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The talent process of successful academic women scientists at elite research universities in New York state

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William & Mary - School of Education

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THE TALENT PROCESS OF
SUCCESSFUL ACADEMIC WOMEN SCIENTISTS AT
ELITE RESEARCH UNIVERSITIES IN NEW YORK STATE

A Dissertation
Presented to
the Faculty of the School of Education
the College of William and Mary in Virginia

In Partial Fulfillment
Of the Requirements for the Degree
Doctor of Philosophy

by
Lisa M. Kaenzig
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THE TALENT DEVELOPMENT PROCESS OF SUCCESSFUL ACADEMIC WOMEN SCIENTISTS AT ELITE RESEARCH UNIVERSITIES IN NEW YORK STATE

By Lisa M. Kaenzig

Approved May, 2009

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Some life experiences are sprints to the proverbial finish line, requiring swift strides and a rapid pace. Other events are marathons, necessitating stamina combined with alternating periods of slower steps and quick dashes that eventually lead a successful runner to the end of the race. Many years ago, my father encouraged me to “just run through the tape” during the final weeks of writing my senior undergraduate honors thesis at Rutgers on the career path of a successful women in campaign politics. Over the years this expression has become our family’s “secret code,” when any of us have needed the motivation to complete a challenging life event. The process of completing this dissertation has certainly been a marathon, requiring sustained interest in my topic, persistence to endure the ups and downs of a ten-year journey, and wise coaches and encouraging fans lined up along my path. It was the perfect metaphor that the date of the defense of my dissertation occurred on the same day as the iconic Boston Marathon!

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ABSTRACT

The importance of science in our society continues to increase, as the needs of the
global culture and the problems of the world's growing populations affect resources
internationally (DeLisi, 2008; Fischman, 2007; Park, 2008). The need for qualified and
experienced scientists to solve complex problems is important to the future of the United
States. Models of success for women in STEM disciplines are important to improve the
recruitment and retention of women in academic science. This study serves as an
examination of the facilitators and barriers -- including external factors and internal
characteristics -- on the talent development process of successful women academic
scientists.

Since there are few studies relating specifically to the career experiences of
successful women in academic science careers (Ceci & Williams, 2007; Wasserman,
2000; Xie & Shauman, 2003), a literature review was conducted that examined the (1) the
gifted literature on women, including the eminence literature; (2) the higher education
literature on women faculty and academic science, and (3) the literature related to the
internal characteristics and external factors that influence the talent development process.
The final section of the literature review includes a literature map (Creswell, 2009) outlining the major studies cited in this chapter. The conclusion, based on a critical analysis of the literature review, outlines the need for this study.

The current study utilizes the framework of Gagné’s differentiated talent development model for gifted individuals (Gagné, 1985, 1991) to examine the themes cited in multiple studies that influence the talent development process. Through a mixed-design methodology (Creswell, 2009) that incorporates quantitative and qualitative analysis using a survey and follow-up interviews with selected participants, this study seeks to explore the effects of internal characteristics, external influences, significant events, and experiences on the success of women scientists at elite research universities in New York.

A criterion sample (n=94) was selected resulting in forty-one successful academic women scientists as the study participants, representing a response rate of 43.6%. Findings include the important roles of parents, teachers, mentors and collaborators on the talent development process of the participants. The perception of the study participants was that there were multiple facilitators to their talent development process, while few barriers were acknowledged. The most important barriers cited by participants were perceptions of institutional culture and sexism.

Implications for practice in both gifted and higher education are suggested, based on the findings of the study. For gifted education, these suggestions include the need to provide parental education programs emphasizing the importance of intellectual engagement at home, providing dedicated time for science in primary education, and fostering science and mathematics opportunities, particularly for girls and young women.
Stressing the importance of hard work, persistence and intelligent risk-taking are also important for encouraging girls in science. For higher education, the study provides models of success of academic women scientists, outlines the importance of mentors and collaborators, and emphasizes the critical role that institutions and departments play in facilitating or impeding women’s career development as academics.

The current study suggests several areas for further research to continue the exploration of the talent development influences on academic women scientists. Based on the findings of this study, recommended studies include examining the differences of generational cohorts; probing the roles of collaborators/mentor colleagues; exploring differences for women from various ethnic and racial backgrounds; replicating the current study with larger populations of women scientists; investigating the role of facilitative school environments; examining the patterns of influence of first generation successful academic women, and evaluating matched pairs of male and female successful academics.
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Chapter 1: The Problem

Introduction

Science continues to dominate the international news with headlines about the role of scientific discovery and applications in our global culture (Hermes, 2007; Kantrowitz, 2007; Park, 2008). The work of scientists is at the forefront of public attention as debates about genetics, the environment and the origin of diseases garner media coverage. Advances in medicine with the recent mapping work of the Human Genome Project (DeLisi, 2008) and political controversies regarding stem cell research place scientists and their research in public discourse, including during the recent U.S. presidential election and in international debates about the economy (Park 2008; Science Debate, 2008). The work of scientists also serves as a primary lens through which an awareness of the historic debate of nature vs. nurture is constructed. Therefore, an understanding of the talent development influences on the current and future pool of scientists is of particular importance to our society (Fischman, 2007).

Several recent government reports document the continued and growing interest of the United States in improving the status of students in mathematics and science competencies. The congressionally requested report “Rising Above the Gathering Storm” (Committee on Prospering in the Global Economy, 2007) was published by an eminent committee of scientists and policy-makers and documents the gap in U.S.
readiness in the areas of science, mathematics and technology. The authors propose specific recommendations that the federal government should initiate to ensure an adequate number of prepared future scientists. The suggested reforms include a significant increase in the scientific talent pool through improvements in K-12 science and mathematics education and a renewed commitment to recruiting and retaining the top science students and professionals. The report strongly asserts that these steps are needed now to ensure that the United States continues as a leading nation for scientific research and innovation (Committee on Prospering in the Global Economy, 2007).

The Third International Mathematics and Science Study (TIMSS) was developed by the International Association for the Evaluation of Educational Achievement (IEA) to assess specific patterns in students' mathematics and science achievement. TIMSS provides participating countries with an important opportunity to measure students' progress in mathematics and science achievement on a regular four-year cycle. Significant data were gathered in 1995, 1999, 2003 and 2007 (National Center for Education Statistics, 2008). Through TIMSS, the United States continues to collect critical, timely data on the science and mathematics achievement of students in the U.S., in comparison with other participating countries. The most recent data collection from 2007 and released in December of 2008, revealed that only 15% of U.S. 4th graders and 10% of U.S. 8th graders scored at or above the international benchmark for science and that the assessment results in science for U.S. students were not measurably different from the 1995 results. These most recent survey results demonstrate that significant efforts at the national level must continue in order to secure a needed supply of future
scientists for the United States (Gonzales, Williams, Jocelyn, Roey, Kastberg & Brenwald, 2008).

Concurrent with the international focus on the critical role of science education and scientific discoveries is the national dialogue in higher education regarding the role of women faculty in the STEM (Science, Technology, Engineering and Mathematics) disciplines. The resignation of former Harvard president Lawrence Summers was the front-page story in the New York Times on February 22, 2006 (Finder, p. A1). Although multiple factors led to Summers’ departure from the helm of one of the nation’s top research universities, the dramatic and long-lasting national outcry to his comments more than a year before, at a scholarly meeting in January of 2005, may have contributed most significantly to his resignation (Fogg, 2005). At that now infamous conference, Summers suggested that he believes innate biological differences between the genders may account for the limited number of women pursuing careers in science and mathematics. This comment, particularly seen within the context of the national debate regarding the small percentage of women and minorities in leadership positions in the sciences, contributed to a series of pressures that led to the resignation of Summers as president of Harvard in 2006 (Daniell, 2006).

Though academics hold varied opinions regarding Summers’ comments, the topic of gender equity in academe is a consistent theme in recent higher education literature, with several authors discussing the role of gender in faculty representation and university promotion (Daniell, 2006; Rosser, 2004; Williams, 2008; Wood, 2008). The role and experiences of women in both academic and administrative leadership roles in higher education have now reached a level of public attention (Ceci & Williams, 2007; Finder,
2006; Fogg, 2005; Isaac, 2007). Renowned institutions including Princeton University and MIT have recently established policies to address the perceived barriers for women in reaching parity with their male counterparts at every level of academic rank. There have been notable gains for women’s participation at all levels of the STEM disciplines in the past two decades. The most recent report from the National Science Foundation (2007) demonstrates these gains and also illustrates that women continue to strive for parity at each level of STEM participation. Table E1 in Appendix E represent the most recent data, based on statistics from 2006, available on the STEM disciplines and women's participation. Although women are gaining in numbers of degrees earned in the STEM disciplines, the representation of women continues to be much less in areas including computer science, mathematics, geoscience and the physical and engineering sciences than in the life sciences (Hill, 2008).

Statement of the Problem

At the nexus of the national debates regarding the representation of women in higher education and the role of science in modern society are the experiences of academic women scientists. Numerous studies recount the barriers to success faced by women scientists and other high-achieving women (Daniell, 2006; Fassinger, Scantlebury & Richmond, 2004; Hermes, 2007; Monroe, Ozyurt, Wrigley & Alexander, 2008; Rosser, 2004; Rossiter, 1982, 1995; Williams, 2008) and discuss the struggles that many academic women face to earn tenure, documenting the reasons why some women leave academic science for industry, and relating the perception of a “chilly climate” for women faculty in general (Sandler & Hall, 1996; Xie & Shauman, 2003).
However, few research studies document models of success and discuss the factors that may contribute to the achievement of those women who do achieve the highest ranks of their professions. The majority of previous research studies recount a deficit model, outlining rationales for why women do not reach the highest echelons of their professions. Those studies that do relate success models focus primarily on the roles of the environment, family influences and/or mentoring on the advancement of gifted women.

Literature in both gifted education and higher education (Clark & Corcoran, 1986; Simonton, 2004; Williams, 2008) relates the effect of variables such as gender, race, and class, as significantly influencing who is included in the published ranks of highly successful scholars in various domains. Based on the historical and contemporary societal and psychosocial differences that women and other minority groups have experienced in achieving their potential, should gifted researchers change how success is defined? Should higher education researchers seek new definitions of successful scholars? What determines success as a scholar? How does Western society generally define the term and how does the academic culture determine how success is measured? What are the common experiences and internal characteristics of successful female scholars?

Women appear to face certain obstacles in attaining top ranks in their professions, including careers in academia. The numbers are deceiving at times. For example, the most recent report of the National Center for Education Statistics (NCES, 2008) documents that more than half of all recent baccalaureate and master’s degrees were earned by women. However, the report also notes that significant gender differences in certain majors still exist, as female bachelor’s degree recipients remain far less likely than
their male peers to major in computer science, engineering, or the physical sciences. The NCES also notes that women continue to lag behind men in enrollment in professional and doctoral programs, despite gains in the past three decades (U. S. Department of Education, 2008). This discrepancy is particularly true for women’s representation in the STEM disciplines (Fassinger et al., 2004).

Rarely, despite their relatively equitable numbers early in the academic pipeline, do women achieve a place in the inner circle of academia where critical decisions about who stays, who is awarded grant funds, and who earns promotion and leadership roles, are made. Rare indeed is the publicly recognized woman scholar, particularly in certain male-dominated talent domains like the natural sciences (Daniell, 2006; Fassinger, et al., 2004; NCES, 2008; Williams, 2008).

**Significance of the study**

Utilizing the framework of Gagné’s well-established model of the differentiated talent development process (1985, 1991, 1993, 1995, 1999, 2007), this study examines the primary catalysts that act as facilitators and/or barriers to the talent development process for successful academic female scientists in the most traditionally male-dominated of the science disciplines.

At a macro level, this topic is significant because society needs more highly qualified and experienced scientists to solve the complex problems of the future. Since the monetary rewards and perks may be more attractive in the practitioner arenas of the sciences, strategies for recruiting and retaining valuable individuals as problem-solvers and contributors in academic fields in the sciences are critical. Society garners no benefit when individuals with the potential to reach the top levels in their profession –
particularly as scientific scholars who serve as contributors of new knowledge critically necessary for the world’s population – drop out of science entirely or fail to reach the top ranks. The result is talent left unfulfilled, for the individual, the area of scientific inquiry, and the society.

Models of success should prove critical to reverse these trends. Research that enumerates external influences, internal characteristics, educational experiences, and significant events that lead to success in certain populations of gifted individuals is notably lacking in the literature. This study seeks to add to the paucity of literature available on successful models of female achievement, notably for women in the academic sciences.

*Significance for gifted education*

VanTassel-Baska (1996) suggests, in her study of eminent female writers Charlotte Bronte and Virginia Woolf, that an examination of the lives of eminent individuals should lead to common patterns in the experiences of talented individuals. This research should provide guidelines for facilitation by families and educators of the talent experience in specific domains. There is significant evidence to suggest that those who become highly successful in any talent domain have not reached this level of esteem through ability alone. The roles of external and internal catalysts on achievement have been well established (Albert, 1983; Csikszentmihalyi, Rathunde, & Whalen, 1993; Gagné, 1985; Maines, 2007; Yewchuk & Schlosser, 1995). Determining how families, schools, or other factors have influenced the development of talent is important to promoting a further understanding of what internal characteristics and external factors are most conducive to fostering ability and encouraging talent in gifted individuals. A further
recognition of the different experiences of highly successful women in specific disciplines can also more directly guide educators and families in cultivating the talent development process for gifted females who may significantly contribute to scientific inquiry and discovery in the future.

Significance for higher education

For higher education, this topic is of particular interest in a growing literature base that argues for the need to retain and promote the best and most diverse group of faculty. Several studies focus on the importance of providing faculty members with incentives to enter academia and share their talents in the higher education community as their careers progress, instead of leaving for jobs in industry where salaries are often much more enticing (Daniell, 2006; Williams, 2008). Faculty diversity initiatives are underway at many institutions of higher education in the United States (Fischman, 2007; Hermes, 2007; Tilghman, 2005), and further research into how to recruit, retain and support outstanding faculty members is particularly germane to these efforts.

A trend in the research literature on this topic indicates an assumption that, since women are now achieving parity with men in enrollments in undergraduate institutions and in entry to previously male-dominated fields (Xie & Shauman, 2003; Wood, 2008), it is only a matter of time before women make their way to the top. However, as Heward (1996) observes, "the fruit of nearly two decades of anti-discrimination legislation (appears) to be an increasing number of women in the lowest echelons of higher education without any significant change at the top" (p.12). In her 1926 seminal work, Hollingworth found that so few women emerged among the eminent due to environmental factors instead of biological ones. She described how the "interaction of
ability and environmental stimulation serve to enhance variability in males and inhibit it in females” (as cited in Silverman, 1989, p. 93) and noted that “what a person can do may depend on congenital equipment, but what he or she actually does do probably depends on the environment” (p. 94).

Although a large percentage of women appear on the faculty rosters of departments as diverse as the social sciences, humanities, arts, and medical sciences at many institutions, the senior positions in each of these areas are predominately occupied by men (Hermes, 2007; Kantrowitz, 2007; Park, 2008). A glass ceiling still holds firm in academia, just as it does in politics and other career areas. The reality for educational practice, revealed in the literature discussing female talent development, is that the variables of external influences and internal characteristics must be accounted for in order to guarantee that gifted girls’ and women’s development is not hindered and their choices not limited due to a lack of support and encouragement. This is particularly true in traditionally male-dominated fields like the sciences.

Gifted women often fail to reach their full potential due to psychosocial barriers to achievement. One effective strategy is providing gifted girls and women with mentors who exhibit and model the characteristics of resilience, persistence and risk-taking. These models seem to prove particularly successful for gifted individuals because they are independent and highly motivated learners. Thus, models of risk-taking and persistence, in addition to traditional talent development factors such as family background and educational experience, are essential ingredients in developing career potential in gifted females. Therefore, studies such as the current one, that demonstrate key factors for the fulfillment of potential can provide important information for educators and policy-
makers regarding the key variables in the positive career development of gifted girls and women in the sciences.

**Conceptual Framework**

Several lenses serve as the basis for the theoretical framework of this study. A new look at talent development through the lens of multiple contexts is critical to view talent in a variety of domains, including science. As the editors note in the introduction to *Talent in Context* (Friedman & Rogers, 1998):

> Perhaps more than any other field focusing on exceptionality, the study of giftedness is best viewed as an exploration of its contextual variables, reflecting a rich conceptual legacy and expressing society's hopes for ensuring the survival of the species.... There is a dynamic interplay of social and historical forces on conceptualizing and nurturing talent. (pp. xv, xix)

Given this contemporary interest in exploring environmental influences on achievement, researchers in gifted education have recently begun to examine the lives and the talent development patterns of exceptional individuals through the lens of gender (Eccles, 2001; Jacobs, Lanza, Osgood, Eccles & Wigfield, 2002; Noble, Subotnik, & Arnold, 1999; Reis, 2002).

