, and she helped me craft the email. (Megan, African American, PWI)

This faculty member acted as a true advisor as she acknowledged Megan's problem, guided her through the decision making process, and helped her find potential solutions. While it was rare to find faculty members acting as such effective advisors, there were several instances, like this, where individuals stepped in to fill this role.

Faculty as Networking Coaches

Although students rarely describe other faculty members providing this type of support, other faculty members can act as networking coaches as well. In enacting this element of direct support, they connect students to others within valuable networks.

There are a number of the opportunities the faculty members inform you of. You know. They realize that they're quite limited in some of the services they can provide. But they're also helpful in that they will do some research and let you know, 'oh, this is something you should look into'. Or 'I do know this colleague from this institution, and he or she would be very helpful'. (Julia, African American, HBCU)

In this way faculty members both model networking behavior and help students develop relationships with important people in their fields.

Lab Mates as Resource & Knowledge Agents

Beyond receiving direct support from advisors or other faculty members, most students describe critical elements of support coming from from their lab mates. These individuals are sometimes advanced graduate students and sometimes post-docs. No matter their position, it is clear that the lab serves as a teaching and learning network for graduate students, providing them with important sources of direct support. Students note that some of these tasks, such as

providing feedback on a research paper or teaching new lab group members how to use an instrument might have fallen on the advisor or principal investigator, yet lab mates often filled these roles acting as resource and knowledge agents.

There's also a fair amount of post docs. As far as the dynamic goes, I really like the way our lab interacts. Pretty much everyone can just walk up to the other person and be like, hey, you know explain this biology to me. Or show me how to use this machine or whatever the case may be. That's how a lot of my learning has – as I said, my advisor isn't necessarily holding me under his arm and saying, hey, here's how you use the SEM machine or here's how you confocal microscope. Like it's pretty much all this stuff has been like other grad students you know or post docs pretty much taking me under their wing and saying, okay, this is how you do this. (Austin, African American, PWI)

When I started working in the lab, it was a pretty big lab. So most of my contact...was working with the other graduate students – and that's who I learned from. Going in, I had no research experience. I didn't know how to do anything, so it was a little bit difficult to get into the pace of things. But all the other graduate students understood. They'd been in the same place I was. So they were very understanding and very helpful. So most of my interactions in learning are from other graduate students because that's who you see every day and that's who you work with. (Lauren, Latina, HSI)

Both Austin and Lauren detail the important ways in which lab mates act knowledge agents, providing them with subject matter knowledge, practical research knowledge, and generally teaching them how to navigate research settings.

Yet beyond the teaching and learning occurring in the lab, labmates are also a tremendous source of social support for students, especially considering the amount of time they spend there.

We social outside of lab all the time together. Our significant others are friends with other and socialize with each other. So there's a lot of social support, truly social support. In the lab there's support as well. Everything I've learned I've learned from them. I mean my boss is never in the lab. So all the techniques, how to do science, how to interpret results, that all comes from people in my lab. (Mac Kenzie, Caucasian, PWI)

Most students described similar lab environments, where labs served as true intellectual and social communities.

Peers as Institutional Agents

Many students also describe similar intellectual and social communities existing amongst their peers, but almost exclusively in the early years of graduate school. Most students in their first year of graduate school were elated with the level of collaboration amongst peers and found them to be excellent sources of both knowledge and psychosocial support and encouragement. In this way peers within graduate programs are able to provide elements of direct support to one another, mostly as knowledge agents and/or resource agents.

I think if not for my cohort I would have really gotten through this program. Just – we have this talented 10 because there's 10 of us in our program – the cohort of 10. So we study together. We have groups where we just get together and work on certain classes. We got ready to take our comprehensive exams. We all studied together, shared notes. And so I think it's definitely been a supportive atmosphere amongst my cohort.
(Brooklyn, African American, HBCU)

Students describe peer support like that experienced by Brooklyn, where peers band together, sharing resources and acting as sources of knowledge for one another. Likewise, students often describe the ways in which peers acted as resource agents, providing immeasurable psychosocial support to one another.

Our – each incoming class for now is – they put a really big stress on it of getting to know each other. We're gonna be spending a lot of time with these people for the next couple of years. So my peer support is excellent. I love my incoming class. I know we gelled as a class. The support from kind of the upper years is also really good. There is a lot of opportunity especially in the beginning of the years to – of each year to kind of get to know people from other years which I have found really, really helpful. (Dylan, Caucasian, PWI)

Dylan's description of his relationship with his peers in science is quite representative of most of the student interactions detailed by first year STEM graduate students, as most students talked about this initial seamless peer socialization and integration.

