Advancing Women in Leadership Online Journal
Volume 20, Spring 2006

GRADUATE STUDENTS' DESCRIPTION OF THE IDEAL SCIENCE ADVISOR: IMPLICATIONS FOR GRADUATE WOMEN'S SUCCESS

Dr. Maria M. Ferreira

Abstract

Research indicates that doctoral students' relationship with their advisor is the most important factor in the degree progress, and often the main reason for student attrition. In this study interviews with graduate students in two science departments, biology and chemistry, at a large research university were used to explore their concept of the "ideal" science research advisor and the extent to which their present advisor fits this ideal. Students' descriptions of the ideal research advisor included many of the traits that characterize the advisor as a mentor. However, student responses also indicated that most of their advisors deviated considerably from students' descriptions of the "ideal." This perception was particularly common among the female students in chemistry.

Introduction

According to Tinto (1993) the graduate education process progresses in three stages, (1) transition to the program, (2) acquisition of skills, and (3) the conduction of research. Student persistence in the third stage is primarily the result of the student relationship with the advisor (Girves & Wemmerus, 1988; Hollenshead, Younce, & Wenzel, 1994; Tinto, 1993). Studies show that students' satisfaction with their doctoral program is directly related to satisfaction with advisement relationships (Bargar & Mayo-Chamberlain, 1983; Davis,

1999; Golde, 1996, 1998; Hollenshead et al. 1994; Office of Scientific and Engineering Personnel, 1996). The quality of the interpersonal relationship between graduate students and their advisor has been found to be a better predictor of success in a doctoral program than a student's GRE scores and undergraduate grade point average (OSEP, 1996; Sorenson & Kagan, 1967). Regrettably, the advisor-advisee relationship is often perceived as the most disappointing aspect of many students' experiences in graduate school (Curtin, Blake, & Cassagnau, 1997; Ferreira, 1997; Golde, 1998; OSEP, 1996).

Female students who join graduate science programs with few or no female faculty members, who can serve as role models, are particularly vulnerable and depend on their advisor for successful integration into the existing departmental culture (Bizzari, 1995; Davis, 1999; Lovitts, 1996). These students are at a greater risk of leaving a promising career in science when their advisor shows little interest in their success. Subotnik and Arnold (1995) point out that women, in particular, who may question their ability to succeed, do best in colleges and universities that offer responsive advisors. According to Widnall (1988), "the advisor is the primary gatekeeper for the professional self-esteem of the student" (p. 1743).

The graduate advisor performs a minimum of five essential roles: 1) a reliable information source, 2) a departmental socializer, 3) an occupational socializer, 4) a role model, and 5) an advocate for the advisee (Golde, 1998; Lovitts, 1996; Winston, Miller, Ender, & Grites, 1984).

Mentoring

Researchers define mentoring as an intentional process in which a more skilled person (the mentor) serves as a role model and provides information, support, and guidance, to a less skilled or less experienced member of the organization (the protégé) (Anderson & Shannon, 1988; Campbell & Campbell, 1997; Romberg, 1993). Although most definitions of mentoring portray the protégé as the main beneficiary in the relationship, others contend that both mentor and protégé benefit from a mentoring relationship. While the protégé benefits from the mentor's knowledge and experience, the mentor, in turn, benefits from the satisfaction of making a positive impact on another person and often receives admiration, respect, and gratitude from the protégé (Fagenson, 1994; Hall & Sandler, 1983; Healy & Welchert, 1990).

According to Brown and others (1989), the mentoring process involves three stages: "modeling," "coaching," and "fading." The mentor "models" by revealing his/her problem-solving strategies; "coaches," by supporting the students' attempts to perform new tasks; and "fades" after having empowered the student to work independently.