**Gagné's differentiated model of talent development**

The current study utilizes the model of talent development espoused by Gagné (1985, 1991, 1995, 2007). Gagné proposes a differentiated model of talent development in which domain-specific talents are influenced by intelligence, creativity, socio-affective, sensory-motor and others, while simultaneously following a developmental process that is inherently affected by external influences and internal characteristics.
Gagné’s model was transformational for its emphasis on the end product of the talent development process, stressing a deeper evaluation of the factors that may significantly influence the talent development process over the lifespan. This model of talent development serves as the primary framework for the current study as it illustrates the multiple and complex areas of influence – both as facilitators and barriers – that are present in the talent development process for gifted individuals.

Gagné’s model highlights the role of intrapersonal factors that act as internal catalysts (motivation and temperament/personality) on the talent development process for individuals with giftedness in specific talent domains. He also accounts for the equally significant role of environmental influences as external catalysts (surroundings, persons and events) on the talent developmental process. Gagné’s model is most appropriate for this study, as it illustrates the key areas of focus for the development of talent in successful individuals. Evaluating the effects of each of the areas of the Gagné model on the successful women in the current study should reveal whether these women perceive that their career development has been significantly affected by the variables represented in the Gagné model. These types of questions regarding the talent development process of successful women scholars will aid a further understanding of successful women's experiences as they relate to Gagné’s framework for differentiated talent development. This research also should result in a refinement of the model of female talent development (Noble et al., 1999) and revise the major research question in the area of science from “Why are there so few women?” to “What are the catalysts – both internal and external – on the talent development process for successful women scientists in academia?”
**Feminist theory**

Since the talent development process of women is the focus of this study, the lens of feminist theory is applicable to the different experiences faced by women (Gilligan, 1992; Goldberger, Tarule, Clinchy, & Belenky, 1996). In their seminal work, *Women’s Ways of Knowing*, Belenky, Clinchy, Goldberger, and Tarule (1986) studied 135 women of various backgrounds. The researchers attempted to provide a counterpart study to Perry’s (1970) examination of the development of men over the lifespan. This study of gender in the development of women’s lives created a new basis for understanding the “major social, historical, and political categories that affect the life choices of all women in all communities and cultures” (Goldberger et al., 1996, p. 4). This work established that gender does serve as a significant variable in the talent development process of both women and men.

**Positive psychology**

Positive psychology research (Csikszentmihalyi & Csikszentmihalyi, 2006; Peterson, 2006; Seligman, 2002; Snyder & Lopez, 2005) also serves as a lens for this study, as it focuses on the internal characteristics explored in this study. Positive psychology literature studies the ways in which individuals and communities thrive, often against tremendous odds. Based on the concepts introduced in attribution theory that describe how individuals make causal explanations – how individuals perceive, judge and then attribute achievement or failure in their lives and/or organizations (Heider, 1958; Weiner, 1986) – the area of positive psychology continues to deepen this research with a further exploration of the factors of resiliency, creativity, persistence and self-knowledge.
There is also substantial historical support in the gifted literature for the exploration of internal characteristics. As Cox (1926, cited in Ochse, 1991) notes, in her study of eminent historical figures: “high but not the highest intelligence, combined with the greatest degree of persistence, will achieve greater eminence than the highest degree of intelligence with somewhat less persistence” (p. 335). Sonnert and Holton (1995) also observe in their frequently cited, in-depth study of 700 scientists:

A key characteristic of successful scientists must be a high tolerance for uncertainty and a disciplined work habit in the face of potential failure. A basic optimism that, despite temporary setbacks, things will work out eventually... may be an essential quality for a successful scientist. (p. 184)

Further supporting this concept of the importance of resilience to success is Sonnert and Holton’s (1995) theory of “positive kicks” and “negative kicks” in a scientist’s career. They observe that the “appropriate strategy to counter negative kicks is resilience and hard work – gritting one’s teeth in the face of obstacles and persisting.... Women scientists, on average, experience more negative kicks and fewer positive kicks” (p. 184) than male scientists. These “positive and negative kicks” are similar to the catalysts described in the Gagné model, as they affect the talent development process. For women scientists, persistence and high intelligence may not be enough to achieve high levels of success in their careers as the influence of “negative kicks” or barriers may predominate over positive factors and influences.

Statement of Purpose

Previous research on talented individuals suggests that themes may emerge from continued research exploration into talent development patterns. In a study of 200 gifted
and talented teenagers, Csikszentmihalyi, Rathunde, and Whalen (1993) found that the talent development process is fostered in families that balance stability with encouragement of risks. Therefore, the assessment of whether risk-taking and persistence, combined with familial experiences, have significant influences on the career trajectories and experiences of the study participants should help frame future research on the effects of various external and internal factors on the career success of talented individuals.

Tomlinson-Keasey (1998) offers an intriguing metaphor of a puzzle as the challenge facing gifted women in constructing and making meaning of their lives. The various influences in a woman’s life must all connect, in order to complete the puzzle of a complete and meaningful life. The author traces the substantial literature supporting the need for a new model of female talent development, particularly showcasing the results from studies of the Terman women (Terman & Oden, 1959). She highlights the need for a focus on goal-setting and motivation in further examinations of the lives of gifted women. She concludes by calling for an original theory that will serve to assist researchers in fitting together the pieces of the puzzle that compose the complex lives of gifted females. The current study should contribute to this research need.

Adding to the literature base with studies of the experiences of women scholars in certain domains of talent and to the female talent development process in general, while using current research to provide better guidance and support to gifted girls, may be the best way to increase the numbers of women who serve as models of career success. Certainly, an examination of motivation and persistence in achieving goals would contribute to Tomlinson-Keasey’s puzzle.
An understanding of the factors that may contribute to success as a scholar and the barriers to its achievement for women scientists has important educational implications, as it relates to both gifted and higher education. An examination of the characteristics of and influences on successful professional adults is important to determine what educational, environmental and/or internal factors may support the talent development process of exceptional individuals who will shape the future with their creative production of ideas and products.

*Implications of the study*

There are several implications of this study for educators. For gifted educators, a better understanding about the nature of the talent development process for successful female scientists may provide important recommendations for gifted and talented programs. Since gifted individuals will not succeed in fundamentally changing fields and disciplines without a significant command of the knowledge base in those areas, Bull (1985) recommends three important criteria for the education of the gifted: “(1) disciplined study of subject matter consistent with contemporary approaches to it, (2) breadth of subject matter offerings, and (3) opportunities for metaphysical discussion and speculation” (p. 16). Of particular significance is the influential research of Covington and Omelich (1979) that suggests that individuals who attribute their success to their own ability will be most likely to sustain high levels of achievement. Therefore, studies that guide girls and women in learning to acknowledge the role of their own abilities in their achievements may assist in enlarging the pipeline for women along the path to future success.
Many questions remain unanswered in research about the talent development process and specifically to the fulfillment of potential as it relates to women scholars in the sciences. The study of the career paths of successful women scholars is in an early phase of research. Studies that determine if various models of career and talent development are appropriate for gifted professional women in general, for specific talent domains, and for female scholars are needed. For gifted education researchers interested in fostering talent development, further studies on this topic will provide a new lens for examining both the experiences of successful female scientists and potential differences for other talent domains. For higher education researchers, determining how to recruit and then retain the best female faculty in the sciences and also refine the understanding of the variables that affect the career patterns of successful scholars will also further the research base in these key areas of faculty development.

Definition of terms

Several terms utilized in this study warrant specific discussion and definition for the current focus of inquiry into the specific influences on the talent development process of successful women academics in the sciences.

Giftedness: There are many definitions and ways of constructing the meaning of giftedness. For the purpose of this study, giftedness refers to the ability, potential and capacity (Van-Tassel-Baska & Olszewski-Kublius, 1989) of a study participant to achieve as an academic scientist.

Motivation: The ways in which an individual garners internal and external resources in order to complete work that fosters further career development and success (Walker & Mehr, 1992).
Persistence: Continued striving for the short and long-term career goals of the study participants (Cox, 1926; Piirto, 1991).

Resilience: The ability of an individual to find benefits to adverse experiences and bounce back from challenging events or barriers to success (Siebert, 2005).

Risk-taking: The willingness to take intellectual and creative risks during the study participant’s life (Andreason, 2005; Simonton, 2004; Wasserman, 2000).

Social support: The role of supportive individuals – including family members, friends, colleagues and mentors – in a study participant's life that have positively impacted that individual woman’s talent development process (Noble et al., 1999; Xie & Shauman, 2003).

Successful: Refers to those women who have earned tenure and promotion in departments in the sciences as defined by the National Academy of Sciences (2008) as Categories I and III at the top-ranked institutions chosen for this study and who have also met the criteria for success as defined for this study. A review of the study participants (N=94) was conducted on each of the selected institutions’ available publication information. Study participants were determined to have met all of the following criteria for their respective disciplines: (1) Significant national and/or international awards for their scientific research and/or competitive career awards in their disciplines, and (2) significant grants funded by established national and international agencies, and (3) authors of multiple publications in top-tier, peer-reviewed journals (Andreason, 2005; Rosser, 2004; Wasserman, 2000; Xie & Shauman, 2003).

Talent: For this study, talent is defined using Gagné’s (1991) interpretation of talent as the developmental product of the interaction of aptitudes, with intrapersonal and
environmental catalysts. This is a particularly appropriate definition of talent, as the current study utilizes Gagné's model as a framework for further inquiry into the talent development process.

_Talent development:_ The process of the development of talent for the study participants that is directly influenced by external and/or internal catalysts. These include facilitators and barriers to the individual's talent development process (Bloom 1985; Gagné, 1985; VanTassel-Baska & Olszewski-Kublius, 1989). This study utilizes the framework of Gagné's (1985, 1991) model, in order to illustrate the specific influences on the process of career development and success in the lives of the study participants.

**Limitations and delimitations**

Several unavoidable elements limit this study. First, the cost to personally interview at length each participant in the study would be prohibitive. Therefore, the study is limited to survey data, biographical information available on the women in the sample, and interviews with selected participants in the study who were determined after an analysis of survey data. Second, the study relies primarily on self-reporting by the study participants in a retrospective manner to accurately describe their demographic and family backgrounds, self-identify the internal and external facilitators and barriers to their success, and relate their career development experiences. Third, non-participation of women selected for this study may serve to further reduce the sample size and potential findings. Fourth, the study is limited by the survey instrument used for this study. The survey instrument was created by the researcher and has not been tested previously in other studies. The instrument was not piloted for construct validity and lacks overall reliability to generalize to other populations outside the one represented in this study. The
instrument was not piloted for construct validity. Finally, the study is limited by the ability of the researcher to elicit the necessary information from study participants, whether through questions on the research survey and/or through telephone interviews.

There are several delimitations of this study. First, the study is delimited by the choice to investigate the area of science. Science is a particularly relevant discipline for this research, as scientists represent their research as one in which analysis is viewed objectively, where the best science wins and the search for scientific truths dominate (Kuhn, 1970, 1996). Women are also dramatically under-represented in this career area that purports to recognize merit and achievement of scientific results over all other factors. Research interest in the career experiences of women scientists has grown in recent years, and this study seeks to build on this burgeoning area of research. Second, this study is delimited to include only women scientists judged as successful (as defined for the purpose of this study) in their respective areas of the sciences. Therefore, this study is delimited to a very specific population of individuals at a limited number of institutions. Thus, the size of the population for this study is a limited one (N = 94). Only female faculty members in the sciences at top-ranked research universities in New York are included in this study, in order to elicit the specific experiences and characteristics of female participants who meet these criteria. This study is delimited by a choice of analysis based on the experiences of one gender, not a comparison model of inquiry between the genders.

Finally, this study is delimited to specific areas of sciences – defined here by the National Academy of Sciences’ categories (Categories I and III) of the “physical and mathematical sciences” which include Mathematics, Astronomy, Physics, Chemistry,
Geology and Geophysics and "engineering and applied sciences" which include Engineering Sciences, Applied Mathematical Sciences, Applied Physical Sciences and Computer and Information Sciences (National Academy of Sciences, 2008). These specific areas of science were chosen for this study, as they are the most traditionally male-dominated of the sciences (National Science Foundation, 2007).

Conclusion

This study seeks to fill gaps in the current literature in both gifted and higher education. There is a research need in both educational areas for a further exploration of the specific influences on the talent development process for successful gifted women academics. There is also a void in the literature of models of success for women scientists in academe. Utilizing Gagné's differentiated model of talent development (1985, 1991) as a framework, the current study seeks to explore the primary catalysts – including both facilitators and barriers – on the talent development process of the study participants. Understanding the influences that affect the talent development process in promoting the success of the academic women scientists in this study will help further the literature in both gifted and higher education.
Chapter 2: Review of the Literature

The current study explored the models of success of successful academic women scientists by examining the influence of internal characteristics and external factors that acted as facilitators and/or barriers on the talent development process, utilizing Gagné’s model of talent development (1985, 1991). Since few studies relate specifically to the experiences of successful women in academic science careers (Ceci & Williams, 2007; Wasserman, 2000; Xie & Shauman, 2003), a literature review follows that examines (1) the gifted literature on women, including the eminence literature; (2) the higher education literature on women faculty and academic science, and (3) the literature related to the internal characteristics and external factors that influence the talent development process. The final section includes a summary of the literature review, outlining the major studies in this chapter with significant findings (Creswell, 2009).

The gifted literature

Research in gifted education has long focused on the process of the development of talent across the lifespan (Bloom, 1985; Gagné, 1985, 2007; Galton, 1869; Terman, 1954; VanTassel-Baska & Olszewski-Kublius, 1989). Recognizing and tracking both the external influences and internal characteristics on the development of talent in individuals and/or in groups is a critical component to understanding the reasons why individuals may or may not fulfill their potential. Gifted researchers continue to seek explanations for the development of talent that results in the recognition of gifted individuals as
prominent contributors to their respective domains (Cox, 1926; Simonton, 2004; Subotnik & Stenier, 1994; Terman & Oden, 1959). As VanTassel-Baska (1996) notes, "the development of any talent is a complex process involving the interweaving of many factors" (p. 295). Although the transformation of childhood giftedness into adult eminence is a rare phenomenon, research has indicated that there are certain patterns and developmental indicators of later prominence (Albert, 1975, 1996; Bloom, 1985; Gross, 2003).

Although many studies in the gifted education literature discuss the talent development patterns of gifted children who become highly successful adults (Albert, 1990; Bloom, 1985; Gross, 2003; Subotnik, 2000), and several studies highlight successful scholars in the higher education literature (Baldwin & Chang, 2006; Bystydzienski & Bird, 2006; Cattell & Drevdahl, 1955; Daniell, 2006; Isaac, 2007), few studies outline the connections between precocious children and the adults who later join the top ranks of their professions (Berger, 1994; Bloom, 1985; Subotnik & Stenier, 1994). The majority of connections made between these two foci are enumerated in biographies of successful individuals where an examination of the childhood backgrounds of these exceptional people emerges (Albert, 1987; Bateson, 1989; Simonton, 2004).

Eminence

Systematic research on eminent individuals originated with Francis Galton's *Hereditary Genius* (1869) in which he argued for the significant role of genetics in determining eminence. Galton documented several English families that produced generations of eminent achievers and developed a careful method for assessing high
levels of cognitive ability which he believed was closely correlated with eminence or reputation in a discipline or field. Based on his findings, Galton concluded that no person could achieve a significant reputation without being highly gifted and that most individuals who did possess high ability would typically succeed in achieving eminence.

One of the earliest studies of the primary influences on the success of scientists is found in Galton's (1875) *English Men of Science: Their Nature and Nurture*. Galton examined both the internal characteristics and external influences on his sample of 180 successful English male scientists, describing "their earliest antecedents, including the hereditary influences, the inborn qualities of their mind and body, the causes that first induced them to pursue science, the education they received and their opinions on its merits" (p. 1). Galton documented that his respondents frequently noted the considerable importance of family members, teachers/tutors, and early scientific experiences in their later talent development process. This early study of the influences on scientists also established the critical importance of internal characteristics such as "energy, perseverance, and independence of character" (p. 56), as well as the prevalence of first-born status, on the career success of male scientists. Galton's pioneering work established the framework for all future inquiries into the talent development influences for successful scientists, including the current study.

Historical studies of eminent individuals include different types of populations, thus making a conclusive resolution of possible common patterns of influence among eminent individuals even more difficult to determine (Albert, 1983; Cox, 1926; Galton, 1869, 1875). This variance is even more acute for studies of eminent females, since few women are included among the ranks of the eminent (Simonton, 1994, 2004).
Additionally, generalizing to a larger population is made more challenging by the fact that diverse domains of talent manifest themselves differently.

