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# How Do Interaction Experiences Influence Doctoral Students' Academic Pursuits in Biomedical Research?

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Xiaoqing Kong<sup>1</sup>, Devasmita Chakraverty<sup>2</sup>, Donna B. Jeffe<sup>3</sup>,  
Dorothy A. Andriole<sup>3</sup>, Heather D. Wathington<sup>1</sup>,  
and Robert H. Tai<sup>1</sup>

## Abstract

This exploratory qualitative study investigated how doctoral students reported their personal and professional interaction experiences that they believed might facilitate or impede their academic pursuits in biomedical research. We collected 19 in-depth interviews with doctoral students in biomedical research from eight universities, and we based our qualitative analytic approach on the work of Miles and Huberman. The results indicated that among different sources and types of interaction, academic and emotional interactions from family and teachers in various stages essentially affected students' persistence in the biomedical science field. In addition, co-mentorship among peers, departmental environment, and volunteer experiences were other essential factors. This study also found related experiences among women and underrepresented minority students that were important to their academic pursuit.

## Keywords

doctoral students, biomedical research, interaction experiences, socialization, academic pursuit

## Introduction

The purpose of this study is to investigate how doctoral students perceive the influences of their interaction experiences on their academic pursuits in biomedical research. Doctoral student attrition is considered a critical problem for the entire higher education system (Bowen & Rudenstine, 1992; Nettles & Millett, 2006), including the fields of science, technology, engineering, and mathematics (STEM; Lovitts, 2001). Similarly, the attrition problem also applies in the biomedical research field (Guelich, Singer, Castro, & Rosenberg, 2002; Ley & Rosenberg, 2005). Biomedical research is a broad area of science that provides a body of knowledge of how to prevent and treat diseases (National Research Council, 2011). MD (Doctorate of Medicine) and MD-PhD (Doctorate of Medicine and Philosophy) degree holders with primary careers in research, referred to as physician-scientists, are essential members of the biomedical research workforce (Kaushansky, 2003; Varki & Rosenberg, 2002).

So far, many researchers find that socialization is an important factor that may explain the widespread phenomenon that students leave their specializing areas in the middle of study (Gardner, 2008; Golde, 2000). Furthermore, interaction with people, both personal and professional, is a specific and essential component under the socialization umbrella. As a result, it would be beneficial for the medical workforce,

including program directors, policy makers, as well as educational researchers, to study the effect of interaction experiences on students' academic pursuits in biomedical research. Educators in biomedical research can potentially reduce attrition and improve the educational experiences of students by studying the association between their interaction experiences and persistence in the doctoral programs.

## Literature Review

The attrition of doctoral students, especially female and underrepresented minority (URM; including Black, Hispanic, and American Indian/Alaska Native) students from all disciplines has become a major concern in higher education (National Academy of Sciences, 2007; National Science Foundation, 2011). After all, the number of elementary students who are interested in science-related careers is much

<sup>1</sup>University of Virginia, Charlottesville, VA, USA

<sup>2</sup>University of Nebraska, Lincoln, NE, USA

<sup>3</sup>Washington University, St. Louis, MO, USA

## Corresponding Author:

Xiaoqing Kong, CISE Department, Curry School of Education, University of Virginia, 417 Emmet Street South, Charlottesville, VA 22903-2493, USA.

Email: xk4wa@virginia.edu

larger than the number of people who eventually become scientists. Overall, approximately half of doctoral students leave their respective programs during their academic pursuits (Berelson, 1960; Bowen & Rudenstine, 1992; Council of Graduate Schools, 2008; Lovitts, 1996; Nettles & Millett, 2006) before finishing their degree. Furthermore, the doctoral student attrition is a cause of serious concern in the STEM-related fields. According to Lovitts (2001), doctoral student attrition rates in the sciences could range from 23.2% to 50%.

The attrition problem also exists in the medical community. Among all MD-PhD program enrollees nationally who graduated from medical schools between 2000 and 2006, 28.5% of the students left the PhD portion of the MD/PhD program (Andriole, Whelan, & Jeffe, 2008). In addition, female and URM students have even higher attrition rates and are thus still underrepresented in the biomedical research field (Andrews, 2002; Cooper, 2003; Fang, Moy, Colburn, & Hurley, 2000). Doctoral student attrition not only leads to discontinuity of academic pursuits for individual students but also presents a significant financial loss for institutions (Smallwood, 2004).