Ideally, advisors become true mentors to their students. Students who have a mentoring relationship with their advisor feel professionally affirmed and are more productive after graduation. Research indicates that successful scientists often had, at some stage of their career, supporting and influential mentors (Davis, 1999; Subotnik & Arnold, 1995).However, for a mentoring relationship to develop, advisors of incoming graduate students must take the initiative in establishing sound interpersonal communication with their advisees that is grounded on trust, openness, and mutual willingness to grow (Bargar & Mayo-Chamberlin, 1983; Luebs, Fredrickson, Hyon & Samraj, 1998).

Heinrich (1991) contends that advisors who have a mentoring relationship with their students use an "androgynous" approach and are "gender-sensitive." These advisors tailor their mentoring to the needs of their individual students by using a combination of masculine and feminine principles. They combine "task- and goal-oriented" approaches while attending to the interpersonal dimension of the relationship with their advisees, and take on "father-daughter/son" and "colleague-colleague" roles with their advisees (Heinrich, 1991). In contrast, to the "androgynous" and "gender-sensitive" approach, some advisors use a "traditionally masculine" or "traditionally feminine" approach. Advisors who use a traditionally masculine approach to advisement are task-oriented and handle conflict with their advisees through direct confrontation, while

those who use a traditionally feminine approach to advisement overly emphasize the interpersonal dimension and try to avoid conflict with their women advisees (Heinrich, 1991).

Although the research points to the important role that the advisor plays in graduate student success, little is known about the qualities that students wish their advisors to emulate. This information is particularly important in scientific fields where the student/advisor relationship is often analogous to that of an employer/employee. Unlike the humanities where the majority of doctoral students conduct research independently from their advisor, in most science areas incoming graduate students frequently become part of large research groups and work in research projects financed by grants secured by their advisor. Thus, the Ph.D. thesis in science is primarily an apprenticeship in research and students' success depends primarily on their relationship with the advisor (Widnall, 1988).

In this study graduate students in two science departments (biology and chemistry) at a large research university were asked to describe an ideal research advisor and the extent to which their present advisor matched this ideal. Students' perspectives, often missing in the research, are an important contribution to the existing literature on academic advising and on the under-representation of women in science.

Method

Setting

The study took place in two graduate science departments, biology and chemistry, at a large research university in the midwest. The biology department offered doctoral and Master's degrees in seven areas of biology from molecular biology to ecology. The department had 177 graduate students, 43 percent female. Of the 48 tenure-track faculty members nine were women at various rank levels (2 of assistant, 5 of associate and 2 of full professor). The chemistry department offered only Ph.Ds in all of the major subdisciplines of chemistry, from biochemistry to physical chemistry. However, students who decided to leave before completing their Ph.D. were given a Master's Degree if their work was deemed of sufficient quality. The student's advisor controlled this decision, solely. The chemistry department had 34 faculty members, all male, 74 percent of them at the rank of full professor. Of the 186 graduate students in the chemistry department 30 percent were female.

In both departments the doctoral program was primarily based on research. Incoming graduate students were funded for a period of five years in the form of teaching and/or research fellowships. Most students taught the first year and received research assistantships when they joined a research lab.

Participants

The primary participants in this study were 32 doctoral students, 16 from biology and 16 from chemistry. The participants were selected using a short survey returned by 170 students from both departments. Student responses to the survey were used to insure a "representative sample" (LeCompte & Preissle, 1993) in regards to gender, department, and students' perception of the level of mentoring in their program.

Data Collection and Analysis

Data were collected primarily through semi-structured interviews with 32 graduate students (16 female and 16 male), and a short 5-point Likert-type scale survey questionnaire returned by 170 students (86 from

biology and 84 from chemistry). In addition to demographic items (gender, age, ethnicity, marital status), the survey included a statement addressing students' perception of the level of mentoring in their department and asked students to report the weekly number of hours they spent conducting research in the lab and/or in the field. Department records were used to determine student and faculty composition of each department, student graduate and undergraduate GPAs, and the student attrition rate in each department over a nine-year period.