As little is known about the roles institutional agents play in STEM graduate programs, these findings have described those roles most commonly cited by students. We have discussed the ways in which advisors, faculty, and lab peers provide students with various elements of direct support in inclusive ways, and in essence shown how valuable and inherently supportive these institutional agents can be. In the following section we describe the ways in which these same parties exclude students from their direct support and other opportunities based upon racial, gender, SES, or ethnic identities.

Institutional Agents' Exclusionary Practices

Exclusionary Peers

While the majority of the students interviewed describe a seamless peer socialization process and sense of unity amongst their peers, some students experienced instances of exclusion that hampered their integration and interaction with their peer group. These experiences were often based on social identities such as race and gender.

It was just hard to interact, because like he was saying, like the fear of the affirmative action type thing. 'Cause some students actually voiced that opinion, you know. Like, I mean, just blatantly 'oh, maybe, you got in through that' or something. And so, one of my friends who came from Fresno State with me, another Latino student, me and him, kind of like, we always worked together. So me and him relied on each other a lot to transition. When I talked to my friend, who is the only other Hispanic student in the class, I told him like I was really afraid that if we did bad in the class or something, compared to everybody, that we could kind of be like looked down upon. And so, even when I went into my second quarter here, I ended up as a number one student on one of the cumulative exams. For me, it was like satisfying, because the students that were kind of accusatory of that, some of them weren't afraid to say it. – Noah, Latino

In Noah's case, he was blatantly confronted by accusations of being admitted due to race rather than merit and felt pressure to prove he was capable of doing well in his classes. He sought the support of the lone same race peer in order to navigate the transition into an already challenging first year of graduate school. Like Noah, Gianna too felt set apart from her peers, but because of her gender. Like he sought out same race peers, she sought out the other rare woman in her classes in order to "stick together" after being excluded by the men in her class.

Nobody wanted to be my lab partner, and I ended up with this guy who – 'Okay, I guess I'm the only one left.' I think it was 'cause I was a woman because – and every now and then in some of my classes there might be one other woman and then – and I say, 'Well, let's stick together' ...My drafting, I ended up with one other woman in the class. Gianna, Latina, CSUF

Gianna felt that her gender affected perceptions of her ability and thus male peers did not want to be her lab partner unless she was the only option. Her only option for peer support was to pair up with another woman in class if she was fortunate enough to be in a class where she was not the sole female.

Students also feel excluded because of socioeconomic status. Sophia describes her background and lack of monetary resources as a perceived barrier between herself and her peers.

I came from a very low income family so the kind of resources I have available to me and throughout college and even now is very different from that of other people and that's always been very salient to me. It's difficult oftentimes to really share certain experiences because it feels like a large barrier. And so it makes it a little harder to fit in with the other grad students I've met. But I think there are often groups or workshops that you can go to if you feel like you don't have a community but if they are based on Mexican Student Alliance or, you know, they're not usually something based on, you know, 'I came from a low income family.' There's generally overlap but I think those are the features that make me feel like I stand out the most. Not necessarily because I'm Hispanic or anything. It's just the different sorts of resources I had available to me and the kinds of things I reference. Sophia, Latina, UCLA

Low income students, such as Sophia, and first generation students are the minority in graduate education where a number of students have parents who have advanced degrees, or even doctorates (Gardner & Holley, 2007). The barrier between low income or first generation students and more affluent students can prevent the latter from gaining critical knowledge about advancing through the doctoral process. Sophia had to seek support from a different source that she could relate to, the Mexican American Alliance.

Noah, Gianna and Sophia's experiences of exclusion contrast greatly to the seamless peer socialization experience Brooklyn and Dylan described previously. While Brooklyn and Dylan's peers became institutional agents who functioned as study partners and friends, offering psychosocial support, Noah, Gianna and Sophia felt excluded from their peers based on race, gender or socioeconomic status.

Exclusionary Lab Mates

Feelings of exclusion due to race, gender and socioeconomic status extend from peers in the classroom to peers in the lab. While the lab mates described above by Austin and Lauren were resource and knowledge agents, who taught each other how to use instruments, provided useful critiques on research papers and became close friends, Emma and Chase felt excluded from their lab mates or groups due to their gender and citizenship status.

Emma admits to feeling infantilized by her male lab mate when she needs assistance in the lab or with coursework.