Consequently, it is important to investigate the factors that may influence doctoral students' decisions to persist in or depart from their respective programs. In the previous studies, researchers summarize the theories of socialization and integration that may elucidate the issue of doctoral student attrition. Socialization refers to "how new skills, belief systems, patterns of action and, occasionally, personal identities are acquired (or not acquired) by people as they move into new social settings" (Van Maanen, 1984, p. 211). A student's experiences throughout the doctoral program (from the very beginning when they apply and get admitted to the program to the end when they graduate from the program) can be considered as a process of socialization. Specifically, socialization for graduate students can be considered as their learning and accommodating process as they get integrated and become a member in an academic community in a particular field (Golde, 1998). The degree of socialization is directly related to whether graduate students decide to stay in or leave their programs (Council of Graduate Schools, 2004).

In addition to socialization, Tinto (1993) utilizes integration to describe the phenomenon of doctoral student attrition. He emphasizes that students' persistence in their academic pursuit, to some extent, can reflect "the degree to which their social and intellectual experiences serve to integrate them into the social and intellectual life of the institution" (Tinto, 1993, p. 50). Furthermore, Tinto (1993) interprets integration in two parallel systems: academic integration and social integration. Academic integration mainly refers to doctoral students' experiences of being exposed to the research world and academic environment, whereas social integration refers to doctoral students' experiences of being situated in informal environments, such as family, friends, and the community (Tinto, 1993). Academic and social integration processes

are always intertwined, since graduate students' social life and work situations are often inseparable (Golde, 2000). According to Golde's (2000) qualitative study, academic integration plays a greater role in the doctoral students' attrition phenomenon than social integration.

In the STEM-related fields, graduate students' interaction experience is a crucial component in socialization and integration theories. Many researchers recognize the important role that the interaction experience plays in the level of persistence in the graduate students' academic pursuits (Lempp, Cochrane, Seabrook, & Rees, 2004; Lott, Gardner, & Powers, 2010; Wilkinson & Harris, 2002). Based on the integration theory discussed above, the interaction experiences can be tentatively interpreted in two parallel perspectives: social interaction experiences and academic interaction experiences. Meanwhile, the two types of interactions also intertwine with each other within graduate students' experiences.

As for social interaction experiences, school-based factors, family, and self are important initiatives that stimulate students' early interest in science (Maltese & Tai, 2010). A qualitative study on African American male students indicates that strong familial influences and encouragement are critical to students' career trajectory in the engineering field (Moore, 2006). Besides, some researchers believe that students' cultural identification, including gender and race/ethnicity, also plays an essential role in their academic pursuits (Gardner, 2008; Lott et al., 2010). Based on a comprehensive review of previous studies, interpersonal barriers (i.e., interaction experiences with other people) are found to be a major challenge for women's participation and persistence in STEM professions (Wyer, 2003). Another review of research literature suggested that more URM students may be attracted to and retained in the STEM pipeline with the improvement of student-mentor interactions and student-student interactions (Tsui, 2007).

In addition to social experiences, many other researchers have investigated doctoral students' experiences in their academic integration. Based on a qualitative study interviewing both doctoral students and faculty members across various disciplines, Gardner (2009) finds that students and faculty members have different opinions about various issues like students' lack of ability or motivation, personal problems, and departmental issues. Furthermore, according to Gardner (2009), peer relationship is much stronger than faculty-student relationship in terms of influencing students' academic pursuits.

Meanwhile, several other studies show that faculty-student interactions are of much importance. Carduner, Padak, and Reynolds (2011) conducted a qualitative study to study the necessity for many undergraduate students to consult to their teachers in terms of their major choices and career pursuits. Another qualitative study interviewing graduating seniors demonstrates that in addition to the coursework and research experiences, the interactions with advisers and professors are critically essential in the STEM-major