As Bloom's (1985) study of talented young people revealed, the maturation of talent in pianists, mathematicians, and world-class swimmers varies greatly, depending on the domain of talent. Bloom's research illuminated the need to focus on specific talent domains when evaluating significant influences on the talent development process. While researchers continue to seek patterns in the experiences and characteristics of eminent individuals, the very nature of eminence is so rare that the pathways towards its achievement may be different for those in various areas of expertise and/or for women and men (Yewchuk & Schlosser, 1995).

Gifted women

Women have made tremendous progress in the public sphere of work in the United States in recent decades. Significant changes in cultural and societal mores combined with an eagerness of women to seek more public roles in the workplace have resulted in two generations of professional American women. These women have energetically asserted their right to make the significant choices that govern the patterns of their careers. Women have made noted advancement in securing equity in several professions; however, the metaphorical glass ceiling has prevented the majority of women from moving beyond the middle management level of careers in many areas to the ranks of the eminent (Harper, Baldwin, Gansneder & Chronister, 2001; Hermes, 2007; National Science Foundation, 2007).

For intellectually gifted women, the perception exists that they will reach their full potential, if given equal educational opportunities. However, the talent development
process appears to be significantly different for males and females, even for those who are gifted (AAUW, 2001; Salomone, 2005). Several studies (Reis, 2002; Rosser, 2004; Settles, Cortina, Malley & Stewart, 2006; Xie & Shauman, 2003) have noted that, although women can and do achieve academically as well as men and also have the motivation to achieve at levels comparable to their male peers, they are not fulfilling this documented potential in numbers in adulthood that confirm this early promise. Piirto (1991) observed that, due to the childbearing and raising responsibilities historically relegated to women in the early stages of traditional career paths, women tend to peak later in life than their male counterparts, thereby not fitting the early productivity predictor cited by many studies (Simonton, 1994, 2004) as a chief indicator of later success or eminence. When measured by the standards that have been formulated on the basis of men’s experiences, women fall short of achieving traditional measures of career success. Silverman (1996) asserts that

eminence is a man’s game, rooted in hierarchical power structures, driven by competition...with the victor gaining a permanent place in history....Even now, although women are permitted in the game, the determination of who will be publicly recognized still is largely the prerogative of influential (predominately white) men. The attainment of eminence never has served as an equitable criterion of ability, nor is it likely to become one in the immediate future. (p. 41)

Studies of gifted women

Although several studies indicate patterns in the lives of gifted women (Kettle, 1996; McGrawe, 1993; Reis, 2002; Reis & Callahan, 1989; Rimm, 2001; Rosser, 1982; VanTassel-Baska, 1996; Yewchuk & Scholsser, 1995), there are limitations inherent in
the ways in which much of the data were collected. For example, McGrayne (1993) conducted a reflective study of Nobel Prize-winning women in science throughout history, relating themes and patterns in the lives of this group of successful women. However, her study was weakened by the fact that she could not interview the majority of the women she profiled, as most were no longer living. Instead, she relied heavily on autobiographies and biographies of her subjects. As Heilbrun (1988) warns, autobiographies and biographies of women do not always portray a realistic picture of women's lives.

Reis (1996) conducted an ethnographic study of the lives of twelve living women who had obtained prominence in their respective fields (including the arts, environmental conservation, academia and politics) between the ages of 55 and 90. Four factors emerged from Reis’ study that she argued account for the achievement of her sample of highly successful women. These factors are (1) above-average intelligence, contextual intelligence, and/or special talents, (2) personality traits, (3) environmental contributions, and (4) the perceived social importance of the use or manifestation of talent (pp. 153-154). Reis asserted that these four factors, combined with a strong belief in self and a desire to develop one’s talent, resulted in the attainment of high levels of success by this sample of women in their respective careers. Of special interest is Reis’ finding that this sample of women tended to peak in their careers later in life than their male counterparts; thus, they appeared to “lag behind” in the race to eminence in a given discipline. As VanTassel-Baska (1996) recorded in a study of the talent development of Virginia Woolf and Charlotte Bronte, “being female made the development of their talent and their
ultimate recognition somewhat precarious. Their eminence today was due to their own resourcefulness, not to discovery by a literary agent” (p. 312).

Silverman (1996) recorded that “the women who were successful in breaking through all the barriers to attain world fame found that success came at a high price...they were the ‘exceptions’...exceptional women who had achieved more than most prestigious men” (p. 40). The result of these women breaking through the glass ceiling in their respective fields was that the bar was set even higher for the next exceptional woman. The outstanding achievement of one woman ranking among the most notable contributors in her discipline inadvertently seems to cause other women to have even less chance at consideration as one of the renowned in the same area in the future. The perception is that the discipline now “has” one token woman to represent all talented females in that field (Silverman, 1996).

Although the numbers of women in science and other talent domains continues to increase, Reis and Callahan (1989) revealed that gifted females are not achieving recognition in the numbers anticipated. The determination of who is considered to have attained “career success” has always been problematic (Albert, 1996; Galton, 1869; Yewchuk, 1995). Definitions of success vary considerably in distinct cultures, epochs, and populations. Yewchuk (1995) defined “eminent individuals (as) those who have made a great and lasting contribution to their society” (p. 3), a definition that may or may not include the criterion of being famous. Yewchuk and Schlosser (1995) suggested that “eminence is the study of unique individuals” (p. 82) and that the definition of eminence should include recognition of “degrees, income, honors, living up to potential, creative work, and publications” (p. 83). Although eminence is often used as a term to reflect
ultimate success in a profession, Noble et al. (1999) recognized the significant problem of this term for the attribution of gifted women's success. They observed that women's experiences with the recognition of their achievements have often been very different from those of their male counterparts (p. 25). Notably, physical chemist Rosiland Franklin never received public recognition for the critical role she played in the discovery of the structure of DNA; instead, her male colleagues Francis Crick, Maurice Wilkins and James Watson received the Nobel Prize for this research in 1962 (Maddox, 2003).

The most widely-used format to date for research into the characteristics of and patterns of influence on gifted women is the case study (Reis, 1996; VanTassel-Baska, 1996; Wasserman, 2000), both for women who are no longer living but whose lives are already well-documented as well as for those successful women who are still living and able to be personally interviewed. Due to the unique nature and relatively small number of eminent individuals in various domains of talent, qualitative designs with one or a small number of exceptional individuals are more conducive to the study of this population. The investigative case-study approach used by some (Reis, 1996; VanTassel-Baska, 1996) researchers of gifted women could prove useful in future studies. The case study method is certainly a rich source for information (Yin, 1989); however, the most significant limit to this type of analysis is that only a very small number of individuals can be reasonably surveyed.

Yewchuk and Schlosser (1995) contended that modifications of models of achievement for men should be made to account for women who achieve in traditionally male-dominated disciplines and fields. Since many landmark studies assess the life influences on achievement for men (Albert, 1996; Cattell & Dreidahl, 1955; Galton,
1875; Simonton, 2004), new research into the talent development process as it pertains specifically to the lives of women must be investigated. For example, VanTassel-Baska (1996), in documenting the talent development process of Charlotte Bronte and Virginia Woolf, discovered eight themes that marked the lives and work of these two eminent writers. From these themes, VanTassel-Baska related that “the use of writing as preventative therapeutic activity has not been exhibited to the same degree in the lives of male writers,” and the influence of emotionally supportive others cannot be underestimated in the lives of these women (p. 308). Based on insights such as these on the gender-specific experiences of women literary artists, similar patterns that are unique to highly successful women in other domains should be investigated. The continued use of thematic coding from research data – both quantitative and qualitative – is particularly useful to the study of the patterns that affect the lives of groups of successful gifted women.

Gifted women's talent development

Although there are many studies that discuss the various influences on the talent development process of gifted females, only one model of gifted women’s talent development currently exists. Initiated with the publication of Remarkable Women: Perspectives on Female Talent Development (Arnold, Noble & Subotnik, 1996), a new model of talent development for gifted women was developed and revised (Noble, Subotnik, & Arnold, 1999). The model of female talent development espoused by Noble, et al. (1999) is the first to incorporate multiple overlapping factors, particularly appropriate for an evaluation of women’s career development and achievement, and to
include the experience of eminent women. However, there has been no empirical or qualitative testing of the components of the model in the literature to date.

Noble et al.’s (1999) model of female talent development builds on Gagné’s (1985, 1991) talent development work and further emphasizes the complexity of the challenge of fulfilling potential that faces many talented women. This model could be utilized as a starting point in order to determine if the experiences of successful women scholars tend to fit the theoretical basis of the model that illustrates the “complex and interactive system of relationships among several critical variables” (p. 141) that face gifted women in their careers and personal lives. These variables include demographic and individual factors (personality traits, family background, and protective factors), opportunities, talent domains, and spheres of influence (personal and public).

Gifted women scientists

Recent interest in women’s scientific careers has produced a robust new strain of research that investigates the barriers facing this group of female professionals. This same literature serves as an important foundation for additional inquiry into the career trajectories of women scientists, in both industry and academia. Numerous studies conducted in the past decade examine the obstacles – both perceived and real – to women’s success in science. Of particular note are the numerous studies examining the many reasons researchers believe that women are not succeeding at the same rates and ranks as their male counterparts (Daniell, 2006; Glenn, 2007; Preston, 2004; Rosser, 2004; Wasserman, 2000). The themes related to this literature strand include the significant role of childbearing and child-rearing responsibilities for women, the role of women as primary caretakers of aging parents and the systematic discrimination faced by
women in the workforce in general. All of these themes can apply to women in most career paths and are also applicable to women in the sciences.

*Higher education literature*

Faculty scholars are not one homogenous group, easily evaluated and analyzed. In fact, in few career areas is the population so remarkably diverse. As Clark (1987) observes:

> Who can fathom an econometrician when he or she is in full stride, let alone a high energy physicist, a molecular biologist, an ethnomethodologist newly tutored in semiotics, or an English professor determined to deconstruct literary texts...grasping the sheer magnitude of the differentiation...of the academic domain is a necessary step in the triumph of realism over romanticism in understanding American academic life. (pp. xxi, xxix)

Defining an individual as a successful faculty member is varied and complex, since disciplines or institutions of higher education do not share the same criteria for evaluating faculty contributions. Also, faculty responsibilities include diverse and distinctive areas of possible evaluation: scholarship, teaching, and service. Each of these levels of faculty responsibility may differ in degree and quality, depending largely on the institution with which the faculty member is affiliated.

Additionally, defining what makes a person successful in any career area is both subjective and individual specific. However, one definition of career success found in the career development literature may suffice for evaluating successful faculty – whether from the individual, organizational, or societal perspective. Fitzgerald and Betz (1994) define career success as a “combination of internalized evaluations of the self by
significant others, as well as evaluations of self in comparison to peers and one’s progress with respect to age or career expectations” (p. 104). This definition of career success seems particularly appropriate for faculty since they are evaluated by so many different constituencies – including self, departmental peers, deans, provosts, boards of trustees, students, and members of their discipline – and at many different levels, including in the classroom, at the department level, across the university, as well as nationally and internationally within their area of expertise.

A definition of faculty success must be flexible in order to meet these varied evaluation needs while not limiting the potential roles of faculty in these different communities of scholarship/teaching/service. As Baldwin (1983) observes:

Our definition of the successful academic career too often inhibits professors from experimenting with alternative roles and branching out into new potentially stimulating professional areas.... In many cases, higher education’s devotion to specialized teaching and research locks professors into narrow career paths and forecloses many challenging vocational opportunities. (p. 65)

Any recognition of a successful scholar must also take into account the variability of the many disciplines and fields that comprise the arenas of scholarship in academia. As Light (1974) noted in his analysis of the structure of the academic profession: “each discipline has its own history, intellectual style, distinct sense of timing, different preferences for articles and books, and different career lines” (p. 12). An important caveat is necessary when contemplating commonalities in career paths for successful scholars. Although many renowned scholars may share similarities in patterns from their childhood, educational experiences and/or career paths, there is no “prescription” for the best career
path for a scholar to reach a level of prominence in their discipline or field. And, there is also a lack of clarity in understanding how a faculty member is to move from a top-ranked position as a tenured or full professor to an even higher level of academic renown in his or her area of expertise. As Schuster (1990) comments, “many faculty...find themselves at the top rank with no formal rung in the career ladder remaining to scale” (p. 10).

Faculty career stages

Important recent work on faculty stages and levels of expertise by rank (Finnegan & Hyle, 2009) has suggested that it is the combination of many factors working together that influence faculty confidence in their own expertise in their fields and disciplines. This qualitative interview study focused on 13 randomly selected faculty members in History at two different research universities to lend understanding to the process of faculty aggregated knowledge and comfort with expertise.

Using Baldwin’s analysis of the five stages of a faculty member’s career provides a useful framework for an understanding of the trajectory of a successful faculty member’s career path (Baldwin & Chang, 2006; Baldwin, Lunceford & Vanderlinden, 2005; Baldwin, 1990; Baldwin, 1983; Baldwin, 1979). Baldwin and Chang (2006) cautioned that faculty members should not be viewed as one synonymous group, as the academic career path has certain developmental stages, necessitating a distinction of needs for faculty members at different stages of their careers. There are certain milestones in each of the levels of a faculty member’s career where tasks need to occur, in order for a scholar to have later recognition as a highly successful contributor to her field.
In the “career entry” stage, many researchers observe that a faculty member who publishes early (and, most notably, from his/her dissertation) is likely to gain tenure and further promotion later in their career (Collins, Chrisler & Quina, 1998). Since many faculty find that they are most fervent about scholarship early in their careers (Baldwin & Chang, 2006; Baldwin, 1990), those faculty members who are able to develop a consistent zeal and ability to publish scholarly articles in later career stages may be the most likely to end their careers as exceptional members of their discipline or field.

The “early career” stage is marked by a “good period for creativity and innovation” (Baldwin, 1990, p. 25). These are key determinants in the career of a creative producer and contributor to a field. The “midcareer” stage, when many faculty members may be decreasing in their motivation and productivity, can be a particularly productive time for those individuals who are very involved in the continued mastery of their areas of expertise (Baldwin, 1990). “Late career” may find many faculty simply doing the minimum requirements, while the highly successful scholar is typically engaging in a period when they seek to utilize their amassed knowledge base and years of experience to make important contributions that may serve as their legacy to their field or discipline (Baldwin, 1990, p. 26). It is in these later years when many scholars begin to receive public recognition for their contributions to the advancement of their respective discipline/field areas.

The fifth stage of career development, “the career plateau,” can occur at any point in an academic career but is most commonly found in the middle of the academic’s career (Baldwin & Chang, 2006). Research from the gifted literature suggests that this plateau may also occur for those who are creative producers, as there may be a pause in the
individual's career when a reflection on past achievements is made that assists the person in thinking anew about his or her future career path (Reis, 2002; Subotnik, Maurer & Steiner, 2001).

Certainly, an academic career is appealing to many because it is inherently flexible in nature, allowing multi-talented individuals access to an academic culture that tends to value gifts in the varied areas of teaching, scholarship and service to the institution and to the scholar's discipline or field. This appears particularly true for young women entering faculty positions in recent years (Philipsen, 2008). However, the path to success for scholars is unclear. For example, many academics perceive that the key to successfully attaining positions in the highest ranks (as chaired professors and/or research professors) depends on their ability to focus the majority of their attention on research in a narrow, scholarly interest and to publish as many papers as possible in the top journals of their discipline. Published advice to young faculty suggests that the novice faculty member's best hope for tenure and promotion is to publish on a specific topic of interest, garner success in obtaining research grants and teach as few classes as possible while doing the minimum of service (Rosser, 2004; Philipsen, 2008; Xie & Shauman, 2003). Certainly, for those scholars who achieved recognition as renowned scholars in their disciplines, this is generally true, as the primary accelerator of academic careers at top-ranked research institutions is significant research and publications (Schuster, 1990).

Success in academic careers

Career success among scholar-researchers is also correlated with high general intelligence in combination with personality factors including ego-strength, stability, dominance, adventurousness, and self-sufficiency (Baldwin & Chang, 2006; Cattell &
Drevdahl, 1955; Hill, 2008). As Heward (2006) related, “in the academic profession, the importance of self-confidence and seeing yourself as potentially able and being seen as such continues to the (higher) levels” (p. 14). Additionally, a key factor to career success for academics appears to be sustained creative productivity, usually in the form of publications that advance knowledge and understanding of a field or discipline. Parallels in the organizational sociology literature provide useful comparisons for maximizing the motivation of faculty to higher aspirations as original contributors to their respective fields/disciplines. Kanter (1977), in her landmark study of corporate culture, observed that those individuals (the “movers”) who sensed that they had opportunities to develop their talents or job further were more likely to develop higher aspirations and be more motivated. Those employees who believed that they had few opportunities to progress in their careers lacked further motivation and productivity (“the stuck”). Similarly, faculty members who continue to seek challenges and interdisciplinary research topics may benefit from these varied perspectives as original contributors to new scholarship in their talent domain.