There's one guy who – I think – I take it as a cultural thing. He's also been more open with me, like, we've talked a lot. But like everything else, if I go to him with a simple question about class, I'm having trouble getting this one little thing to work, he will sit me down, and he has to explain everything, from beginning to end as if I was a kid. And I don't know if it's just him like it's some sort of a control issue or if he feels like because I'm a female I need to know – explain everything exactly. Emma, Latina, UNM

While Emma's peer did not completely exclude or ridicule her, as reported by the female chemistry students Ferreira's (2003) study, she still felt unsettled in the interaction. This experience could influence her decision to ask help from her lab mate in the future, cutting off her access to a potential knowledge agent.

Chase's international lab group consisted of Korean and Irish cliques. His status as a Latino from the United States set him apart.

So when I joined the group I was the only like American citizen in the group and that was maybe like six or seven people. And there was like a Korean clique and an Irish clique. My advisor came from Ireland, so he kind of brought them over from where he used to teach there. And when he first assigned me to a project he said, 'Okay, why don't you help so and so out with this project?' You know I tried. I emailed them a few times. Tried to set up a meeting. But just I felt kind of excluded from that. Like he didn't really want me to help on it. But you do notice that there's like a, you know a clique of Koreans. They get together and they work on their projects with each other all the time and they collaborate. I kind of feel like, well, I need some help, too man. Then you ask a question and you get like the one line answer. So sometimes you see a little bit of separation within the group like that. At least I've noticed it. Chase, Latino, Michigan

Chase felt excluded when he noticed the differences in the way the Koreans worked together and the way they interacted with him. His lab mates were even unwilling to collaborate on projects are directed by the principal investigator. He laments how he could have used additional assistance from his peers, how he really needed them to act as knowledge agents.

Exclusionary Faculty Members

As noted above, other faculty members share similar roles to advisors, acting as knowledge agents, resource agents, true advisors and networking coaches. However, due to preconceived notions based on social identities, the faculty members described below made students feel excluded. Jasmine's professor showed a great deal of insensitivity about race through her choice of language and racial microaggressions.

Yeah. The interactions – I just feel like people don't get me. I had a teacher call me 'one of you' before. He was like, 'I've never taught one of you before.' And I was like, 'You've never taught a middle student before? Never taught a softball player?' Trying to figure out what he meant by one of you. And he finally came out and said, 'I've never had a black student before.' It was just very, very uncomfortable. But a lot of those, like, little things, they add up and you're like, 'Okay. Is this department exactly where I want to be?' Jasmine, African American, Michigan

Jasmine notes the accumulative nature of experiencing racial microaggressions on her sense of belonging within her department. Taken in sum, they caused her to question whether or not the department was the best place to continue her graduate education due to the negative racial climate. In addition to race based exclusion, other students felt excluded based on gender. Lucy describes how her gender is a disadvantage in a male-dominated department.

And then also being a female, there's also gender dynamics at play sometimes when you have – when you're in a discipline with a majority of male professors and the probability of getting in a social space where you might get a co-authorship or a research project. The opportunity doesn't come up as much as it does with other guys where they're like, 'Hey, let's go get a beer after class.' There's no male professor that's gonna ask me to do that... it's like okay, what other spaces can I be in that would put me at a level of equal footing with other students. So those are things that are actually continuing challenges, but I'm more aware of them and other ways to try to get around them. Lucy, African American, Michigan

She views male faculty as exclusionary and only willing to invite same sex students to socialize in informal settings. Through this, males in her department are offered opportunities that could advance their careers. In contrast, Julia's professors served as effective networking coaches, informing her about opportunities and seeking to connect her with faculty at other institutions.

Exclusionary Advisors

Here we first turn to Carson, an American Indian student who was recruited to his graduate school through a program targeting underrepresented students. He describes a clash with his advisor who would not allow him to participate in recruitment for the very same program that he was recruited through. His advisor clearly does not care how much Carson

values the program, its mission and his own racial identity. Not only does she not care, but she actively tries to impede his educational progress.

My first advisor actually was pretty awful and wouldn't let me engage in extra – we fought about whether I should engage in extra-curricular activities. She wouldn't – I was recruited by a minority recruitment person here, so when I got here the woman said it would be nice if you could help recruit more students. My advisor wouldn't let me, so I told her I can't do that – the recruiter. So the recruiter went to the director of my program and said, 'What's goin' on? Carson's not helping out. We helped him get here.' And then my advisor, we just never worked out and eventually she cut my funding and told someone else to cut my funding. It was a really ugly thing. So then I was without an advisor for about a month...the program just really didn't know what to do with me.
Carson, American Indian, Michigan

This advisor is completely out of touch with Carson as a person, and as a student. She perceives the importance he places on his racial identity to be a distraction from research, and thus excludes him from her continued support.