**Table 1.** Interview Questions Analyzed in This Study.

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1. When do you first remember actively considering a career in science or medicine?
  2. How did you decide to pursue a [graduate or medical] degree?
  3. What are your experiences with advising or mentoring—from professors or peers—in your program?
  4. What are your interactions with other people in your program and in your field?
  5. What are the supports or preparation you received prior to your program that helped prepare you for your program?
  6. What are the supports or preparation that you did not receive prior to your program, which you feel might have helped prepare you for your graduate program?
  7. Looking back at your own past experiences, were there one or two things that—had they happened differently—might have led you to choose some other educational path that did not involve obtaining a [graduate or medical] degree?
- 

undergraduate students' educational experiences (Thiry, Laursen, & Hunter, 2011). By interviewing three participants who used to be doctoral students in different disciplines but later dropped out, Golde (2000) illustrates two main interpretive themes about the doctoral students' attrition issue—relationships with faculty and student community. Other studies also discuss the important effects from the interactions with advisers, departmental staff, and patients in hospital (Cumming, 2009; Gardner, 2008; Lempp et al., 2004; Moore, 2006; Patton, 2009; Robert, Pomarico, & Nolan, 2011).

However, these studies focus on the doctoral students in general across different disciplines and on all sorts of influences. Only a few studies examine the experiences of doctoral students specializing in the STEM-related fields (Thiry et al., 2011). Moreover, little research has been conducted studying the experiences of doctoral students, especially minority students during their programs in medical schools (Andriole et al., 2008). In addition, there is a paucity of research related to doctoral students' interaction experiences in biomedical research, and the mechanisms by which the interaction influences the academic pursuits of doctoral students, including minority students.

## Research Question

This study seeks to understand the educational experiences of doctoral students, including minority students in biomedical research, and to address key gaps in the literature of doctoral students in medical schools. We are particularly interested in students' experiences of interacting with familial (e.g., parents, siblings, etc.) and professional individuals (e.g., advisers, other professors, etc.), and how these experiences influence the students in their academic pursuits, if at all. Our research question is the following:

What do doctoral students report about the experiences of their interactions with people (familial and professional) that they believe may influence (facilitate or impede) their academic progress in biomedical research?

## Method

The data used in this study were part of a large-scale qualitative project "Transitions in the Education of Minorities

Underrepresented in Research" (TrEMUR). For the overall project, we purposefully sampled potential medical schools and biomedical research centers based on their location, affiliation, and the number of underrepresented minorities enrolled in research. We solicited consent of faculty members, postdoctoral candidates, scientists, nonscientists, and doctoral students to voluntarily participate in the interviews by sending out posters and flyers, and by asking deans of medical schools to send an announcement.

This study specifically focused on doctoral students' personal and professional relationships with their teachers, peers, family members, as well as friends, and how they believed these interaction experiences might influence their academic pursuits in biomedical research. To answer our research question, we analyzed transcripts for the interviews with 19 PhD and MD-PhD students from eight American medical schools who volunteered to participate during the first year of our data collection in 2011. This study served as the exploratory study for further research. We collected data through semistructured in-person or telephone interviews. Typically, each interview lasted for about 45 minutes. Specific interview questions related to the research question in this study are listed in Table 1.

## Data Analysis

Qualitative research is most appropriate for research projects in which understanding the processes that participants undergo within a particular context is important (Maxwell, 2005). In this study, we were interested in examining doctoral students' various experiences during the process of interacting with people around them, and how these reported experiences influence them in their academic pursuits in medicine and biomedical research. Through a qualitative research design, we sought to gain a detailed understanding of the phenomenon of social, personal, and professional interactions (Creswell, 2007). Specifically, we applied the analytic approach created by Miles and Huberman (1994) to analyze our interviews, since it is important to investigate the relationships underlying interaction experiences. In this method, data analysis consisted of three concurrent flows of activity: "data reduction, data display, and conclusion drawing/verification" (Miles & Huberman, 1994, p. 10). We used QSR NVivo 9 (a software package of qualitative data

**Table 2.** Demographics of the 19 Interviewees.

Gender		Race/ethnicity		Degree pursued	
Female	10	Asian	3	PhD	6
Male	9	Black	3	MD-PhD	13
		Hispanic	2		
		White	11		

analysis) to assist us with data analysis, since the approach by Miles and Huberman (1994) is highly appropriate in computer-assisted data analysis.