Interviews. According to Bogdan & Biklen (1992), interviews allow the researcher to "consider experiences from the informants' perspectives" (p. 32). In this study semi-structured interviews were used to assess students' perspectives on the attributes of the "ideal" science research advisor and on the extent to which the students' present advisor reflected this ideal. The interviews were audiotaped and took between 30 and 45 minutes. The transcripts of the students' answers to the interview questions were analyzed using the techniques of naturalistic inquiry (Lincoln & Guba, 1985; Miles & Huberman, 1994). After the interview tapes were transcribed verbatim, a text-based coding was used (Miles & Huberman, 1994). As each transcript was read several times, one- or two-word codes were attached to each segment of the data. After all transcripts were coded in this manner, similar codes were grouped together and organized into broader themes. The accuracy of the themes was accomplished through "member checking" and a peer reviewer (Lincoln & Guba, 1985).

Results

All students interviewed for this study were asked to describe their "ideal" science research advisor and to comment on the extent to which their present research advisor matched this ideal. The results are presented in two major sections. The first section provides a thematic characterization of the ideal science research advisor based on students' descriptions whereas the second provides students' comments on the extent to which these characteristics were expressed in their present research advisor.

Characteristics of the Ideal Science Research Advisor

The students in this study described their ideal advisor at two levels: personal and professional. These two broad themes are further broken down into sub themes.

The ideal advisor is personable. Even though students recognized their advisor's main role was related to their scientific work, they also wished their advisors related to them outside the realm of the discipline. As a male student from biology pointed out, "If you work with someone for five years in the same room and they are never willing to talk about anything except the details of science, that's emotionally not a very welcoming environment." According to this student,

One of the things I value a lot is a certain degree of candor and casualness in the relationship. My boss likes to talk about politics, about culture, and other topics. I consider him my friend as well as my scientific advisor. We have a relaxed relationship yet tense in the sense that in the back of our minds we are both focused on science. But he feels he can break out from his role as scientific mentor from time to time, and I really appreciate that.

While the previous passage illustrates a "colleague-colleague" sort of relationship between the advisor and his student, the next quote from another male student in biology, portrays another type of relationship -- "parent/child:"

First the ideal advisor is a professor who genuinely cares about the students. It's almost like a father and son or mother and daughter type of relationship. He has to have the basic skills of the field, but if he is not interested in the students, then the skills are lost; they won't be transferred. He has to have that feeling for

them.

The ideal advisor is a "guide on the side." **On the professional level, the ideal advisor gives his/her students the proper combination of guidance and autonomy. Students needed guidance to help them make progress in their research, but sufficient autonomy to test their creative ideas. Guidance was particularly important during the students' first two years in graduate school as reflected in the comments from a female student in biology:**

An ideal advisor is able to direct while allowing for the students to contribute their individual approaches. When you bounce off some ideas as you're developing your research, the advisor helps direct your research but is not in control of it. The ideal advisor is someone who is willing to allow a lot of individualism on the part of the student.

A male student from chemistry expressed a similar perspective:

An ideal advisor should be supportive of your goal, and try to find some balance between telling you what to do, and letting you sort of run your own research project. I wouldn't want an advisor who is completely hands-off, but I also wouldn't want someone who just came in and told me what to do every day.

The ideal advisor provides quality feedback. According to the students, providing meaningful feedback is an important aspect of the communication skills of an ideal research advisor. Although making mistakes may be a useful aspect of the learning process for incoming graduate students, they can also be costly by robbing precious time needed for productive research. A female student from the same department stressed the importance of such communication in the following manner:

An ideal research advisor communicates well with his students. He does not necessarily have to do hands-on work with them in the lab, but is in frequent communication with them -- on the progress of their work and on their standing with him. I can't emphasize how important the communication aspect is.

A male student from chemistry used an example from his department to illustrate the importance of the advisor's feedback:

An advisor who was on my committee tended to let people flounder and continuously make mistakes. When his students made mistakes his attitude was like, "Wrong, try again." In my opinion an advisor like that is of no value at all because if you are just going through the process on your own, what is the point of being in graduate school?