In another instance of race-based issues problematizing advisor-student relationships, Austin's advisor made him feel that as an African American, he was less capable than his Asian peers by steering him away from classes where other students would ostensibly do better than him. In this way he tries to exclude him from participation in certain classes because of his race.

Regarding race, it's a very subtle undertone. And I've noticed here...I definitely feel as if there's a subtle undertone. I've had to deal with my own advisor telling me not to take courses because I'm gonna be up against Asian people...he was the one I was telling me to maybe stay away from some classes because there's some Asians in there and you know whatever, they might bust up the curve for me or whatever the case may be. I feel as if there's already some kind of, I don't want to say stigma, but there's always that, you know he [a student of color] has to prove himself. Austin, African American, Michigan

The subtlety of the suggestion to avoid courses due to competition from perceived more capable peers is a classic example a racial microaggression. Solórzano (1998) described racial microaggressions as racist behavior carried out indirectly and usually occurring automatically in a

verbal or non-verbal manner. This racial microaggression from Austin's advisor disrupted their student-advisor relationship and lessened the support he received. In turn, it made him feel less-than and with a sense that he had to prove his capabilities and justify his presence in the STEM graduate program.

Carson's and Austin's advisors stand in stark contrast to the supportive and caring advisors described by Amelia, Mason and other students above. Moreover, rather than serve as a networking agent like Sadie and Cooper's advisors, Carson's advisor actively sought to disrupt and block his relationships with other faculty members. Austin's advisor did not fulfill his role as a true advisor by offering direct support and aiding in the decision making process. Instead, he formed an opinion about his capabilities based on his racial identity. It is these types of exclusionary practices that can contribute not only to students' dissatisfaction with their doctoral program experience, but can cause them to leave their program, or science altogether.

Implications/Conclusion

Doctoral attrition is the subject of numerous studies (Burnett, 1999; Gardner 2009; Lovitts 2001; Wright and Cochrane, 2000; Lovitts, 2005;), and thus it has been well established that social isolation is a major contributing factor towards this attrition. Being defined as a "lack of meaningful relationships" (Hortulanus, Machilese, & Meeuwesen, 2006), it is indeed easy to see the graduate degree process as inherently isolating, particularly in STEM, where much time is devoted to bench science research. Students in this study confirmed the isolating nature of this educational journey, describing their programmatic experience moving towards their operating in individual "silos" with their institutionally based socialization revolving around advisors, faculty members, and lab mates. It is precisely because of this isolation that these relationships become so critically important. Thus we investigated students' relationships with each of these types of

institutional agents, examining the ways in which they acted as combinations of resource agents, knowledge agents, true advisors, or networking coaches in providing students with various elements of direct support. Given that graduate students in our sample described these particular relationships as fundamental to their success in working towards degree completion, we also examined the ways in which the enactment of support or lack thereof directly affected students' programmatic experience.

These findings provide both rich examples of the ways in which institutional agents can enact direct support to graduate STEM students, and the ways in which they can exclude them from such support based upon racial, gender, SES, or ethnic identities. Not only do we highlight effective support, but also the role institutional agents play in the reproduction of social inequalities. In this way we nuance the current understanding of what institutionally based social support looks like for this population of students. While we certainly acknowledge the role that outside relationships play in social support, the purpose of this paper was to investigate those relationships that students describe as stemming from and revolving around their graduate program.

This study demonstrates the need for institutions and departments as a whole to assist faculty members in becoming more effective institutional agents for ALL students. When faculty exclude students from their direct support, they are significantly hampering their success. Thus it is critically important that faculty be made aware of the ways in which subtle cues like their choice of language, rationales regarding course selection, or the climate of their labs influence students in such profound ways. In the same way, fellow students and post docs need to be made aware of their exclusionary practices and the impact they have on individual students and institutional culture. Another critical element of creating inclusive environments is

continuing to work to increase the diversity of STEM graduate education, so that the isolation that students already feel as a result of the nature of graduate programs, is not compounded by exclusion based on race, gender, SES, or nationality. By continuing to conduct further research documenting the prevalence of differential treatment based on these student identities, we make the issue more and more salient and difficult to ignore.

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