### Participants

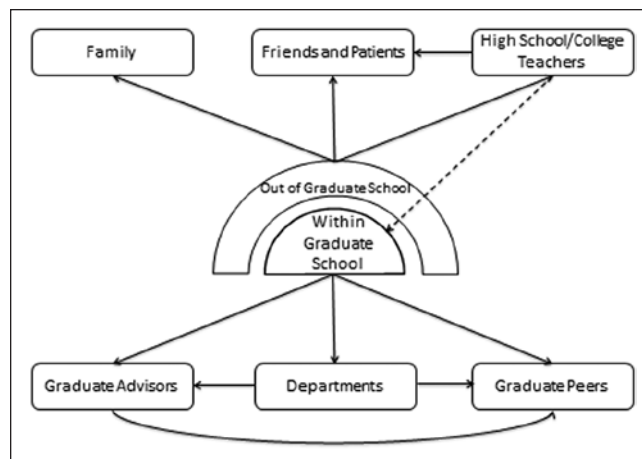
The 19 participants we interviewed were demographically diverse (Table 2). We had an equal distribution of gender and representation from racial/ethnic groups including Asian, Black, White, and Hispanic students. As for the programs, 6 students were enrolled in PhD programs and 13 students were in MD-PhD programs.

## Results and Discussion

### Sources of Interaction

Figure 1 presents six main sources of interaction experiences grouped into two categories—out of graduate school and within graduate school. Three sources of interaction experiences out of graduate school are: family, friends and patients, as well as high school teachers and college professors. The other three sources of interactions mainly take place within graduate school and include graduate advisers, administrative people and other professors in graduate departments, as well as graduate peers.

The dashed arrow from high school/college teachers to within graduate school indicates the potential connection between students' high school/college study life and their experiences when they become graduate students. The high school/college study period, though relatively short, plays an important role in students' selection of majors as well as careers. Additionally, this period is also the essential transition for individuals from consumers of knowledge as students to producers of knowledge in the biomedical science field as potential scientists. Some sources are also interacting with each other. Based on our data, in the out of graduate school category, high school teachers and college professors may influence not only the interviewees but some of their friends, who are also their schoolmates. In the within graduate school category, administrative environment and policy influence both graduate faculty and students in some cases. From another perspective, graduate students are affected directly by their advisers or mentors to some extent.

**Figure 1.** Sources of interaction.

### Types of Interaction

After summarizing the sources of interaction, we wanted to learn about the types of interaction experiences from the identified sources. Based on our data, we generated more specific themes as opposed to the social and academic integration systems described by Tinto (1993). We found that there are five main types of interaction: academic interaction, emotional interaction, environment, specific interaction, and other interactions. Table 3 shows the combination of sources and types of students' interaction experiences.

### Combination of Interaction Sources and Types

To present the data in a simple and clear way, we interpreted our findings by combining the sources of interaction and types of interaction. Matrix coding query was conducted in NVivo with the combination of sources and types of biomedical science students' interaction experiences (Table 3). Columns refer to sources of interaction, whereas rows stand for types of interaction. Each cell represents an intersection between the corresponding sources and types of interaction. Cells with check marks indicate the cases where the corresponding sources and types of interaction experiences occur at the same time. Cells with dashes indicate the cases where corresponding sources and types of interaction experiences do not occur at the same time. For example, the table shows that interviewees report that their academic experiences are mainly influenced by their interactions with teachers, advisers, peers, and family members. Explanations about the combination table are presented below based on the types of interaction.

First of all, according to students' perceptions, their academic experiences which may facilitate or impede their progress through the doctoral programs are mainly from



**Table 3.** Combination of Interaction Types and Sources.

Types of interaction	Sources of interaction					
	Out of graduate school			Within graduate school		
	Family	Friends/patients	High school/ college teachers	Graduate advisers	Graduate departments	Graduate peers
Academic interaction	√	—	√	√	—	√
Emotional interaction	√	—	√	√	—	√
Environment	—	—	—	—	√	—
Specific interaction	—	√	—	—	—	—
Other interaction	√	—	√	—	—	—

Note. Each cell represents each intersection between the corresponding sources and types of interaction. Cells with check marks indicate the cases where the corresponding sources and types of interaction experiences occur at the same time. Cells with dashes indicate the cases where corresponding sources and types of interaction experiences do not occur at the same time.

interacting with teachers, graduate advisers, peers, and their family members. As for the positive experiences, students believed that they received academic support mainly from their family and teachers from high school, college, and graduate school. Nine interviewees reported that they had at least one parent or one sibling who was working in the medicine related fields, which had exposed them to the field early on. Furthermore, some interviewees reported some of their family members as role models that influenced their decisions to enter the field of biomedical research.