The ideal advisor is empathetic. The ability to show empathy and provide encouragement to his/her students is another important attribute of the ideal research advisor. Although students recognized the importance of having their mistakes addressed, they also believed such acts should be followed by words of encouragement. The following statement from a female student in biology captures well the importance that encouragement plays in a student's perseverance necessary to succeed in graduate science:

My ideal research advisor or mentor would be somebody who is very positive because research can be very frustrating. And if you have somebody who is constantly on you saying, "When is this going to be done?" or "Why didn't that work?" You're going to come down harder on yourself. You have to have somebody who says, "Keep trying, it'll work. Keep going," and help you move in the right direction.

Encouragement and support were especially important to students who did not intend to pursue a career in academia. Even though they enjoyed science, their professional goals were related to careers in industry or teaching in a four-year college. They needed their advisors' affirmation and support of their goals. In the words of a female student in chemistry, the ideal advisor "is supportive of whatever you decide to do in the future, which is kind of hard to find if you are not planning to go straight into academia."

The ideal advisor has good managerial skills. According to students, good managerial skills are particularly important in science where students work in research groups managed by their advisor. Indeed, some of the research labs in this study comprised as many as 25 graduate students and a few post-doctoral fellows. Running such a lab required comparable managerial skills to those akin to managing a small firm. As the main authority, the advisor's managerial style set the tone for the work environment in the research lab. According to a female student from biology,

An ideal advisor is somebody who has good managerial skills, somebody who can manage all the people that work under him or her and can handle confrontation really well. Students have different personalities and will do things in different ways. It may get a little crazy sometimes and can get some people frustrated. A good advisor sets some basic rules in the lab for everyone to follow.

The "ideal." The characterization of the ideal advisor from a female student in biology reflects all the major attributes that students believed an ideal advisor would emulate:

The ideal advisor is someone who rather than trying to dominate a student, provides the student with a language and a framework that allows the student to follow the interests that s/he has already instinctively chosen; is someone who is critical in the positive sense of the word; is someone who is engaged in your work at an intellectual level regardless of how far removed it may seem to his/her own interests; is someone who wants you to succeed and recognizes that your success is an extension of his/her success, and, is someone who is flexible and comfortable with the different rates at which different students make progress; it's someone who appreciates that graduate school is tough and is sensitive to the fact that we all make a lot of personal sacrifices to be here.

Discrepancy Between Reality and the Ideal

When asked the extent to which their present advisor matched their ideal, students' responses ranged from "very close" to "not at all. However, only one student, a male from chemistry characterized his advisor as the ideal:

My advisor is excellent. He isn't overbearing and never makes you stay in the lab for hours on end. He doesn't push people; he wants people to push themselves. He trusts us and respects our ideas. You con go to him any time and talk about things. He tries to teach us more than chemistry. He teaches us how to write and how to work the ropes. I respect him and liked him a lot. In my mind my advisor is the ideal.

When the interviewer asked, "would you consider him a mentor?" The same student replied, "Certainly!"

The advisor as "boss." Although most students spoke kindly about their advisors, rarely did they use the term "mentor" when referring to them. Indeed, the great majority of them referred to their advisors as "boss." A male student from biology provided the following explanation for the use of this term:

In most science fields, when students join a graduate program (especially Ph.D.) their research advisor gives them a project. I think they rarely understand why they're doing this project and even less frequently have any real input into what they're going to do. It's sort of a bargain. They give you a project to do because they need to get this research done for their own purposes, you do this research for three or four years and get a Ph.D., while the advisor will gets a number of papers published to help him get more grant money for another research project.

Although this symbiotic relationship benefited both parties -- basic financial support for the student and cheap labor for the advisor -- it limited students' input in most aspects of their own training. Furthermore, efficient use of resources and fast results often became a priority and instead of the "advisor as mentor," the advisor became the "boss."