Although faculty are evaluated on many levels for different types of contributions, there does seem to be a direct correlation between publication and achievement of recognized career success. Prominence as a scholar has long been attributed in academia to citation counts in various literature bases (Walberg, Rasher, & Hase, 1978); however, there are many faculty members with numerous publications who fail to contribute new ideas to their respective disciplines and yet are ranked as some of the most prolific members in their talent domains. The key differential in faculty who succeed in publishing prolifically but do not reach prominence as a successful scholar and those who
manage to do both, seems to be the contribution of original ideas and novel concepts to the literature, as well as luck (Gladwell, 2008; Isaac, 2007; Simonton, 2004).

Creative productivity

According to Albert (1975, 1996) and Andreason (2005), creative productivity is the attainment of high and publicly recognized levels of career success. Additionally, scholars in gifted education comment that the measure of an individual’s talents or gifts is often defined more by the value that the society, at that time in history, places on those talents than on any other individual measure of talent that exists (VanTassel-Baska, 1997). In Creating Minds, Gardner (1993) describes the creative individual as one who frequently solves problems, generates products, and/or defines new questions in a field/discipline in a manner that is originally deemed as unconventional but later determined to be essential to the domain. Gardner’s definition is certainly fitting for the work of most scientists.

Mentors

There are other characteristics, in addition to scholarly productivity, that appear to enhance the likelihood that a faculty member will be recognized as an influential contributor to his or her field. Many successful scholars cite important mentors along their career paths. Mentors are defined by Ragins and Scandura (1994) as “individuals with advanced experience and knowledge who are committed to providing support to and increasing the upward mobility of junior organization members, their protégés” (p. 957). The importance of mentors to the career advancement of faculty has been firmly established as extremely significant (Daniell, 2006; Philipsen, 2008; Rosser, 2004).
Women scholars, although experiencing the same career stages of faculty development as their male peers, appear to also have varied trajectories brought on by different factors. Clark and Corcoran (1986) recorded the effects of “accumulative disadvantage” on women faculty members. Mentors and sponsors are very important to career advancement for faculty and yet male faculty are much more likely than their female peers to have such advisors. Indeed, some studies (Heward, 1996; Philipsen, 2008; Rosser, 2004) have revealed that sponsorship is even more important in the higher ranks of academia, as chaired and research professorships are sought. Since success as a scholar may be as much about confidence and perception by one’s peers as it is about publication of important work, women faculty may face unique barriers in this last important criterion, as societal and psycho-social pressures on females do not necessarily make the promotion of self a socially-accepted or easy task.

**Career development of women faculty**

For gifted women in the United States, aspirations to careers as scholars, researchers, and teachers of future generations are frequently viewed as areas where they may find success in fulfilling extraordinary potential (Philipsen, 2008; Rosser, 2004). However, the literature in this area also highlights the isolation and obstacles to advancement that female faculty may face in academia (Collins, Chrisler & Quina, 1998; Glenn, 2007; Rosser, 2004). The status of women in academia, both at the faculty and administrative levels, has increased in recent years; however, disturbing trends remain. Rothblum (1988) first recorded that women were resigning from academic positions due to pressures from serving as the “token woman in an all-male department” (p. 14), feeling unappreciated, or lacking the support of their male colleagues. More recent accounts and
government reports also support this continuing concern (Daniell, 2006; Monroe et al., 2008; NSF, 2007; U.S. G.A.O., 2004).

Many women believe their work in academia is undervalued and that they are often passed over for senior scholar positions (e.g., professor rank and or research professor/scholars) when they are available (Ajzenberg-Selove, 1994; Ambrose, Dunkle, Lazarus, Nair & Harkus, 1997; Etzkowitz, Kemelgor & Uzzi, 2000; NSF, 2007). The result of this "chilly climate," as documented by Sandler and Hall (1996), is that women are dropping out of the academic community, instead of challenging the structure of academic institutions and working to change them (Rothblum, 1988). Although women are entering graduate programs in almost equal numbers to men and often "enjoy an advantage in securing a faculty position . . . the social and structural hurdles they encounter after being hired are another story" (Blackburn & Lawrence, 1995, p. 43).

Women in academia must be able to access resources historically available to their male peers, including the intrinsic knowledge found in more experienced peers and mentors, so that institutions retain them as they gain higher levels of experience and are promoted in their professions (Philipsen, 2008).

The literature is full of accounts of strategies that may assist women faculty in learning the informal rules that lead to tenure and promotion (Bystydzienski & Bird, 2006; Collins, Chrisler & Quina, 1998; Daniell, 2006; Glazer-Raymo, 1999). However, there is an institutional problem represented in the stories of women faculty (e.g., institutional and societal gender bias) while the majority of solutions proposed in the literature relate to access and pipeline issues (hiring practices, importance of mentoring, etc.). Particularly prevalent in the literature related to female academics is the
importance of mentoring and networking in order to foster the likelihood of promotion and publication opportunities. Wunsch (1994) discusses mentoring as directly related to the retention rate for women faculty in academic institutions and explains her belief that, although mentoring is an ambiguous activity, success in any profession – particularly in a close-knit academic community – depends on the professional interaction and mentoring of faculty. This is especially true for women in traditionally male-dominated disciplines like science. Shavlik, Touchton and Pearson (1989) noted that women faculty must have access to mentoring opportunities in order to prepare for leadership roles in academia. In a landmark study of male and female faculty members, Cameron and Blackburn (1981) observed that one of the resulting gender differences discovered in the sample was the measurement of network involvement. Male faculty members had a significantly larger number of professional peer associations than their female colleagues. Therefore, women were at a disadvantage to their male peers in securing the resources and implicit knowledge needed to further their careers in academia.

Many women faculty face these same barriers to advancement in careers in academia, all of which may contribute to the small overall number of women at the top ranks. Simonton (1994) recorded that women constitute only 3% of the most noted figures in Western history (p. 33); therefore, women have historically been studied within the context of a predominately male conception of success (Albert, 1983). However, in recent decades, there has been increased interest in developing models of success and talent development that include the different experiences of women faculty and highlight the contributions made by women in academia (Fara, 2007; Noble, Subotnik, & Arnold, 1999; Rosser, 2004; Xie & Shauman, 2003; Yewchuk & Schlosser, 1995).
Women scholars in academic science

Recent attention to the barriers faced by women scientists in academia was initiated with the release of a significant self-report of institutional bias at the Massachusetts Institute of Technology (MIT), one of the most elite institutions in the United States for the training and research of scientists (MIT, 1999). The women at MIT recognized that “in the course of their careers (these women had) come to realize that gender has probably caused their professional lives to differ significantly from their male colleagues.... It was clear to the women that their experiences formed a pattern” (MIT, 1999, p. 3). In the Committee's report, one woman is quoted as describing that

The heart of the problem is that equal talent and accomplishment are viewed as unequal when seen through the eyes of prejudice.... There is a perception among many women faculty that there may be gender-related inequalities in distribution of space and other resources, salaries, and distribution of awards and other forms of recognition. Currently, a glass ceiling exists within many departments. (p. 5)

A recent report by the U.S. Government Accountability Office (2004) recorded concerns with federal agencies' compliance with Title IX regulations and argued for further policies to ensure that grant proposals written by both men and women are fairly reviewed and supported. This report and one conducted by the National Science Foundation (2007) discussed the attainment of gender equity by female scientists as a deep cultural one that must be addressed at a societal and governmental level.

Several factors seem to combine to keep women’s numbers so low in the ranks of successful scientific scholars. Career success is traditionally defined as high achievement
combined with societal recognition and valuing of this achievement (VanTassel-Baska & Olszewski-Kublius, 1989). Additionally, for success as a scholar, the key factor appears to be sustained creative productivity (usually in the form of successful grants and top-tier journal publications) that advances the knowledge and understanding of a field or discipline.

For many women, their lives are characterized by interruptions – for childbearing, childcare, housework, moving for a spouse’s career, care of aging parents and/or spending time building relationships with significant others. Women are faced with the challenge of trying to free themselves from the daily interruptions of their lives to make time for scholarly work (Evans & Grant, 2008; Monosson, 2008; Wasserman, 2000). Confirming the findings of the women faculty at MIT, one female graduate student pursuing her degree in physics wrote about the difference between her female and male counterparts:

A high percentage of professional women end up with positions such as full-time lecturer, associate professor or technician, unlike their male counterparts, who usually end up in full professorships or in senior research positions. A young woman’s dreams of a full professorship or senior research position are dashed by a system which views women as primarily social beings who are incapable of the harsh competition inherent in the research venue, or of sole responsibility for a laboratory…. The bureaucratic system implicitly favors those who have someone to care for existing children, someone who is not pregnant, has no glass ceiling,
and is not different from the other members on the board: a man. (Pugel, 1997, p. 3)

For those scholars aiming for the ranks of the most successful contributors to their field or discipline, the amount of time needed to achieve this goal is significant. "Males are demonstrating more creativity...simply [due to the fact that] they have more time for their work and less home-related duties..." (Reis, 1987, p. 84). Further analysis of the role of home and dependent care responsibilities in the lives of successful women scholars may prove illuminating.

Rossiter (1982, 1995) was among the first to connect the problems with the culture of science to the lack of women achieving at the highest ranks. Rossiter (1982) investigated the women selected as one of the top 1,000 scientists in the United States as indicated by a star in Cattell's (1906) American Men of Science. Her extensive research revealed that only 1-2% of the total number starred in any year were women. Further research revealed that many of these same women who had received an exceptional ranking had also been barred from honorary groups, overlooked for awards, and were not chosen for leadership positions in scientific professional societies or academic departments. Her examination of the historical antecedents of women's participation in science in her two-volume collection of women's experiences in scientific inquiry in the United States provides the model for studies on women scientists.

Many accounts of women faculty scientists have reported discriminatory practices in higher education and scientific organizations. Countless studies document the perceived barriers to women’s success in academia, particularly in traditionally male-dominated disciplines (Monroe et al., 2008; NSF, 2008, 2003; Olson, 1999; Philipsen,
The current president of Princeton University, Shirley Tilghman, a molecular biologist, gave a speech at Columbia University, just months after the now infamous conference at which Lawrence Summers began his descent as Harvard’s then president. Tilghman (2005) reflected on her own journey as a woman scientist, attributing her own success to several factors including mentors, parental influences and senior women colleagues and, most significantly, to her own “absolute inability to recognize reality.” She explained to the audience that she wished to emphasize this factor:

Let me amplify the last point, which may be the least obvious. It has been my experience that many successful women in science simply fail to perceive that there are obstacles in their path. They are able to go through life with metaphorical blinders on— not that they would deny that there are forces working against the progress of women, but rather that they refuse to acknowledge that those forces apply to them. A blunt way to describe such women is to say that they refuse to allow themselves to become victims. They are able to deflect any slings and arrows that come their way. I do think that this is a tremendous survival tool, but one that takes the kind of self-confidence that only comes from strong parents and mentors. As mentors and as parents, we should be encouraging this trait in young women, rather than engaging in a lot of hand-ringing about how tough things are. (Tilghman, 2005, p.4)

Gagné’s differentiated model of talent development

Gagné’s (1985, 1991) differentiated model of talent development provides the framework for the current study. Gagné’s model outlines a talent development model in
which domain-specific talents are influenced by intelligence, creativity, socio-affective, sensory-motor and others, while simultaneously following a developmental progression that is shaped by environmental influences and internal characteristics. Gagné’s model is transformational for its emphasis on the end product of the talent development process, stressing a deeper evaluation of the factors that may significantly influence the talent development process over the lifespan. This model of talent development serves as the primary framework for the current study, as it clearly illustrates the multiple and complex areas of influence – both as facilitators and barriers – that are present in the talent development process for gifted individuals.

Gagné’s model highlights the role of intrapersonal factors or internal characteristics that act as internal catalysts (motivation and temperament/personality) on the talent development process for individuals with giftedness in specific talent domains. He also takes into account the equally significant role of environmental influences as external catalysts (surroundings, persons and events) on the talent developmental process. Gagné’s model illustrates the key areas of influence on the talent development process of gifted individuals. Gagné’s model of talent development is illustrated in Figure 1.
Figure 1 Gagné's Differentiated Model of Talent Development

In a study of *The Patterns of Influence on Gifted Learners*, VanTassel-Baska and Olszewski-Kublius (1989) confirmed many of the findings of the Bloom (1985) study by identifying three factors necessary for eminence: (1) birth into a family that values learning, (2) early precocity in a specific domain, and (3) focus and self-direction. However, as they observed, since these three factors interact with the intellectual, societal, and psychological domains, it is difficult to predict adult eminence based solely on these childhood characteristics. Environmental influences clearly intertwine with individual personality and intelligence variables to shape the talent development process of highly successful individuals.

*External influences on talent development*

Gagné’s model (1985, 1991) posits the critical influence of environmental catalysts on the talent development process. The roles of surroundings (home, school, community), persons (parents, teachers, mentors and peers), and events (encounters, awards, accidents) affect the process of the development of talent over the lifespan in critical ways. The influences of external catalysts on achievement are well established in the literature (Albert, 1983; Csikszentmihalyi et al., 1993; Gagné, 1985; Maines, 2007; Subotnik & Arnold, 1995; Yewchuk & Schlosser, 1995).

Research on women’s careers (Noble et al., 1999, Wasserman, 2000) frequently references the impact of significant others on the success (or not) of gifted women’s talent development. The role of mentors and supportive individuals, both in and outside of a woman’s family of origin and/or choice, are listed as exceptionally significant to the progress of women’s careers (Xie & Shauman, 2003; Young, MacKenzie & Sherif, 1980). Freeman (1979) revealed that, although women Ph.D.s as a group have higher
IQ's, higher grade point averages and higher class ranks than their male counterparts, they are deprived of the rich external environment of high expectations and encouragement that research indicates is best for personal growth and creative production. For many gifted women, the ability to “compose a life” (Bateson, 1989) is significantly different from their male peers. Family roles and responsibilities, as well as the value women place on inter-personal relationships (Gilligan, 1982), all seem to lead women scholars along a different time continuum in their careers than men in the same domain.

Surroundings. The surroundings in the talent development model (Gagné, 1985, 1991) include school, home, and community and significantly shape the career trajectory for a person of high ability. Several studies illustrate the importance of surroundings for women in academic science. The call in the literature for culture change is significant. Doerrer (2001), a woman chemist at Barnard College, argued the need for a shift in culture at the institutional level to ensure that women’s experiences are valued and included. Since much of academic science remains a largely male province, continued programming to target girls and young women's interest in science is critical. For example, 95% of engineering faculty members are men, and most of these male faculty engineers were educated in traditionally male-dominated environments (Farrell, 2002, p. A32). Multiple schools and universities now provide programming targeting girls and women for scientific careers, often specifically targeting engineering. Cornell University, Washington & Jefferson College, Smith College, Carleton College and Oberlin College all have programs in place to provide young women college students with a “nurturing and supportive environment” (Black-McGrath, 2005, p. 13; Farrell, 2002). Based on surveys of graduates of these innovative programs for women in
science, the results are promising. Many women report changing their majors to science, continuing on to graduate school in the sciences, and persisting in scientific careers (Black-McGrath, 2005).

The issue of senior women faculty representation appears most significant at research universities. The American Chemical Society reported that eleven of the top fifty research universities in the U. S. have no women chemists at the rank of full professor (McGinn, 2005). Some universities are actively seeking to recruit large numbers of women to their departments. For example, at Rutgers University, 25% of the chemistry faculty is now composed of women, and several full professors are female scientists. The ability to retain and recruit women academics and female students across the sciences has significantly improved for this top research university in recent years, due to their efforts to improve the surroundings for their female science faculty (McGinn, 2005).