Well, my parents are both MD-PhD, so I was always around the hospital or like in the lab when I was growing up. It's just like something that I always knew I wanted to do, or hoped to one day be like them. (Female, Asian, MD-PhD)

I think our relationship is pretty much if she [her sister] can do it then I feel like maybe I can do it too. She, not that I didn't want to do it but when she did stuff it would be like oh so I really can do it, you know it was motivation, it was inspiration. (Female, Black, MD-PhD)

Besides family members, teachers also play a very important role in interviewees' academic life. Based on what the interviewees reported, high school and college teachers have influenced them, since college teachers are present at a critical period when students choose their majors as well as their future careers, offering advice. As a result, for those interviewees whose families have little to do with medicine-related careers, their teachers were the most essential group of people that encouraged them to continue to pursue their study in biomedical research.

She [the teacher] encouraged me and I worked for her for the summer after my sophomore year and then most days after school I would commute to the lab during my junior year. This is in high school. Then I also worked the summer after my junior year at her lab and did some presentations at—they had little fairs for the high school students. Yeah, and then in 2004 she

published a work and put me as a coauthor. (Female, Black, MD-PhD)

However, there are some cases where students reported their interaction experiences that may impede their academic pursuits. The main source of their negative academic interaction experiences was from the within graduate school category. Advisers or mentors in medical graduate schools were supposed to offer help to their graduate students, but this did not apply in some cases. Five interviewees explicitly mentioned that their advisers were not helpful, which was discouraging.

For a while, yes, I think that kind of discouraged me from a research career. I think the people that were in that program felt like we lacked the mentorship support during those six years. I think that was more discouraging. (Male, Hispanic, MD-PhD)

At the same time, students also reported that some negative academic influences were from out of graduate school, among which family was an important source. In some cases, students' family members played an important role in affecting students' perceptions of their educational and career choices. For example, one student's parents did not support their academic pursuit at the beginning because they were not familiar with that field. Paradoxically, another student's mother did not support her academically because she knew the field well and did not want her daughter to follow her footsteps. Below are the quotes from the two extreme examples.

My family wasn't initially that supportive of the research side since they weren't familiar with it. They were concerned that it would derail me from finishing medicine. (Male, Hispanic, MD-PhD)

My mom just didn't even want me to go to med school. . . . If I did MD-PhD she just felt like it was too hard, and she just really wanted me to have like an easy but good life. She was not supportive of me doing MD-PhD. (Female, Asian, MD-PhD)

Second, in most cases interviewees received emotional supports from their family, graduate peers, and teachers from various stages. It should be noticed that different people provide different forms of emotional supports. Family members always encouraged the interviewees verbally and spiritually in our data. In addition, one interviewee reported that he treated his parents as the role model, since they were always ready to help others, and thus he also wanted to be that kind of person. Graduate peers tried to help interviewees with the program study through mentoring. Three interviewees reported their experiences of receiving help from senior students and offering help to junior students, which was a really positive effect for those students. According to interviewees, teachers provided a different type of emotional support which made them feel more confident in their academic study.

The year above me, our school has a support system built into a family system. Where when you start off in medical school, you're given sort of a big brother or a big sister to sort of watch out after you and make sure you're adjusting to medical school in a good way. My big sister is a year above me in the medical school, she has been extremely supportive and she's a good friend of mine now. My little sib, a student beneath me one year, she is also a good friend of mine. (Male, White, MD-PhD)

My PI has always been really supportive and understanding. When I had those panicky moments and I was just like I can't do this anymore, she was just like take a deep breath. It's gonna be fine. So, I guess that's as much support as I got. (Female, White, PhD)

Third, another important influencing aspect of students' continuous pursuit of their study is the environment created by graduate administrators. The environment had both positive and negative impacts on interviewees according to their reports in the interviews. As for the positive experiences, there are 14 cases where the administrators and professors provided a positive environment for graduate students. Some interviewees mentioned that their lab managers, program heads and other professors were very helpful in terms of taking care of logistic problems, answering quick questions, as well as actively talking with students.