A female student from biology, who recently had left the program, responded when asked if she considered her advisor a boss. “Absolutely!” she replied; “I guess I worked for him. In fact, it was more along the lines of an overseer instead of just a boss. Our ideas as students counted almost nothing.”

Although few of the students in this study viewed their advisor as a mentor, seven of them considered their advisor to be very close to their ideal. These students usually felt fortunate to be under the supervision of such a person. When describing her advisor a female student from biology remarked, “I feel like I’ve been extremely fortunate. She likes to have more control than what I would like, but I think part of it is that she’s trying to train us in a way that she feels we need to learn.” According to a female student from chemistry her advisor “is willing to take special time to train the students. He spends special time with us. I’ve worked with other advisors and I’m very happy where I am now.”

Lack of collegiality. The ability to be personable was mentioned as a trait lacking in most advisors. These students, particularly those in the last stages of their program, wished their advisors treated them more like colleagues. When discussing his advisor a male student in biology remarked:

He is pretty close to the ideal, except that he’s not very approachable. He’s not a very personable guy. He doesn’t really care at all about your personal life or any of that stuff, and although that’s not exactly required of him, I think that can also be a good thing.

A male student from chemistry faulted the culture of the chemistry department for his advisor’s lack of personal rapport with his students. According to him, professors were discouraged from becoming too personable or from socializing with their students:

Some advisors do mix with their students sort of on a social level as well as outside of work, though apparently that’s frowned on by most of the professors in the department. When I’ve been to meetings with my advisor we go out to dinner together, we sit around and talk, and that’s something that doesn’t happen once we’re back at the university.

Returning students, in particular, resented the lack of collegiality with their advisor. As pointed out by a female student in biology, “One of the problems with being a grad student is not being treated as a colleague. I worked for a long time before going back to school and it irritates me to be talked down to.”

Lack of quality feedback. The nature of the feedback provided by advisors was another area of concern to some students, particularly those in chemistry. According to them, most professors in the chemistry department were more apt to providing negative feedback on students’ oversights, than positive feedback on their successes. The following account from a male student illustrates this issue:

In six years that I’ve been here, I’ve been told I was doing a good job once, and that was this year. So I went for six years without it. It’s definitely a big hit on your morale. When you are working hard you definitely need to be recognized for that, to keep you going.

This view was similarly portrayed in the comments of another male student from the same department:

I don’t really get much direct pat-on-the-back type of deals. I gave a seminar last semester and actually got a letter in my mailbox from one of the professors congratulating me on one of the best seminars he had attended in a long time. It would have been nice if I had gotten that letter from my own advisor.

Lack of managerial skills. Although most students had advisors who exhibited various degrees of the “ideal.” Good managerial skills were often perceived to be a shortcoming for many advisors. Even students, who described their advisor rather positively, felt they lacked good managerial skills. As pointed out by a male student in biology, “I have a very good boss. His downfall is managing people.”

The advisor as the gatekeeper of student success. The last group of students had a rather negative opinion of their advisor. This view was especially prevalent among the female students in chemistry. Students spoke of advisors who used favoritism and did not treat their students in an equitable manner. In the words of a female student in chemistry her advisor "did not encourage and help everybody; he just helped the people that he felt like helping, and that was never me."

Other students commented on advisors who used a Social Darwinist approach in the running of their lab. According to a female student in chemistry her advisor "has used the term 'survival of the fittest,' and that's how he believes his lab should be run. That's how he believes the department should be run -- survival of the fittest." She further remarked:

My advisor gives you enough rope to hang yourself, and if you're making a wrong course he's not going to stop you.

Another female student from the same department who had quitted commented on the competitive atmosphere that her advisor had created in the lab:

I thought our group would work more as a team, and I thought professors would help you like a leader would. I think my professor runs his research groups so that we compete against each other. I'm competitive and I can compete against other people, but it's not really the type of atmosphere that I was interested in.