In a case study of eight women academics at different research universities in Great Britain, Kettle (1996) discovered that the women surveyed perceived that the major obstacles to their advancement in careers in academia were more related to cultural constraints than to practical considerations like childcare responsibilities. This group of female academics felt that the chief obstacles to their advancement were primarily institutional. The common theme among the women was that the “criteria for promotion were weighted in favor of the men” and that “the universities described appear to display and reflect a series of attitudes and cultures, which, when taken as a whole, act as invisible but stalwart barriers to the career progression of women academics” (p. 63).
Some innovative programs are creating networks to address these concerns for women academic scientists. For example, "COACh" (the Committee on the Advancement of Women Chemists), actively seeks to provide women academic chemists with the establishment of a collegial network of similar peers. Since 90% of the tenure-track chemists at the top 50 research institutions in the United States are men, the founders of COACh observed a critical need to bring women chemists together to network and share strategies to improve the trajectory of their careers in academic science (Schneider, 2000). These formalized networks of women scientists are growing nationally with similar organizations for women in computer science, engineering, geology, and mathematics forming groups for their members (Schneider, 2000; Wilson, 2003).

Home demands also influence the tendency of many academic women to peak later than their male counterparts, as the burdens of child-rearing fall on women in more significant and career-affecting forms (Kantrowitz, 2007). Many academic women choose to wait to start families for fear of not achieving tenure and promotion. Many women recount the agonizing conflict between the competing demands of their biological and tenure clocks while other women make the choice to have no or few children (Daniell, 2006; Monosson, 2008). Several narratives have recorded the significance of a spouse/partner who also works as a scientist and/or as an academic (Daniell, 2006; Kantrowitz, 2007; Wasserman, 2000) and suggested the possible role of the academic woman scientist's spouse or partner in contributing to her career success. Further research is needed to determine if there is a prevalence of similar patterns in the lives of successful women academics and what role this may play in their career success.
Persons. Significant persons in Gagné’s model (1985, 1991) include families, teachers, mentors and peers. Each of these constituency groups influence the development of the talent process significantly by fostering (or not) the ability and talent development of gifted individuals. Several universities are constructing programs to foster intentional mentoring of women science faculty. For example, at Columbia University, retired senior academics are hired by the university to coach younger women faculty in deliberate and institutionally sponsored mentoring roles, in order to promote success in tenure and promotion rates (Rimer, 2005).

Career development models of both gifted men and women have revealed that the family plays a significant role in shaping the developmental process of career orientation (Bloom, 1985). Yewchuk and Schlosser (1995) studied 197 women listed in Who’s Who of Canadian Women, discovering that eminent women share many characteristics with their male counterparts. Consistent with comparable studies of male high achievers (Albert, 1978, 1983), many of the women in this study described their parents as “cooperative, work-oriented, just, loving, consistent, supportive, and fair” (p.79), and the participants also revealed that they did not feel “limited by their gender” (p. 80). The women also felt that they were “raised to believe that they were capable of outstanding achievement and supported in their aspiration for career goals” (p. 82).

Several studies have recorded the influence of families of origin and current families. A meta-analysis conducted by the National Science Foundation (2003) discovered that current family structure in the lives of women scientists appears to play a critical role in career development milestones. Several studies cited in the NSF’s meta-analysis reflected that having children significantly reduces the chances of promotion for
women but not for men (Olson, 1999). Monosson's (2007) volume of collected accounts by women scholars who are also mothers explored in-depth, through first person narratives of several scientist scholar-mothers, the negative impact that having and raising children can have on a female scientist's career trajectory.

Subotnik's longitudinal study of the 1983 Westinghouse scholarship winners (Subotnik et al., 2001; Subotnik & Steiner, 1994; Subotnik, Duschl & Selmon, 1993) also documented the importance of significant people in the talent development process of gifted individuals. The Westinghouse Science Talent Search (now Intel Talent Search) is the most prestigious science competition in the United States. Subotnik followed the winners for over thirteen years, until the group was in their mid 30s. As high school students, the winners had worked with mentors and completed internships with scientists; however, Subotnik discovered that once the winners went to college, the experience was markedly different. They were in large classes, often with other students who were not academically prepared for college-level science, and they had few mentors. She discovered that a majority of the female winners chose to pursue other majors and did not continue with science careers. The absence of mentoring and other guidance from significant others (e.g., professors, college advisors) proved a significant roadblock for these promising young potential scientists.

Events. Gagné also notes the importance of events as one of the primary environmental catalysts on an individual's talent development process. His model includes encounters, awards, and accidents as example of significant events. Settles, Cortina, Malley, and Stewart (2006) studied 208 women faculty scientists, examining the effect of experiences and events on the participants' career development outcomes.
Utilizing a hierarchical multiple regression model, they found that perceived or actual negative events, including sexual harassment, a sexist work climate, and lack of collaborative assignments, act as barriers to the career development of women science faculty members.

Women faculty also documented feeling more social isolation (Glenn, 2007; Xie & Shauman, 2003), a condition that acts as a daily “event” for many women scholars, gradually reducing their connections with significant others and to important career-enhancing experiences. Specific events in the lives of scholars throughout the career trajectory, including receiving awards and fellowships, also appeared to influence the talent development process (Rosser, 2004; Sonnert & Holton, 1995; Wasserman, 2000). Rossiter’s (1982) investigation of the top women scientists in the United States also revealed the significance of events in the lives of women researchers. Women in her study who had received an exceptional ranking as scientists had simultaneously been barred from honorary groups, overlooked for awards, and lacked leadership positions in scientific professional societies or academic departments.

*Accidents.* Individuals also do not control the families into which they are born or the order in which they are born. These accidents also appear to significantly affect the odds of success for academics and women. Birth order was often cited (Bloom, 1985; Galton, 1875; Gross, 2003) as playing a role in the likelihood that an individual will become a high achiever. As Gross (2003) records, “an unusually high proportion of highly gifted children are first-born” (p. 76). Parental occupation is also a factor in the career choice of individuals. A case study of several faculty members who are also the
progeny of successful faculty themselves recorded the importance of this chance of birth to the future success of several faculty members. As Schenider (1999) documents:

For most professorial progeny, it was the sight of their parents at work, whether on scholarly tomes or plain old textbooks, that got them hooked on the profession. Seminars in the living room, heady debates at the dinner table, index cards and blue books scattered around the house, car rides spent solving math puzzles, summer trips to faraway places: That's what most of the professors think of when asked to reflect on life in an academic household. (p. A16)

A recent study by economists at the University of Maryland and North Carolina State University, utilized three large data sets of women and their families spanning birth cohorts from 1909 through 1977, and recorded a 13-20% probability increase (versus a control group), that a women will choose her father's profession as her own career (Hellerstein & Morrill, 2008). This study strongly suggested that – with the increase in professional women in recent decades – women's career choices are significantly influenced by those of their fathers. The authors hypothesized that this trend may be attributed to the increased transmission of “occupation-specific human capital” between fathers and daughters including teaching a daughter his trade and/or bringing her into his place of work; spending time with his daughter and demonstrating the value of his work; paying for his daughter to be trained in his trade; spending more time with his daughter, and assisting his daughter in securing a job or training for a job.

*Internal characteristics*

VanTassel-Baska and Olszewski-Kublius (1989) noted that one of the critical factors necessary for high levels of career success is focus and self-direction. Intrinsic to
an understanding of these characteristics is motivation: the ability and internal set of reasons for an individual to consistently work towards personal and professional goals. Striving for completion of tasks is often a self-directed process whereby the individual must draw on internal resources to garner energy and intellectual resources while simultaneously allocating time and space to complete assignments and projects.

Gagné’s talent development model (1985, 1991) demonstrates the critical importance of these intrapersonal catalysts on the process of transforming giftedness (aptitude or potential) into talents (actual performance). Gagné’s model illustrates the primary internal characteristics of motivation (initiative, needs, interests, and perseverance) and temperament/personality (adaptability, attitudes, competitiveness, independence, self-esteem, and values) on the talent development process. These intrapersonal catalysts, viewed also as internal characteristics, appear to have a significant effect on the process of career development for women in science, and they are investigated in several studies.

Motivation. Motivation is one of the two primary intrapersonal catalysts in Gagné’s model of differentiated talent development. Numerous studies of the talent development process of gifted individuals record the critical importance of motivation, often noted as perseverance or persistence, to career success. Howe and Berenson (2003), in their study of the factors that contribute to success for high-achieving girls in mathematics, related that girls attribute their success to the “desire to understand mathematics, assertiveness and the belief in hard work” (p. 87). The girls in the study specifically attributed their success in math to their own hard work, not to innate ability.
Cox, in her study of 300 eminent historical figures, (1926, as cited in Ochse, 1991) recorded that the most prominent attribute among these exceptionally high achievers was their perseverance, regardless of obstacles. This intensity of focus and commitment (Piirto, 1991) represented the ability of gifted individuals to move forward, despite interruptions – whether short or long-term – to the ultimate trajectory of their careers. Filippelli and Walberg (1997) in their study of the childhood traits and conditions of eminent women scientists recorded the similarities and differences between their study participants (21 eminent American women scientists) and a group of 235 eminent women in other non-scientific fields. The ability and desire to persist and focus on specific tasks as young girls appeared to be an influential factor for future successful women scientists. Significant to the purpose of the current study, Albert (1975) noted that perseverance and the ability to revise seem critical for the individual who is later recognized as an important scholarly contributor (Albert, 1996).

Bloom (1985) conducted a retrospective interview study with notable individuals in six talent areas covering the arenas of athletics, art, and intellect. This study is frequently cited in the literature as the hallmark longitudinal study of the talent development experiences of individuals who are recognized as significant contributors to their respective fields by early adulthood. Bloom’s work shaped the focus on domain-specific talent development for all future studies of gifted achievers and provided a framework for the study of the influence of variables such as genetics, family, and expert instruction on successful individuals. Themes emerging from this study relate specifically to intrinsic motivation, persistence and risk-taking. Additionally, since both renowned mathematical and scientific scholars are included in Bloom’s study, the talent
development patterns leading to success in these specific intellectual domains were revealed. As one of the successful mathematicians in Bloom’s study revealed:

I definitely have the feeling that this is tied up with motivational factors, things that are part of the larger experience of life. I can’t imagine someone coming totally out of the cultural context with no support from the family, and then somehow through some cleverly designed educational program turning into a mathematician. It simply seems completely impossible. One sets up values from early on. Not only things that are desirable or not, but things that you feel capable or not capable of doing. You do this by copying the people around you. If there's one thing that stands out to me, it’s that the whole business in some peculiar way boils down to people. If you are in contact with the people who had the right approach and the right ideas, then you will wind up at least having the opportunity of doing certain things, and otherwise you won’t. (Bloom, 1985, p. 133)

At Washington University, researchers are conducting studies of brain functions with brain imaging to investigate the trait of persistence. A recent study (Gusnard, Ollinger, Shulman, Cloninger, Price, Van Essen & Raichle, 2003) of 24 subjects (twelve men and twelve women) revealed that specific brain activity simultaneously occurs when study participants engage in focusing on a specific task, while consciously eliminating distractions until the completion of the task was fulfilled. Scientific studies of this kind should continue to enhance understanding of the internal characteristics of motivation and persistence.

Temperament/personality. Temperament/personality is the second primary intrapersonal catalyst, or internal characteristic, in Gagné’s (1985, 1991) model of talent
development. President of Princeton and molecular biologist Shirley Tilghman's (2005) account of her perceptions of successful women scientists is particularly notable as she attributes her own success and that of other women scientists to the "absolute inability to recognize reality" and the failure to "perceive that there are obstacles in their path" (p. 4). This innate personality trait of temperament and unwillingness to view events, surroundings or people as barriers appears as a recurring theme in the literature about successful individuals.

Risk-taking is also one of the elements of personality/temperament. For scientific scholars, risk-taking is viewed as a critical component of future creative productivity, as it requires the mastery of the knowledge base and the ability to think beyond the current limits of the domain (Kantrowitz, 2007). Interest in and willingness to take intellectual risks to produce something new and transformational is critical to success as a scientific researcher. Although the quantity of articles is not necessarily the key to the door marked "successful scholar," there are also indicators that the more research studies conducted and the more ideas tried out in the journals leads to a refinement of ideas and research designs that build toward a revolutionary conceptualization that earns the scholar a place among the top ranks in her discipline or field. This concept of creativity and trying out new ideas is particularly relevant for scientists who experiment in their research as a critical element of the process of discovery. Heidi Hammel, a senior research scientist at the Space Science Institute, advises younger women scientists in a recent interview: "Don't turn down an opportunity because you are afraid... Be willing to take a chance!" (Kantrowitz, 2007, p. 54)
Simonton (2004) proposed that creative genius is often the result of both chance and risk-taking. He outlined specific causes and correlations with science creativity. He believes that creativity in science is a combination of logic, chance, genius and the zeitgeist of the time and culture in which the individual scientist is present. He advocates for the “equal-odds rule” which indicates that the average publication of any particular scientist does not have any statistically different chance of having more of an impact than any other scientist's average publication. When one scientist's work does result in a significant impact in his/her field of inquiry, it is basically the product of “trying” enough times. This scholarly risk-taking is inherent to forward movement in research. Peer evaluations of publications, teaching credentials, educational institutions, conference papers, and applications of research form the basis upon which scholars are evaluated in their disciplines/fields. Additionally, risk-taking in an academic career can also be measured by the times when an academic was willing to “change course” in their research area(s) or in their path in a particular discipline (Philipsen, 2008; Pugel, 1997; Xie & Shauman, 2003).

For intellectual thinkers, early productivity is linked in several studies (Albert, 1975; Cox, 1926; Terman, 1954) as one of the most important predictors of how productive and creative a person will be later in their career. Early productivity also increases the likelihood that the individual will receive recognition as a significant contributor to their talent domain. Creative productivity requires the mastery of the domain of knowledge, the ability to think beyond the current limits of the domain, perseverance, and the interest in and willingness to take intellectual risks to produce something new and transformational.
Since early productivity is an indicator of later career success, the initial identification of promising talent in the sciences is important. A review of the literature revealed that early identification of exceptionally gifted individuals in the sciences is difficult for several reasons. Unlike language arts and mathematics, very few elementary schools designate time for frequent exploration of scientific concepts and ideas. And, few teachers, even in the upper grades of middle and high school, have more than an undergraduate education in the sciences. Since many science teachers at the high school level possess only a Bachelor of Arts degree, they have experienced a limited breadth and depth of the specific scientific discipline(s) they are teaching. Therefore, there are few opportunities for early identification and development of exceptional talent in promising young potential scientists. This may significantly impact girls more than boys as several studies have indicated the important effects of mentorship and early encouragement for girls in science (Arnold, 1995; AAUW, 2001; Fischman, 2007).