Other mentors and people helping out are the head of our program actually. He started up about two years ago and he's actually been tremendously helpful in terms of making sure everything's taken care of and like if I have questions, he's more than happy to talk to me. I also spoke to a couple other MD-PhDs about how their careers have gone and what they think is in store for the future. They've been all pretty helpful. (Male, White, MD-PhD)

Also, other professors. I didn't talk to them. I didn't say that I didn't know what to do directly, but they were talking behind me and some professors contacted me. I'm doing something like this, are you interested? It was really helpful for me. That's how

biology department is, friendly to students. (Female, Asian, PhD)

As for the negative part, some interviewees talked about the departmental politics or hierarchical issue in the graduate program. As the students perceived, these issues were not related to academic perspective at all and certainly lead to problems or difficulties, such as delay of dissertation and graduation.

So I think that for me kind of the—and the reason for me for my PhD being long is not really anything. It was all like committee politics and wrestling with my adviser. It wasn't science. It wasn't productivity. It was all kind of more political and people issues. (Male, Black, MD-PhD)

In some circumstances, they [some students in my program] are in a situation where the PI basically only wants their ideas pursued. Many times, there are clear strong arguments against those ideas, and they're much better experiment to do, and yet the experiments suggested by the PI are done simply because of the hierarchical nature of the situation. (Male, Hispanic, MD-PhD)

Fourth, many interviewees found that their previous interaction experiences led them to the biomedical research study. Here the "interaction" refers to a narrow meaning of interaction—communicating together. Five interviewees mentioned that their volunteer experience provided them a chance to interact with patients, which made them interested in studying biomedical science. We may infer that such volunteer programs were very helpful so as to attract students into biomedical research.

I mean there are a lot of things that could have happened differently. One of my friends was pretty instrumental in me actually pursuing medicine. I hadn't given it too much thought until he mentioned it; suggested I volunteer at that clinic. Yes, I think it's likely if I hadn't chosen to volunteer at that clinic, there is a lesser likelihood I would have pursued the medical route. (Male, White, MD-PhD)

When it comes to the interactions with graduate peers, some of the interviewees stated that they did not have many opportunities to interact with their peers. One reason was that in some cases, each student was doing their own research study. Another reason was that students were not at the same stage or did not share the same experience according to several interviewees. In other words, graduate students sometimes may feel they are on an island themselves, doing their own research projects.

Well, when I first—well, they actually do try to get the people to meet together, but it's difficult because people are at different stages and so it ends up being, I don't know, quite isolated most of the time. (Female, Black, MD-PhD)

Fifth, sometimes a special incident around the interviewees may change their academic life. There are some incidents that make interviewees give up their original study fields. An interviewee talked about experiences that her college advisers for some reasons left the university at that time, which brought a huge problem for her. She could not find an appropriate adviser later on and thus had to change her study areas in the end.

Compared with the special incidents illustrated above, gender and race/ethnicity may be a special long-term cultural issue for some students which may be considered as challenges during their academic pursuits. Based on the data, four interviewees talked about the phenomenon that female students in medical schools had to consider having a child during their study especially under the pressure from parents, which might either postpone their progress or even make them leave medical schools. Another female interviewee mentioned that she wished she had had the opportunity to talk to female peers or mentors who might have a different perspective from male people. As for the issue of race/ethnicity, two interviewees reported that minority students did not receive enough support from their advisers, programs, and medical schools, which caused difficulty of their academic pursuit in medical schools.

## Conclusion

Through interviewing 19 doctoral students in MD and MD-PhD programs in biomedical research, we examined their interaction experiences that they believed might facilitate or impede their progress through the doctoral research programs. We conducted exploratory qualitative analysis (Miles & Huberman, 1994) and found many results.

Family interaction is one of the main sources of interaction experiences that students believe may influence their academic pursuit in the biomedical research field. Parental medicine related careers and emotional encouragement are essential positive experiences for the interviewees to further biomedical research study. Previous research studies suggest that parental influence is important to students' academic pursuits especially until undergraduate study (Sax, 2001; Sharp, Caldwell, Graham, & Ridenour, 2006). The results in this study not only confirm previous findings but also indicate that parents may have even further influence on the students' academic pursuits in the long term.