Unfortunately these experiences where not uncommon in the chemistry department where the female attrition rate, for each entering cohort over a nine-year period, averaged 45% and was significantly higher than the attrition rate for males, which averaged 30% for the same time period $X2\ (1, N = 433) = 8.90$, $p = .003$. Moreover, all the students interviewed for this study who had left the program before completing their degree (4 females and one male), attributed their leaving to the poor relationship with their advisor. The following comments from one of them illustrates some of the issues that female students experienced in the chemistry department:

I don't mind having a hands off advisor, that part didn't bother me, but the part that bothered me was that when I needed help, and when I asked for help, I didn't really get very much help. Well, I got maybe a tiny bit, but it wasn't like the type of help that I saw other people getting, and I didn't get any encouragement at all, not like some of the people in other projects.

Discussion and Conclusion

Except for the managerial skills, students' characterization of the ideal advisor included the attributes identified in advisors who use a mentoring approach with their students (Belcher, 1994; Heinrich, 1991; Holland, 1993). Although some students used more complex descriptions in their characterization of the ideal research advisor, a number of characteristics were common across most descriptions. According to the students in this study the ideal research advisor provides guidance, feedback, and encouragement within an atmosphere of respect for each student's competencies. The ideal advisor treats each student as an individual and tailors his/her mentoring approach to each student's needs. These results support the findings of other researchers who contend that effective advisors help their students reach their potential by showing interest in their students' personal and professional aspirations (Healy & Welchert, 1990; Randall, 1982; Romberg, 1993).

Students wanted advisors who were approachable, and who could relate to them outside the realm of the discipline. In other words, students wished their advisors treated them as colleagues (Heinrich, 1991). According to Hollenshead and others (1994), being treated as a junior colleague by the advisor is critical at the doctoral level, and accounts for much of the variability in degree progress.

Although some students had advisors close to their ideal, students' narratives also indicated that most of the advisors did not use a mentoring approach in their interactions with students. This view was particularly prevalent among the female students in chemistry. Of the students in the chemistry department who returned the survey, only 24% of the females and 60% of the males agreed that the level of mentoring in their department was very high, $X2$ (2, N = 79) = 14.40, p = .001. In the biology department these figures were 57% for females and 56% for males, $X2$ (2, N = 81) = 1.56, p = .459. These results support the findings of othe researchers who have concluded that mentoring relationships are infrequent in most graduate programs and gender issues continue to exist in many graduate programs (Heinrich, 1991; Hollenshead et al. 1994; Holland, 1993; Golde, 1998; Seagram, Gould, & Pyke, 1998).

In the chemistry department the gender issues were compounded by the lack of female faculty members, and, as a consequence, lack of female role models and mentors. Although research indicates that a mentor or role model does not necessarily need to be of the same sex as the protégé, seeing women in positions of power and expertise helps affirm female students' career aspirations (Astin & Astin, 1993; Hartman, 1995; Janes, 1997; Kegel-Flom, 1995). Researchers have also

found a direct relationship between the quality of the climate in a science department and the proportion of women faculty and students (Dresselhaus, Franz, & Clark, 1995). The lack of female faculty members in the chemistry department was an indication of the unsupportive environment that existed for female students, as indicated by the comments from one of them:

I chose this department because it seemed to be the best academically. So I disregarded the fact that it didn't have female faculty. I should have paid attention to it because I really didn't realize what kind of indicator it was.

Another female student from the same department agreed. Although she had attempted to ask revealing questions, the answers she received did not reflect the reality in many labs. As a consequence, she joined a research group that was not very supportive of women:When I came to visit this university I was given the impression that my advisor was interested in his graduate students, that he was there for them. I asked people (men) in the group whether it was different for men than for women. "No, I don't notice any differences," they answered. "How many women have graduated with a Ph.D. as compared to men?" I asked. "Oh, I'm sure it's comparable to the ratio that enters," they answered. Instead I should have asked, "Have any women graduated with a Ph.D. while you have been here? How many left with a Master's Degree?"