Resiliency is also a hallmark trait of those who achieve success in academia (Csikszentmihalyi & Csikszentmihalyi, 2006; Seligman, 2002; Siebert, 2005; Snyder & Lopez, 2005). Defining resilience is challenging, as multiple definitions exist in the literature. The general consensus from the relevant literature is that resiliency is the capacity that allows a person, group or community to prevent, minimize or overcome the damaging effects of adversity (Grotberg, 1997). Specific to this study, resiliency is the ability of an individual to find benefits to adverse experiences. As Nietzsche famously noted: “that which does not kill me makes me stronger” (as quoted in Frankl, 1956, p. 103). Siebert (2005) observed that “self-confidence, self-esteem and self-concept function like gatekeepers that control access to higher-level resiliency abilities” (p. 73).
Summary of the Literature

The review of these major literature strands related to the gifted literature on women, higher education literature on women faculty and academic science, and the literature regarding the external factors and internal characteristics that influence the talent development process, provides a comprehensive view of the issues explored in this study. Figure 2 outlines the major studies reviewed by strand, research and summary of findings for each area of the literature review.
### Figure 2 Summary of Literature Review

<table>
<thead>
<tr>
<th>Research Strands</th>
<th>Studies</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gagné’s Differential Talent Development Model</td>
<td>Gagne, 1985, 1991</td>
<td>This differentiated model of talent development illustrates the process of the development of talent over the lifespan and demonstrates the patterns of influence – including the critical roles of external and intrapersonal catalysts - that support the talent development process in gifted individuals who become prominent contributors in their talent domains.</td>
</tr>
<tr>
<td>Persons</td>
<td>Cameron &amp; Blackburn, 1981; Evans &amp; Grant, 2008; Monossos, 2008; Olson, 1999; Ragins &amp; Scandura, 1994; Rimer, 2005; Schneider, 1999; Wunsch, 1994; Yewchuk &amp; Schlosser, 1995</td>
<td>These studies explore and demonstrate the findings that important persons have influence – both positive and negative – on the process of talent development in gifted individuals over the lifespan. Important findings include the role of parents, teachers and mentors.</td>
</tr>
<tr>
<td>Events</td>
<td>Gladwell, 2008; Glenn, 2007; Hellerstein &amp; Morrill, 2008; Rosser, 2004; Rosseter, 1982; Settles, Cortina, Malley &amp; Stewart, 2006; Sonnier &amp; Holton, 1995</td>
<td>These studies indicate that events including accidents, awards and encounters play in contributing (or not) the fulfillment of potential in gifted individuals. The role of birth order, the family of origin, and the early recognition of talent in awards and honors are emphasized in these studies.</td>
</tr>
<tr>
<td>Motivation</td>
<td>Cox, 1926; Filippelli &amp; Walberg, 1997; Gusnard, Ollinger, Schulman, et al, 2003; Howe &amp; Berenson, 2003; Piirto, 1991</td>
<td>This group of studies relates the need for the intrapersonal skills of motivation, which include focus and self-direction; a striving for completion of tasks; feeling capable; risk-taking, and self-initiative.</td>
</tr>
<tr>
<td>Temperament/ Personality</td>
<td>Gardner, 1993; Groberg, 1997; Kantrowitz, 2007; Pagel, 1997; Reis, 2002; Seligman, 2002; Siebert, 2005; Simonton, 2004, 1994; Snyder &amp; Lopez, 2005; Tilghman, 2005</td>
<td>These studies examined the importance of self-confidence, the value of hard work, competitiveness, adaptability and independence to the success of gifted individuals.</td>
</tr>
<tr>
<td>Research Strands</td>
<td>Studies</td>
<td>Findings</td>
</tr>
<tr>
<td>--------------------------------------</td>
<td>-------------------------------------------------------------------------</td>
<td>------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Careers of Women Scientists</td>
<td>Ajzenberg-Selove, 1994; Ambrose, Dunkle, Lazarus, Nair &amp; Harkus, 1997; Bystrzyckiene &amp; Bird, 2006; Ceci &amp; Williams, 2007; Daniell, 2006; Etzkowitz, Kemelgor &amp; Uzzi, 2000; Fara, 2007; Maddox, 2003; Maines, 2007; McGraw, 1993; Preston, 2004; Rossiter, 1995; Subotnik &amp; Arnold, 1993; Wasserman, 2000; Xie &amp; Shauman, 2003</td>
<td>These studies cite the need for models of success for women academic scientists and reveal important reasons for why patterns of influence contributing to success for women in science need to be explored and reported in the literature. These studies relate the different facilitators and barriers faced by women scientists during their career development and cite the historical lack of recognition for women science achievers.</td>
</tr>
<tr>
<td>Talent Development Process of Scientists</td>
<td>Berger, 1994; Galton, 1875; Subotnik, 2000; Subotnik, Dusch &amp; Selmon, 1993; Subotnik, Maurer &amp; Steiner, 2001; Subotnik &amp; Steiner, 1994</td>
<td>These studies identify the different experiences and critical milestones for scientists, including an early focus and interest in science, the important role of early teachers, mentors and parents, the need for senior collaborator/mentors and the critical focus on grants for research and publishing results early in their careers.</td>
</tr>
<tr>
<td>Talent Development of Women</td>
<td>AAUW, 2001; Batesen, 1989; Fitzgerald &amp; Betz, 1994; Freeman, 1979; Gilligan, 1982; Glazer-Raymo, 1999; Harper, Baldwin, Gansneder &amp; Chronister, 2001; Heward, 2006; Hill, 2008; Noble, Arnold &amp; Subotnik, 1999; Reis &amp; Callahan, 1989; Rimm, 2001; Silverman, 1996; VanTassel-Baska, 1996</td>
<td>These studies examine the significantly different experiences during the talent development process for gifted women, specifically exploring the importance that the roles of families, mentors, and culture/surroundings play in helping gifted women fulfill their potential.</td>
</tr>
<tr>
<td>Eminence</td>
<td>Albert, 1996, 1990, 1987, 1983, 1975; Andreason, 2005; Cattell &amp; Dreבאhl, 1955; Goertzel, Goertz &amp; Goertzel, 1979; Reis, 1996; Roe, 1951; Walberg, Rasher &amp; Hase, 1978</td>
<td>These accounts of eminent individuals, both historic and current, describe the important early influences in families and education combined with the patterns of personality characteristics common to eminent individuals in a variety of talent domains.</td>
</tr>
<tr>
<td>Talent Development of Gifted Individuals</td>
<td>Arnold, 1995; Bloom 1985: Csikszentmihalyi &amp; Csikszentmihalyi, 2006; Csikszentmihalyi, Rathunde &amp; Whalen, 1993; Galton, 1869; Terman, 1934; Gross, 2003; VanTassel-Baska &amp; Olszewski-Kublius, 1989</td>
<td>These studies focus on the development of talent over the lifespan and examine the patterns of influence that support the talent development process in gifted individuals who do (or do not) become prominent contributors in various domains of talent.</td>
</tr>
<tr>
<td>Research Strands</td>
<td>Studies</td>
<td>Findings</td>
</tr>
<tr>
<td>----------------------------------------</td>
<td>--------------------------------------------------------------------------</td>
<td>------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Women Faculty Career Development</td>
<td>Clark &amp; Corcoran, 1986; Collins, Chrisler &amp; Quina, 1998; Monroe, Ozyurt, Wrigley &amp; Alexander, 2008; Philipsen, 2008; Rothblum, 1988; Shavlik, Touchton &amp; Pearson, 1989</td>
<td>These studies identify important themes including the isolation many women experience the in academic culture; the concept of a “chilly climate;” the importance of mentors and peer networks; the concept of accumulative disadvantage; the role of tokenism, and the interruptions women experience during their career trajectories.</td>
</tr>
<tr>
<td>Faculty Career Development</td>
<td>Baldwin, 1990, 1983, 1979; Baldwin &amp; Chang, 2006; Baldwin, Lunceford &amp; Vanderlinden, 2005; Blackburn &amp; Lawrence, 1995; Clark, 1987; Isaac, 2007; Light, 1974; Schuster, 1990</td>
<td>These studies reveal the important factors for faculty development including the need to persist in publishing; sustain creativity and innovation; and, have the ability to mentor the next generation of scholars. The role of faculty career stages in the career trajectory of academics is also emphasized.</td>
</tr>
</tbody>
</table>
Chapter 3: Methodology

Description of the Study

The current study built on the literature base related to successful academic women scientists, utilizing the framework of Gagné's differentiated talent development model for gifted individuals (Gagné, 1985, 1991). It examined the themes cited in multiple studies that influence the talent development process (Ceci & Williams, 2007; Daniell, 2006; Rosser, 2004; Wasserman, 2000; Xie & Shauman, 2003). This study served as an examination of the facilitators and barriers – including external factors and internal characteristics – on the talent development process of successful women academic scientists.

Through a mixed-design methodology (Creswell, 2009) that incorporates quantitative and qualitative analysis using a survey and follow-up interviews with selected participants, this study determined the effects of internal characteristics, external influences, and significant events and experiences on the success of women scientists at elite research universities in New York.

Research design

With research studies and narratives of gifted women as a foundation, this study investigated the talent development process of successful academic women scientists by utilizing a survey that integrates forced choice and open-ended items. Select follow-up interviews further explored the data collected through the survey. This mixed-methods
design provided opportunities to connect and integrate both the qualitative and quantitative data collected (Creswell, 2009). This mixed-design methodology preserved the importance of the voices of some of the participants in contributing to the knowledge about their own population through the sharing of their talent development narratives in qualitative survey responses and selected interviews. This approach also considered the social constructivist position of the researcher that individuals strive to make meaning about their lives from an understanding of their own experiences (Bateson, 1989; Crotty, 1998; Mertens, 1998). Simultaneously, the use of survey research also provides descriptions of attitudes, opinions and trends (Babbie, 2007).

Research that enumerates both internal characteristics and external influences that lead to success is notably lacking in the literature. The current study adds to the literature related to successful models of female achievement, notably for women in the academic sciences. This study evaluated and explored internal characteristics and external factors, including familial and career influences, on the talent development process of this sample of successful women scientists. This study assessed the talent development process of successful academic women scientists in the disciplines, defined here by the National Academy of Sciences’ categories (Categories I and III) of the “physical and mathematical sciences,” which include Mathematics, Astronomy, Physics, Chemistry, Geology and Geophysics, and “engineering and applied sciences,” which include Engineering Sciences, Applied Mathematical Sciences, Applied Physical Sciences and Computer and Information Sciences (National Academy of Sciences, 2008). These specific areas of science were chosen, as they remain the most traditionally male-dominated of the sciences (National Science Foundation, 2007).
Research questions

Several research questions guided this study. The primary overarching research question for this study was: What are the perceived influences on the talent development process of successful female scientists in academia?

The research questions addressed in the study, based on Gagné's differentiated model of talent development (1991) were the following:

1. *What are the environmental catalysts of surroundings, people, opportunities and events that have contributed to the talent development process of the study participants?*

2. *What are the intrapersonal catalysts of internal characteristics that have contributed to the talent development process of the study participants?*

3. *What are the primary facilitators and barriers that were encountered in the talent development process of the study participants?*

These types of questions regarding the talent development process of successful women scholars further refine this model of differentiated talent development and revise the major research question in the area of female talent development from “Why are there so few women?” to “What are the similar environmental and intrapersonal catalysts and influences on the career paths of successful women scientists in academia?” Table 1 outlines the primary research questions, the instrumentation utilized to collect information regarding these questions, and the data analysis for each question:
<table>
<thead>
<tr>
<th>Research questions</th>
<th>Instrumentation</th>
<th>Data Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Overarching Research Question:</strong></td>
<td></td>
<td></td>
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<tr>
<td>What is the talent development process for</td>
<td>Survey: questions specifically ask about participants’ family of origin and</td>
<td>Survey: Statistical analysis of forced-choice and Likert scale survey data</td>
</tr>
<tr>
<td>successful female academic scientists?</td>
<td>current family structure; significant others including partners, friends,</td>
<td>(including descriptive statistics, frequencies and selected correlations);</td>
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<tr>
<td></td>
<td>mentors, and colleagues and educational backgrounds and experiences of study</td>
<td>coding of qualitative responses of open-ended items.</td>
</tr>
<tr>
<td></td>
<td>participants.</td>
<td>Interviews:</td>
</tr>
<tr>
<td></td>
<td>Follow-up interviews were conducted with five selected study participants.</td>
<td>Content analysis using significant statement coding and categories and</td>
</tr>
<tr>
<td></td>
<td>Interview questions related to the narrative of the participant’s talent</td>
<td>derivation of themes from the interviews.</td>
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<tr>
<td></td>
<td>development story and to the external influences and events most important to</td>
<td></td>
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<tr>
<td></td>
<td>their talent development process.</td>
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<tr>
<td><strong>Research Question 1:</strong></td>
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<tr>
<td>What are the specific environmental</td>
<td>Survey: questions related to internal characteristics that affect the talent</td>
<td>Survey: Statistical analysis of forced-choice and Likert scale survey data</td>
</tr>
<tr>
<td>catalysts of surroundings, people,</td>
<td>development process, based on previous studies related to these factors.</td>
<td>(including descriptive statistics, frequencies and selected correlations);</td>
</tr>
<tr>
<td>opportunities, and events that have</td>
<td>Interviews: Follow-up interviews were conducted with five selected study</td>
<td>coding of qualitative responses of open-ended items.</td>
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<tr>
<td>contributed to the talent development</td>
<td>participants. Interview questions related to the narrative of the participant’s</td>
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<tr>
<td>process of the study participants?</td>
<td>talent development story and to the internal characteristics most important to</td>
<td></td>
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<tr>
<td></td>
<td>their talent development process.</td>
<td></td>
</tr>
<tr>
<td><strong>Research Question 2:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>What are the specific intrapersonal</td>
<td>Survey: A section of the survey is devoted to forced choice and open-ended</td>
<td>Survey: Statistical analysis of forced-choice and Likert scale survey data</td>
</tr>
<tr>
<td>catalysts of internal characteristics that</td>
<td>questions specifically asking study participants about facilitators and</td>
<td>(including descriptive statistics, frequencies and selected correlations);</td>
</tr>
<tr>
<td>have contributed to the talent development</td>
<td>barriers.</td>
<td>coding of qualitative responses of open-ended items.</td>
</tr>
<tr>
<td>process of the study participants?</td>
<td>Interviews: Follow-up interviews were conducted with five selected study</td>
<td>Interviews:</td>
</tr>
<tr>
<td></td>
<td>participants. Interview questions related to the specific facilitators and</td>
<td>Content analysis using significant statement coding and categories and</td>
</tr>
<tr>
<td></td>
<td>barriers more important to the of the participant’s talent development</td>
<td>derivation of themes from the interviews.</td>
</tr>
<tr>
<td></td>
<td>process.</td>
<td></td>
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<tr>
<td><strong>Research Question 3:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>What are the primary facilitators and</td>
<td>Survey: A section of the survey is devoted to forced choice and open-ended</td>
<td>Survey: Statistical analysis of forced-choice and Likert scale survey data</td>
</tr>
<tr>
<td>barriers that are encountered in the talent</td>
<td>questions specifically asking study participants about facilitators and</td>
<td>(including descriptive statistics, frequencies and selected correlations);</td>
</tr>
<tr>
<td>development process of the study</td>
<td>barriers.</td>
<td>coding of qualitative responses of open-ended items.</td>
</tr>
<tr>
<td>participants?</td>
<td>Interviews: Follow-up interviews were conducted with five selected study</td>
<td>Interviews:</td>
</tr>
<tr>
<td></td>
<td>participants. Interview questions related to the specific facilitators and</td>
<td>Content analysis using significant statement coding and categories and</td>
</tr>
<tr>
<td></td>
<td>barriers more important to the of the participant’s talent development</td>
<td>derivation of themes from the interviews.</td>
</tr>
<tr>
<td></td>
<td>process.</td>
<td></td>
</tr>
</tbody>
</table>

*Table 1 Research questions*
Sample

A criterion sample was used. The initial sample (n=94) consisted of all of the tenured women in the sciences in Categories I and III, as defined by the National Academy of Sciences, who also met the criteria for successful as defined for the purposes of this study, currently employed at the top 100 ranked national universities (n=10) in New York State. Criterion sampling was chosen as the method of sampling for this study as it involves selecting a population that meet specific, pre-determined criteria of importance. This method of sampling is useful for identifying and understanding specific populations of study participants (Patton, 2001, p. 238). Table 2 lists the institutions included in this study.
Table 2 Demographics: Surveyed institutions

<table>
<thead>
<tr>
<th>National universities</th>
<th>Ranking in U.S. News</th>
<th>Participants that met criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Columbia University</td>
<td>8</td>
<td>15</td>
</tr>
<tr>
<td>Cornell University</td>
<td>14</td>
<td>14</td>
</tr>
<tr>
<td>Fordham University</td>
<td>61</td>
<td>2</td>
</tr>
<tr>
<td>New York University</td>
<td>33</td>
<td>7</td>
</tr>
<tr>
<td>Rensselaer Polytechnic Institute</td>
<td>41</td>
<td>10</td>
</tr>
<tr>
<td>SUNY-Binghamton</td>
<td>77</td>
<td>5</td>
</tr>
<tr>
<td>SUNY-Stony Brook</td>
<td>96</td>
<td>15</td>
</tr>
<tr>
<td>Syracuse University</td>
<td>53</td>
<td>10</td>
</tr>
<tr>
<td>University of Rochester</td>
<td>35</td>
<td>15</td>
</tr>
<tr>
<td>Yeshiva University</td>
<td>50</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>94</strong></td>
</tr>
</tbody>
</table>

Criteria for selection of institutions

The selected institutions were derived from the recent listing by “U.S. News and World Report” (2008) of the “2009 Best Colleges and Universities in the United States.” From this survey, ten national research universities located in New York state that are also listed in the top 100 ranking for national research higher education institutions were chosen. *U. S. News and World Report* defines national universities as those that “offer a full range of undergraduate majors, master’s, and doctoral degrees. These colleges also are committed to producing groundbreaking research” (2008). After the generation of this
list of universities, a review of each institution’s website was conducted to locate the current tenured women serving in the science departments with inclusion in Categories I and III of the National Academy of Sciences (NAS). The women with the rank of Associate Professor, Professor or Research Professor who also met the above criteria for success represent the sample chosen for this study. Table 3 illustrates the various areas of science (representing NAS Categories I and III) represented by the sample.