Another essential finding in this study is that students realize the significance of the mentorship from high school teachers, university professors, and graduate advisers, as well as graduate peers. This result builds on previous studies where researchers only focus on the graduate adviser-student relationships (Cumming, 2009; Golde, 2000). Based on our data, the interactions between students and their high school teachers as well as college professors also play an important role in affecting students' future study. As a result, it is recommended that researchers and administrators pay attention

to students' early lab experiences with their high school and university teachers. Furthermore, co-mentorship between students is another important form of mentoring activity to maintain students staying in the program. Our results indicate that student training scientists obtain much help from their peers in graduate schools, which is an essential factor of facilitating their continuous study in biomedical research programs. Therefore, future research may focus on how to help develop and improve peer relationships in graduate schools so as to build a comfortable research community for students.

Environment and specific interaction also influence biomedical graduate students' academic life in the biomedical science both positively and negatively. The graduate program administrators are responsible for providing students with a purely academic environment. Meanwhile, they should also try to mitigate the effect of politics and hierarchical aspects which may distract students from their research study. This point is also emphasized in another qualitative study where the researcher demonstrates that the departmental politics negatively influence the graduate students who left (Gardner, 2009). Our analyses also show that changing advisers may bring a hard time to students, or even drive students to leave their original study fields. As a result, departments are suggested to arrange their advisees well in such situations so that their advisees are minimally affected. Besides, our results also indicate that volunteering experiences are really helpful and effective in terms of attracting students to studying biomedical science, which sets a good example of the experiential education supported by Thiry et al. (2011). Researchers in future studies may be interested in studying hospital volunteer programs and how these programs might attract participants to the biomedical research fields.

In addition, our preliminary findings indicated some problems faced by female and underrepresented minority group students in biomedical research. During the long period of study in biomedical research, female students have to consider decisions of starting and raising a family. Such an issue might be one important reason that would explain the high attrition rates among female students. The interview data in this study also showed that female students would benefit if they have more opportunities to interact with female mentors or peers, which provides evidence of the previous finding that larger proportion of female faculty members could attract more female students in the STEM-related fields (Carell, Page, & West, 2010). In terms of the racial/ethnic minority students, this study suggested that some medical schools, programs, and advisers were not quite supportive to these groups of students, though there is some evidence presenting support to minority students in some medical schools (Odom, Roberts, Johnson, & Cooper, 2007). Therefore, policy makers and medical school administrators are suggested to reinforce the supportive system for minority students within more medical schools.



It is widely realized that the attrition of graduate students is a major problem in higher education. In this study, we explore PhD and MD-PhD students' interaction experiences with people that they believe may facilitate or impede their progress through the programs from the socialization perspective. Results show that family and graduate adviser influences are two important factors of students' continuous study in biomedical research. There are also other essential factors that influence biomedical students' stay in their academic fields. The mentoring experiences from high school and university teachers, as well as graduate peers play a crucial role in affecting students' academic pursuits. Besides, departmental environment and volunteer experiences with patients in hospital are also important to students' further study and research in the biomedical science fields. Meanwhile, medical schools including program heads and faculty advisers still need to improve and enlarge the supportive system for female and racial/ethnic minority group students so as to attract and retain a more diverse biomedical research workforce.

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### Author Biographies

**Xiaoqing Kong** (MEd) is a PhD candidate in the Curry School of Education at the University of Virginia. She is interested in application of quantitative and qualitative methodologies to educational research, especially factors associated with students' engagement and persistence in the science related disciplines.

**Devasmita Chakraverty** (PhD) is a postdoctoral research associate in the Department of Chemistry at the University of Nebraska-Lincoln (UNL). She is interested in studying the STEM workforce development and in addressing the issue of attrition and pipeline leakage.

**Donna B. Jeffe** (PhD) is research professor of medicine in the Department of Medicine at Washington University School of Medicine. She studies social support, personal/psychological, and situational factors in relation to health-risk/health-promoting behaviors and emotional adjustment to disease.

**Dorothy A. Andriole** (MD) is assistant dean for medical education and associate professor of surgery, Washington University School of Medicine.

**Heather D. Wathington** (PhD) is assistant professor in the Curry School of Education at the University of Virginia. Her research interest is in issues of access, equity, and diversity in higher education.

**Robert H. Tai** (EdD) is associate professor in the Curry School of Education at the University of Virginia. His work focuses on scientific workforce development from an educational perspective.