Researchers have found that female graduate students in traditional male fields, such as science and engineering, tend to report more negative relationships with their advisors than do their male peers (Curtin et al. 1997; Golde, 1998; Seagram et al. 1998; Sonnert,1995). Davis (1999) points out that advisors in these fields need to show genuine interest in their female students' work and make an effort to help them feel welcome. The ability to show interest and concern for all students requires that advisors tailor their mentoring according to the needs of their individual students. In the chemistry department, the lack of mentoring of female graduate students was a major contributor to their high attrition rate.

Interventions aimed at increasing women's presence in science and engineering have traditionally focused on K-16 education or as it is known "the science pipeline." The rationale is that if we convince girls and young women to choose courses and majors in these areas (enter the science pipeline) that they will become scientists and engineers (successfully exit the pipeline). This perspective has often overlooked the last "stretch" of the pipeline – graduate school. The results of this study indicate that regardless of their previous successes, the graduate school climate can play a major role in these women's final decision to become scientists. A 45% attrition rate indicates that many choose not to do so – a major loss of talent to the nation's scientific and technological advance.

References

Anderson, E., & Shannon, A. (1988). Toward a conceptualization of mentoring. *Journal of Teacher Education, 39*(1), 38-42.

Astin, A. W., & Astin, H. S. (1993). *Undergraduate science education: The impact of different college environments in the educational pipeline in the sciences*. Los Angeles, CA: Higher Education Research Institute, UCLA.

Bargar, R. R., and Mayo-Chamberlain, J. (1983). Advisor and advisee issues in doctoral education. *Journal of Higher Education, 54*(4), 407-432.

Belcher, D. (1994). The apprenticeship approach to advanced academic literacy: Graduate students and their mentors. *English for Specific Purposes, 13*(1), 23-34.

Bizzari, J. C. (1995). Women: Role models, mentors, and careers. *Educational Horizons, 73*(3), 145-152.

Bogdan, R. C. and Biklen, S. K. (1992). *Qualitative research for education*. Boston: Allyn and Bacon.

Brown, J., Collins, A., & Duguid, P. (1989). Situated cognition and the culture of learning. *Educational Researcher, 18*(1), 32-42.

Campbell, T. A., & Campbell, D. E. (1997). Faculty/student mentor program: Effects on academic performance and retention. *Research in Higher Education, 38*(6), 727-742.

Curtin, J. M., Blake, G., & Cassagnau, C. (1997). The climate for women graduate students in physics. *Journal of Women and Minorities in Science and Engineering, 3*(2), 95-117.

Davis, K. S. (1999). Why science? Women scientists and their pathways along the road less traveled. *Journal of Women and Minorities in Science and Engineering,5*(2), 129-153.

Dresselhaus, M., Franz, J., & Clark, B. (1995). Update on the chilly climate for women in physics. *The American Physical Society Committee on the Status of Women in Physics Gazette, 14*(1), 4-9.

Fagenson, E. A. (1994). Perceptions of protégés' vs. nonprotégés relationships with their peers, superiors, and departments. *Journal of Vocational Behavior, 45*(1), 55-78.

Ferreira, M. M. (1997). *Gender issues related to graduate science success*. Unpublished doctoral dissertation, Indiana University, Bloomington, (Dissertation Abstracts International, 9810781).

Girves, J. E., & Wemmerus, V. (1988). Developing models of graduate students degree progress. *Journal of Higher Education, 59*(2), 163-189.

Golde, C. M. (1996). *How departmental contextual factors shape doctoral student attrition*. Doctoral Dissertation, Stanford University.

Golde, C. M. (1998). Beginning graduate school: Explaining first-year doctoral attrition. *New Directions for Higher Education, 26*(1), 55-64.