Criteria for selection of participants

These 94 women were chosen for this criterion sample based on their listing as tenured faculty in the sciences at these institutions. In addition to their earning tenure at these prestigious national research institutions, an extensive survey was conducted of the information publicly available on-line and institutionally for each of the women, to ensure that each participant selected for the study had demonstrated significant productivity and success in their careers as scientists. This review of the participants was conducted on each of the selected institutions' available publication information, and participants were determined to have met all of the following criteria for their respective disciplines: (1) Significant national and/or international awards for their scientific research and/or competitive career awards in their disciplines, (2) significant grants funded by established national and international agencies, and (3) authors of multiple publications in top-tier, peer-reviewed journals (Andreason, 2005; Rosser, 2004; Wasserman, 2000; Xie & Shauman, 2003).
Table 3 Demographics: Surveyed science disciplines and numbers in the sample

<table>
<thead>
<tr>
<th>Discipline of science</th>
<th>Number in the sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>Astronomy</td>
<td>3</td>
</tr>
<tr>
<td>Chemistry</td>
<td>20</td>
</tr>
<tr>
<td>Computer Science</td>
<td>11</td>
</tr>
<tr>
<td>Engineering</td>
<td>13</td>
</tr>
<tr>
<td>Geology</td>
<td>12</td>
</tr>
<tr>
<td>Mathematics</td>
<td>18</td>
</tr>
<tr>
<td>Physics</td>
<td>17</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>94</strong></td>
</tr>
</tbody>
</table>

**Instrumentation**

A review of the literature and available instruments did not reveal an appropriate instrument for this study’s purpose. Therefore, an eight-part, 40 item survey instrument (Appendix A) was developed that incorporated the variables illustrated in Gagné’s model (1991). The survey incorporated those internal characteristics and external influences – including important persons, opportunities and events as well as personality and temperament characteristics – that appear to most often serve as facilitators and barriers in the talent development success of women scientists, based on Gagné’s differentiated model of talent development and a review of the literature. The survey instrument consisted of a combination of forced-choice responses, open-ended questions and Likert scale queries that are clustered in groups to reflect the components of the Gagné model.
explored in this study. The clusters are demographic; educational professional information; external influences (including specific sections on important events and people); internal characteristics, and facilitators and barriers. The survey was used to gather data related to the research questions. The survey was reviewed and revised with input from several experienced women scientists who are not included in the research sample. The survey instrument was created by the researcher and has not been tested previously in other studies. The inferences from this instrument have not been evaluated for construct validity or reliability, partially due to the relatively restricted range of responses.

**Piloting phase.** A pilot of the survey was conducted in early January with a group of ten women scientists at three institutions including Hobart and William Smith Colleges, the University of Richmond and Ursinus College. The pilot phase was utilized to establish content validity and provide feedback on the survey instrument, prior to the use of the survey with the study participants (Creswell, 2009). Feedback from the participants in the piloting process was incorporated into the final survey sent to all study participants. Participants in the pilot had several recommendations for improvement of the survey instrument. First, they suggested asking participants to attach a curriculum vita at the completion of the survey so that respondents did not have to directly answer some of the survey items that are easily found on their curriculum vitae. This suggestion was noted by several pilot participants as important, in order to shorten the length of time needed to complete the survey. Second, a simplification of the survey items was accomplished by moving them to other areas of the survey. Third, items that were confusing or noted as not relevant for this population were removed or rephrased. Fourth,
an item about membership in science affiliation organizations that relate to the
coloration of women was added. Finally, the use of language and terms familiar to this
population was included. All of the changes recommended by the pilot group are
incorporated in the final version of the survey.

Survey design

The survey was divided into eight sections and designed to align with the Gagné
differentiated talent development model (1985, 1991). The first section served as the
introduction to the survey, covering all ethical safeguards and directions for completion
of the survey. The second section probed the origins of the participants’ interest of
science and solicits demographic information. The third section of the survey addressed
professional information including the participants' career development progress,
experiences, and important milestones. These items probed current and past work
experiences, including grants/awards/patents, refereed publications, and other influences
on and indicators of career success in academic science. The fourth section sought to
understand the early programmatic experiences and events during the study participants’
high school and college years. The fifth section of the survey explored the external
influences of significant others on the talent development process. These people,
including the participants’ family of origin, current family structure, important educators
and mentors, have most influenced the study participants' talent development process
(Gagné, 1985, 1991). The sixth section explored the intrapersonal catalysts, including
internal characteristics (as specified by Gagné, 1985, 1991), on the study participants’
talent development process. The seventh section addressed important events (as specified
in Gagné’s model, 1985, 1991) in the study participants’ lives. The final section of the
survey asked study participants about future goals and for their advice to younger women scientists.

These roles of catalysts as facilitators and/or barriers were explored throughout the survey responses. Creswell (2009) recommends a table illustrating the research questions and survey items that correlate to each research question. Several survey items in the current study address more than one research question, as noted in Table 4.
Table 4 Research questions with correlating categories and survey items

<table>
<thead>
<tr>
<th>Category</th>
<th>Subcategories</th>
<th>Survey questions (SQ)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Surroundings</strong></td>
<td>Community/Culture</td>
<td>SQ7, SQ9, SQ11, SQ25, SQ26, SQ33, SQ35</td>
</tr>
<tr>
<td></td>
<td>Home</td>
<td></td>
</tr>
<tr>
<td></td>
<td>School</td>
<td></td>
</tr>
<tr>
<td><strong>Persons</strong></td>
<td>Parents</td>
<td>SQ3, SQ5, SQ6, SQ9, SQ27, SQ28, SQ29,</td>
</tr>
<tr>
<td></td>
<td>Teachers/Professors</td>
<td>SQ33, SQ35</td>
</tr>
<tr>
<td></td>
<td>Mentors</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Peers</td>
<td></td>
</tr>
<tr>
<td><strong>Events</strong></td>
<td>Encounters</td>
<td>SQ4, SQ9, SQ12, SQ13, SQ14, SQ24,</td>
</tr>
<tr>
<td></td>
<td>Awards</td>
<td>SQ33, SQ34, SQ35</td>
</tr>
<tr>
<td></td>
<td>Accidents</td>
<td></td>
</tr>
</tbody>
</table>

Research question 1:
What are the specific environmental catalysts of surroundings, people, opportunities and events that have contributed to the talent development process of the study participants?

Research question 2:
What are the specific intrapersonal catalysts of internal characteristics that have contributed to the talent development process of the study participants?

Research Question #3:
What are the primary facilitators and barriers that are encountered in the talent development process of the study participants?

Facilitators
SQ33, SQ34, SQ38

Barriers
SQ35, SQ36, SQ38
Procedures for the survey

In order to conduct this survey, specific procedures were followed. First, an e-mail was sent to all of the women represented in the sample that outlined the focus and purpose of the study and solicited their participation. This letter guided participants to the link for the survey, located on the website Survey Monkey. Creswell (2009) recommends Survey Monkey as an independent and certified survey tool available to researchers online (p. 149). The following week, an e-mail message was sent to all of the women in the sample with a similar request to participate and an embedded link to the survey for the study. Participants were asked to complete the survey within two weeks.

Procedures for the interviews

Five follow-up interviews were conducted with selected study participants, following the receipt of completed surveys in early March. Respondents were selected for further interviewing based on two factors: (1) Their willingness to be interviewed, as noted by a positive response at the end of the survey and (2) By answers to items posed on the survey that indicated possible outliers in terms of talent development experiences. Creswell (2009) notes the importance of the exploration of outliers in mixed-methodology research designs (p. 218). For this study, outliers were selected if they had responses that were outside the norm for the majority of survey responses. Five women appeared to have different experiences that affected their talent development process than those reported by the majority of the survey respondents. The follow-up interviews ensured a more complete understanding of the influences of the talent development process on the study participants’ career success. Selected interviews as a methodological approach served to more completely describe the meaning of the experiences of the
individuals who are observed (Creswell, 2009; Polkinghorne, 1989). Creswell (2009) recommends conducting a small number of interviews as a follow-up to survey data with relatively few unstructured and open-ended questions in order to "elicit views and opinions from the participants" (p. 181). Creswell specifically recommends the narrative "tell me the story about..." approach to these types of interviews. Additional questions were determined for each individual based on her specific survey responses. Appendix B contains the interview protocol used for this study.

These interviews were conducted on the phone, recorded with permission from each participant, and then transcribed (see Appendix G for the transcripts). Notes were also taken by the researcher during each interview. Immediately after each interview, the tape recordings were checked for clarity (Patton, 2002). Following transcription, member checks were conducted with each participant by e-mailing the full transcript of the individual interview, requesting review and comments.

Data Collection

There was a planned timetable for the data collection process. First, a pilot of the survey instrument was sent via e-mail to tenured academic women scientists who were not included in the sample group. In mid-February, after a revision of the instrument based on the feedback from the members of the pilot group and following the approval of the Human Subjects Committee at the College of William and Mary, collection of data from the study participants commenced. An e-mail was sent to each individual study participant on February 17 or 18, 2009, with a cover letter outlining the purpose of the study and the ethics requirements that had been met, along with an embedded link to the survey located on Survey Monkey. A follow-up e-mail was sent one week after the initial
contact, reminding study participants of the final deadline of March 2, 2009. After the receipt of all surveys, potential interview participants were identified and contacted for follow-up interviews. These selected interviews occurred during the period between March 13-18, 2009.

Return Rate

By February 22, 2009, 29 surveys were received (30.8% response rate). On February 23 and 24, follow-up e-mails were sent to potential participants who had not yet responded, reminding all potential survey respondents of the final deadline, March 2, 2009. By March 3, 2009, 41 surveys were received, resulting in a final, useable response rate of 43.6%.

Interview selection

After the receipt of all surveys, 22 of the 41 survey respondents volunteered, through a positive response on Survey Question 40, to participate in a follow-up interview. This process of selecting participants represented a convenience sample of potential interview participants. The researcher then evaluated these 22 responses for outlier characteristics and selected five. One participant was chosen for a follow-up interview as she listed that she is not happy with her career success, an uncommon response. A second participant was selected for a follow-up interview as she has very young children at home, unlike the majority of respondents with teenage or grown children at the current stage of their careers. The third respondent was chosen for an interview, as she listed very positive experiences with mentors throughout her career. The fourth participant was chosen for her being in the late career stage, one year from retirement. The fifth respondent was chosen due to the exceptional number of early career
awards she received. Each of these interview participants was atypical in her survey responses on one or more questions of the survey. They were each chosen for follow-up interviews to further explore these outlier responses and also deepen the perspective of the research.

Interviews were conducted with the five participants between the dates of March 13-19, 2009. Consent forms were sent to all five participants. All five consent forms were then signed by the interview participants and returned to the researcher. Interviews were conducted via phone with a tape recorder recording the interviews. Interviews lasted between 20-45 minutes, due to the busy schedules of the study participants. The interview protocol in Appendix B was used as a guide, and the order of interview questions was determined by the individual scientists’ responses (Patton, 2001). After transcription of the individual interviews, member checks were done with all interview participants. Each interview participant had the opportunity to review the transcript and make any changes. Three of the five participants chose to make small edits to their interview transcriptions.

Data analysis

Quantitative analysis

Both quantitative and qualitative methodologies were used for the current survey, and two levels of data analysis were employed to code the research results. The survey results that were quantitative in nature were analyzed using descriptive and correlational statistics. The survey data that are quantitative (forced-choice and closed-ended responses) are presented in tables in Chapter 4. This analysis included the means, frequencies, and where applicable, standard deviations and range of scores. Additionally,
selected correlations were run based primarily on rank (full v associate), age and number of refereed publications. The correlations report the relationship between age, rank and/or publication record with the self-reported attributes of selected internal characteristics, perceptions of research characteristics, and perceived facilitators and barriers. The quantitative data were coded and presented in tables and graphs, for each variable represented in the Gagné model and for each area of inquiry on the survey (Creswell, 2009). Results were then interpreted and discussed, based on the coding and data presented by both the qualitative (both survey and interview data) and for and in relation to the quantitative responses by the study participants.

*Qualitative analysis*

*Survey data.* For survey questions that were qualitative, data analysis included coding of the survey data to record categories and themes that reflected the responses of the participants. The qualitative data, represented by the open-ended questions on the survey, were collected and categorized. Coding is the process of organizing the data into categories, chunks or segments in order to make meaning of each segment. Coding provides multiple levels of analysis (Creswell, 2009). For this study, the first level of analysis resulted from the initial generation of reports from the qualitative survey responses. The information collected from these open-ended answers on the surveys was then coded and subsequently categorized for overarching categories and then further coded utilizing these categories. The arising categories for each question were then derived from this coding.

*Interview data.* Interviews were conducted with all five participants. Each interview had five primary questions that were common to all participants (Appendix B).
The five interview participants are coded as IP1, IP2, IP3, IP4 and IP5 in the specific responses referenced in the narrative. The data are presented by interview question and correlate to the central research questions of the study. Themes were derived from the coding and focused on the variables in the Gagné model. Table E2 in Appendix E illustrates the coding scheme, with three levels of categories and corresponding codes. The main level of coding utilized was the third-level (e.g., home, school, community, etc.), as this provided the highest level of coding specificity for each significant statement or phrase during the interview coding process. Creswell (2009) and Patton (2002) both recommend a selective coding process to use with the identification of a “story line” for each narrative that integrates the categories (Patton, pp. 439). Significant statements were extracted from the transcriptions, and themes were derived from these significant phrases and statements.

Individual interview transcript analysis was conducted in the following manner, as suggested by Creswell (2009) and Patton (2002). First, the interviews were reviewed and coded using the categories as explicated in Table E2. This was done using the content analysis method recommended by Patton, with the utilization of “shorthand codes” for each significant statement and phrase in the interview transcripts (p. 463). This process involved identifying, coding, and labeling the primary patterns in the data and writing the codes directly on the interview transcriptions. These coded statements and phrases were then cut and pasted on index cards and sorted into categories to illuminate themes that emerged from the patterns in the data. These themes were then used to re-sort the significant statements and phrases in order to show the patterns in the data, as they related to each of the interview questions. These themes were then used as the framework for
determining the “substantive significance” (Patton, 2002, pp. 463-467) of the interview data. (See Appendix G for interview transcripts).

**Ethical Safeguards**

All participants received a detailed letter outlining the protection of their confidentiality that adheres to the recommendations of both the American Educational Research Association (Strike, 2002) and the guidelines suggested by Creswell (2009) regarding protection of human subjects and the importance of confidentiality, prior to the collection of data (Israel & Hays, 2006). Confidentiality of individual responses was assured. The survey cover page also outlined the Institutional Human Subjects Committee of the College of William and Mary’s approval of the study. Each study participant received this cover letter that outlined the protection of confidentiality assured to all participants in the study (Appendix C and Appendix D). An additional letter regarding ethical standards for the interview process was faxed to all interview participants, in advance of the interview time. This study protects the confidentiality of all study participants, during and after data collection and analysis of all responses. Survey Monkey is embedded with encryption security at several levels. And, all files related to the survey responses and interviews – including all printed survey responses, notes, tape recordings and transcriptions – were kept in a locked cabinet by the researcher and only shared with the dissertation committee chair and members. All respondents were represented in the presentation of the data with pseudonyms. Prior to any data collection, the College of William and Mary's Human Subjects Committee approved this study.
Chapter 4: Results

Phase 1: Survey Results

Forty-one successful academic women scientists participated in the current study that utilizes Gagné's differentiated model of talent development as the framework. These 41 women represent a response rate of 43.6% from the total number of possible participants included in the sample (N=94). This study is delimited to specific areas of sciences, as defined by the National Academy of Sciences' Category I, the "physical and mathematical sciences" which include Mathematics, Astronomy, Physics, Chemistry, Geology and Geophysics, and Category III, "engineering and applied sciences" which include Engineering Sciences, Applied Mathematical Sciences, Applied Physical Sciences and Computer and Information Sciences (National Academy of Sciences, 2008). These specific disciplines of science were chosen for this study, as they are the most traditionally male-dominated areas of the sciences (National Science Foundation, 2007).

The data from all forty-one survey respondents and all five interview participants are presented.

Demographics of study respondents

Survey questions SQ1-SQ7 and SQ15-26 probe demographic and professional information of the respondents. These demographic data are presented first and provide the background for the results of the survey questions that directly address the primary research questions. Nine research institutions in New York State were represented, and
seven different science disciplines were reported including Astronomy, Chemistry, Computer Science, Engineering, Geology, Mathematics and Physics. Table 5 compares the sample and respondents in each scientific discipline. The survey respondents represent all areas of the sciences originally surveyed, with 7-8 each representing chemistry, engineering, mathematics and physics. Astronomy accounted for only three while computer science has four and geology, five.