Hall, R. M., & Sandler, B. R. (1983). *Academic mentoring for women students and faculty: A new look at an old way to get ahead*. Washington, D.C.: Association of American Colleges.

Hartman, I. S. (1995). AIM: Attracting women into sciences. *Journal of Chemical Education, 72*(8), 711-713.

Healy, C. C., & Welchert, A. J. (1990). Mentoring relations: A definition to advance research and practice. *Educational Researcher, 19*(9), 17-21.

Heinrich, K. T. (1991). Loving partnerships: Dealing with sexual attraction and power in doctoral advisement relationships. *Journal of Higher Education, 62*(5), 515-538.

Holland, J. W. (1993, April). *Relationships between African American doctoral students and their major advisors*. Paper presented at the annual meeting of the American Educational Research Association, Atlanta, GA. ERIC Reproduction Service No. ED 359 915.

Hollenshead, C., Younce, P. S., & Wenzel, S. A. (1994). Women graduate students in mathematics and physics: Reflections on success. *Journal of Women and Minorities in Science and Engineering, 1*(1), 63-88.

Janes, S. (1997). Experiences of African-American baccalaureate nursing students examined through the lenses of Tinto's Student Retention Theory and Astin's Student Involvemnt Theory. (ERIC Document Reproduction Service No. ED 415 817).

Kegel-Flom, P. (1995). For girls and women only...? *AWIS Magazine, 24*(5), 2.

LeCompte, M. D., & Preissle, J. (1993). *Ethnography and qualitative design in educational research*. (2nd ed.). San Diego, CA: Academic Press, Inc.

Lincoln, Y. S., & Guba, E. (1985). *Naturalistic inquiry.* Beverly Hills, CA: Sage Publications.

Lovitts, B. E. (1996). *Who is responsible for graduate student attrition - the individual or the institution? Toward an explanation of the high and persistent rate of attrition*. Paper presented at the annual meeting of the American Educational Research Association, New York. (ERIC Document Reproduction Services No. ED 399 878).

Luebs, M. Fredrickson, K. M., Hyon, S., & Samraj, B. (1998). John Swales as a mentor: The view from the doctoral group. *English for Specific Purposes, 17*(1), 67-85.

Miles, M. B., & Huberman, A. M. (1994). *Qualitative data analysis: An expanded sourcebook*. Thousand Oaks, CA: Sage Publications.

Office of Scientific and Engineering Personnel. (1996). *The path to the Ph.D.: Measuring graduate attrition in the sciences and humanities*. Washington, DC.: National Academy Press.

Randall, W. C. (1982). Responsibilities of the mentor to his Ph.D. student in physiology. *Psychologist, 25*(3), 124-126).

Romberg, E. (1993). Mentoring the individual student: Qualities that distinguish between effective and ineffective advisors. *Journal of Dental Education, 57*(4), 287-290.

Seagram, B. C., Gould, J., & Pyke, S. W. (1998). An investigation of gender and other variables on time to completion of doctoral degrees. *Research in Higher Education, 39*(3), 319-335.

Sonnert, G. (1995). Gender Equity in science: Still an elusive goal. *Issues in Science and Technology,*

12(2), 53-58.

Sorenson, G., & Kagan, D. (1967). Conflicts between doctoral candidates and their sponsors: A contrast in expectations. *Journal of Higher Education, 38*,17-24.

Subotnik, R. F., & Arnold, K. D. (1995). Passing through the gates: Career establishment of talented women scientists. *Roeper Review, 18*(1), 55-61.

Tinto, V. (1993). *Leaving college: Rethinking the causes and cures of student attrition,* (2nd ed.) Chicago: University of Chicago Press.

Widnall, S. E. (1988). AAAS presidential lecture: Voices from the pipeline. *Science, 241,* 1740- 1745.

Winston, R., Miller, T., Ender, S., & Grites, T. (1984). *Developmental academic advising*. Jossey-Bass: San Francisco.