*Table 5 Surveyed science disciplines*

<table>
<thead>
<tr>
<th>Discipline</th>
<th>Number in the sample</th>
<th>Number of respondents</th>
<th>Percentage of responders</th>
</tr>
</thead>
<tbody>
<tr>
<td>Astronomy</td>
<td>3</td>
<td>3</td>
<td>100.0</td>
</tr>
<tr>
<td>Chemistry</td>
<td>20</td>
<td>7</td>
<td>35.0</td>
</tr>
<tr>
<td>Computer Science</td>
<td>11</td>
<td>4</td>
<td>36.0</td>
</tr>
<tr>
<td>Engineering</td>
<td>13</td>
<td>8</td>
<td>61.5</td>
</tr>
<tr>
<td>Geology</td>
<td>12</td>
<td>5</td>
<td>41.7</td>
</tr>
<tr>
<td>Mathematics</td>
<td>18</td>
<td>7</td>
<td>38.9</td>
</tr>
<tr>
<td>Physics</td>
<td>17</td>
<td>7</td>
<td>41.1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>94</strong></td>
<td><strong>41</strong></td>
<td><strong>43.6</strong></td>
</tr>
</tbody>
</table>

Of the ten institutions in New York originally surveyed, the study participants represent nine institutions. The only institution from which there are no respondents is Yeshiva University, where only one woman met the criteria for the sample population. All other nine institutions are represented by between one and eight survey respondents as noted in Table 6. Non-respondents were not surveyed for the purpose of this study.
Table 6 Institutions of survey respondents (N=41)

<table>
<thead>
<tr>
<th>Institution</th>
<th>Number of respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Binghamton</td>
<td>3</td>
</tr>
<tr>
<td>Columbia/Barnard</td>
<td>7</td>
</tr>
<tr>
<td>Cornell</td>
<td>8</td>
</tr>
<tr>
<td>Fordham</td>
<td>1</td>
</tr>
<tr>
<td>New York University</td>
<td>3</td>
</tr>
<tr>
<td>Rensselaer Polytechnic University (RPI)</td>
<td>7</td>
</tr>
<tr>
<td>SUNY –Stonybrook</td>
<td>2</td>
</tr>
<tr>
<td>Syracuse</td>
<td>2</td>
</tr>
<tr>
<td>University of Rochester</td>
<td>8</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>41</strong></td>
</tr>
</tbody>
</table>

Country of birth

The survey participants represent ten different countries of birth, as presented in Table E3, with the largest number being U.S. born (32). One each was born in Canada, Germany, Great Britain, Greece, Hungary, Israel, Italy, Korea, and the Netherlands. Of those survey respondents born in the United States, 12 record New York State as their place of birth; four record Ohio; two record either California, Connecticut or Illinois; and, one each were born in Massachusetts, Minnesota, Missouri, New Jersey, Pennsylvania, Texas, Washington State and the District of Columbia. Two respondents did not record their state of birth.

Age of respondents

The survey participants represent a wide age range, from birth years in 1922 to 1973, with current ages from age 36 to age 87. A distribution of age ranges for all study participants is presented in Table 7.
Table 7 Age distribution of study respondents (N=41)

<table>
<thead>
<tr>
<th>Current age range</th>
<th>Percentage of responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>30-39</td>
<td>4.8 (2)</td>
</tr>
<tr>
<td>40-49</td>
<td>36.6 (15)</td>
</tr>
<tr>
<td>50-59</td>
<td>36.6 (15)</td>
</tr>
<tr>
<td>60-69</td>
<td>19.5 (8)</td>
</tr>
<tr>
<td>70+</td>
<td>2.4 (1)</td>
</tr>
<tr>
<td>Total</td>
<td>41</td>
</tr>
</tbody>
</table>

Race/ethnicity

Survey participants were queried about the family in which they were raised. Thirty-nine of the respondents (95.1%) indicated that their parents are Caucasian and/or of European descent, while one respondent indicated that her parents are both Korean. One respondent chose not to answer the question of parental race/ethnicity.

Families of origin

Survey Question 3 probed the educational and professional backgrounds of the survey respondents' parents. The findings were notable as 56.1% (23) of the survey respondents report that one or both of their parents had earned a graduate degree. And, 48.8% of the respondents (20) report that one or both of their parents were scientists and/or academics. However, 22.0% (9) of the study respondents report that neither of their parents attended college, making these participants first-generation college graduates. Tables 8 and 9 illustrate the educational backgrounds and professions of the mothers (41) of the survey respondents. As indicated in Table 8, survey respondents were
asked to record the primary occupation/profession of their mothers. Although most respondents answered simply "professor" or "homemaker," others noted that their mothers did have a career evolution over their lifetimes. One participant recorded that her mother was first "a mother, then a teacher, then programmer, then professor" and another respondent indicated that her mother held "various jobs including a real estate broker and a homemaker."

Table 8 Occupations of Mothers of Survey Respondents (N=41)

<table>
<thead>
<tr>
<th>Profession</th>
<th>Percentage of respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher</td>
<td>21.9 (9)</td>
</tr>
<tr>
<td>Homemaker</td>
<td>21.9 (9)</td>
</tr>
<tr>
<td>Skilled white collar</td>
<td>21.9 (9)</td>
</tr>
<tr>
<td>Scientist</td>
<td>19.5 (8)</td>
</tr>
<tr>
<td>Administrator</td>
<td>4.9 (2)</td>
</tr>
<tr>
<td>Tradesperson</td>
<td>4.9 (2)</td>
</tr>
<tr>
<td>Professor</td>
<td>4.9 (2)</td>
</tr>
</tbody>
</table>

In regard to educational level, it was interesting that 56.2% of the mothers of participants did have a college degree or higher level of education (see Table 9). However, more than 43% of respondents indicated that their mothers completed only elementary, middle or high school levels of education. Additionally, one respondent noted that while she was growing up, her mother possessed a college degree but later completed her Ph.D.
Table 9 Education Levels of Mothers of Survey Respondents (N=41)

<table>
<thead>
<tr>
<th>Highest level of education</th>
<th>Percentage of respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elementary School</td>
<td>2.4 (1)</td>
</tr>
<tr>
<td>Middle School</td>
<td>2.4 (1)</td>
</tr>
<tr>
<td>High School</td>
<td>39.0 (16)</td>
</tr>
<tr>
<td>BA or BS</td>
<td>22.0 (9)</td>
</tr>
<tr>
<td>Masters</td>
<td>19.5 (8)</td>
</tr>
<tr>
<td>Ph.D.</td>
<td>14.7 (6)</td>
</tr>
</tbody>
</table>

Tables 10 and 11 illustrate the educational backgrounds and professions of the fathers of the survey respondents. A notable finding of the participants' fathers was that 27.5% (11) were scientists. Several participants noted in later questions on the survey that this heritage was an important influence on their career choices and development while 45% of fathers were in professions such as law, accounting, managerial, and professors. Over seventeen percent were in trades. The fathers' professions reflect a wide variety of occupational choices.

Table 10 Professions of the Fathers of Survey Respondents (N=40)

<table>
<thead>
<tr>
<th>Profession</th>
<th>Percentage of respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skilled White Collar</td>
<td>42.5 (17)</td>
</tr>
<tr>
<td>Scientist</td>
<td>27.5 (11)</td>
</tr>
<tr>
<td>Tradesperson</td>
<td>17.5 (7)</td>
</tr>
<tr>
<td>Professor</td>
<td>7.5 (3)</td>
</tr>
<tr>
<td>Farmer</td>
<td>2.5 (1)</td>
</tr>
<tr>
<td>Photographer</td>
<td>2.5 (1)</td>
</tr>
</tbody>
</table>
Although almost a quarter of the fathers of the study participants had a high school education (or less), almost one-half of the respondents' fathers earned graduate degrees (48.5%). It is also interesting that the numbers of respondents with either mothers (14.7%) or fathers (18.0%) with doctorates is similar. Only one participant recorded that both her mother and father held doctorates.

*Table 11 Educational Levels of Fathers of Survey Respondents (N=40)*

<table>
<thead>
<tr>
<th>Highest level of education</th>
<th>Percentage of Respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Middle School</td>
<td>2.5 (1)</td>
</tr>
<tr>
<td>High School</td>
<td>20.0 (8)</td>
</tr>
<tr>
<td>Bachelors of Arts or Science</td>
<td>30.0 (12)</td>
</tr>
<tr>
<td>Masters</td>
<td>17.5 (7)</td>
</tr>
<tr>
<td>J.D.</td>
<td>10.0 (4)</td>
</tr>
<tr>
<td>D.D.S.</td>
<td>2.5 (1)</td>
</tr>
<tr>
<td>Ph.D.</td>
<td>17.5 (7)</td>
</tr>
</tbody>
</table>

*Birth order.* A majority of respondents indicated that they were the first born in their family, with 63.4% (26) checking first born while 26.8% (11) checked second born, 7.3% (3) indicated that they are third born in their family, and 2.4% (1) responded as “other” and appeared to come from a larger family.
Current families

Survey participants also described their current marital/partner status. Table 12 demonstrates the current marital/partner status of the respondents, with 70.7% (29) of respondents indicating that they are currently married or in a relationship with a partner. Seven respondents (17.0%) responded that they were single, three (7.5%) were divorced/re-married, one respondent (2.4%) was divorced and not remarried, and one respondent (2.4%) reported that she was widowed.

*Table 12 Marital/partner status of survey respondents (N=41)*

<table>
<thead>
<tr>
<th>Marital/partner status</th>
<th>Percentage of respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single/never married</td>
<td>17.0 (7)</td>
</tr>
<tr>
<td>Partnered/married</td>
<td>70.7 (29)</td>
</tr>
<tr>
<td>Divorced/remarried</td>
<td>7.5 (3)</td>
</tr>
<tr>
<td>Divorced/not remarried</td>
<td>2.4 (1)</td>
</tr>
<tr>
<td>Widowed</td>
<td>2.4 (1)</td>
</tr>
</tbody>
</table>

Of the 32 respondents with partners, all indicated the profession/occupation of their partner. Several participants noted in comments on this question that they had met their partner (now a professor and/or scientist) in graduate school and that having a partner/spouse who is also an academic and/or scientist has had an important influence (sometimes reported as positive, sometimes reported as challenging) in their career development and personal lives. Table E4 represents the different professional categories of these survey respondents' partners (32). “Professor” was noted as the partner/spouse
occupation for 31.3% of respondents; 25.0% indicated that their spouse is a scientist; 18.8% recorded their spouse's work in the computer industry; 9.4% have partners working in finance/accounting, and the remainder (one case each) have spouses who are writer/editors, photographers, government workers, musicians or physicians. The majority (75%) of spouses were in these professions: professor, scientist, computers, and software.

*Children.* Only twenty-six of the scientists in the study (63.4%) indicated that they have children. One respondent recorded that her children are stepchildren. The current ages of the respondents' children range from 23 months to 53 years. The average age of the respondents' children was 14.6; the median age of the respondents' children was 18; and, the modal age of the respondents' children was 13.

Respondents were asked to describe the percentage of primary responsibility they maintain for the areas of "household duties" and "care of dependents." The majority of respondents recorded that they are responsible for 50% or more of both household duties and care of dependents. Thirty-three of the respondents (80.5%) recorded that they have primary responsibility (coded as more than 50%) for the household duties, and 78.0% (32) noted that they have more than 50% of the primary responsibility for the care of dependents (defined by participants as children and/or aging parents).

*Relationship of key variables.* A correlation was run between those participants who have children and those who do not to examine the possible effects of having children on several critical markers of success including rank and number of refereed publications. Additionally, specific attributes were probed to determine if there is any relationship between these attributes and having children. Table 13 illustrates the
correlations between these markers of academic success (rank, publications) and having children as well as between the attributes of pursuing opportunities and risk-taking and having children. Notably, for the study participants, having children appears to have no effect on rank ($r=.003, p>.05$) and very little relationship to publications ($r=-.200, p>.05$). There were no significant relationships found between having children and the career markers.

*Table 13: Relationship of having children to career markers and attributes (N=41)*

<table>
<thead>
<tr>
<th>With Children</th>
<th>Publications</th>
<th>Rank</th>
<th>Pursue Opportunities</th>
<th>Risk-Taking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Children</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Publications</td>
<td>-.200*</td>
<td>1</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Rank</td>
<td>.003*</td>
<td>.359*</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Pursue Opportunities</td>
<td>-.147</td>
<td>.251</td>
<td>-.049</td>
<td>1</td>
</tr>
<tr>
<td>Risk-taking</td>
<td>-.228</td>
<td>.193</td>
<td>-.062</td>
<td>.387</td>
</tr>
</tbody>
</table>

*p < .05.

*Professional demographic information*

All of the study participants are tenured faculty at top-ranked research institutions in New York State. Thirty of the women hold the rank of Full Professor, while eleven women currently hold the rank of Associate Professor. Table 14 illustrates the various faculty career stages for the respondents. Faculty were represented at the early career (0-6 years) by one respondent (2.4%); at the early-mid career stage by seven respondents
(17.0%); at the mid-career stage by 11 respondents (26.8%); at the mid-late career stage by 12 respondents (29.3%), and in the late career stage by ten respondents (24.4%).

More than half of respondents are represented in the later career stages, with 21+ years in the academic profession.

**Table 14 Faculty career stages of survey respondents (N=41)**

<table>
<thead>
<tr>
<th>Career Stage</th>
<th>Percentage represented</th>
</tr>
</thead>
<tbody>
<tr>
<td>Career entry</td>
<td>0.0 (0)</td>
</tr>
<tr>
<td>Early career (0-6 years)</td>
<td>2.44 (1)</td>
</tr>
<tr>
<td>Early-mid career (7-11 years)</td>
<td>17.0 (7)</td>
</tr>
<tr>
<td>Mid-career (12-20 years)</td>
<td>26.80 (11)</td>
</tr>
<tr>
<td>Mid-late career (21-24 years)</td>
<td>29.30 (12)</td>
</tr>
<tr>
<td>Late career</td>
<td>24.40 (10)</td>
</tr>
</tbody>
</table>

Respondents were asked to share the number of institutions at which they have taught. Most survey respondents (47.5%) have only taught at their current institution while 30.0% have taught at two institutions, 12.5% at three institutions, and 10% at four or more institutions. Participants were also asked to record their undergraduate majors, undergraduate, graduate, post-doc and various work positions since their graduate degrees. All of the respondents either completed this information and/or emailed their curriculum vitae to record these educational and work experiences. The results are varied and reflect a magnitude of various national and international educational institutions and work experiences. The responses for each of the four parts to this question were categorized by type and name of institution, within each part of the question, and grouped for inclusion in Appendix F. The content analysis revealed that the participants had a
wide range of undergraduate majors (many outside of science disciplines), and attended both research and liberal arts institutions as undergraduates. The vast majority of masters and doctoral programs attended by the study respondents were at top-ranked Research I institutions. And, the post-doctoral and other professional positions experienced by the study participants also reflected tremendous variety at prestigious institutions and organizations.

Survey Question 25 addressed work environments for survey participants, asking specifically about the numbers of full-time faculty in the department, numbers of full-time women and numbers of tenured women. The mean number of full-time faculty members in the departments of the respondents was 24.53, with 3.0 as the mean number of full-time women, and 2.1 listed as the mean number of tenured women per department.

Study participants were asked to describe their involvement in "associations that specifically support women in science." Twenty respondents answered this question, and Table E5) represents this involvement with a range of participation (0-6 associations) in various national and international associations including Women in Science and Engineering, the Society of Women in Engineering, the Association for Women in Science, the American Chemical Society's Women Chemists Committee, and the Association for Women in Mathematics, among others.

Professional Accomplishments

Respondents were asked to list "significant grants, awards and/or fellowships you have received since receiving your doctorate." Even though reviews of the on-line information of each of the participants established that they each met the original criteria of having received grants and awards, several questions on the survey asked participants
to elaborate on their professional accomplishments. All of the scientists have been awarded or earned numerous international, national and university-level grants, awards and fellowships. Only one participant did not respond to this question on the survey nor did she send her curriculum vita from which further information could be culled.

Twelve had received grants totaling more than six million dollars, and three have received grant funding exceeding 10 million dollars. Eight respondents noted that they have received the National Science Foundation's Faculty Early Career Development Award and/or the National Science Foundation's Presidential Young Investigator Award, both noted achievements for early scholars who show exceptional promise in many areas of science.

Other important awards included the Guggenheim Fellowship, the Susan B. Anthony Lifetime Achievement Award, and the Dreyfus Foundation's Senior Mentor Award. One recipient was named one of the "50 Most Important Women in Science" by Discover Magazine while eight respondents have been elected to the National Academy of Sciences or National Academy of Engineering, one of the top honors of election by peers in the sciences in the United States. Twelve scientists in Chemistry and Computer Science have received several patents for their discoveries. The mean number of patents held by these 12 respondents is six, with a range from 1 to 15 patents.

SQ18-22 asked survey participants to indicate "leadership positions" formerly and/or currently held with professional journals (SQ18), with granting agencies (SQ19), in professional associations (SQ20), in academic administrative positions (SQ21), and in other leadership roles (SQ22). Survey respondents were directed to check all that applied to them.
Twenty-three respondents stated that they are or have served as editor-in-chief or in other senior editorship positions on academic journals. A survey of the wide range of journals in which these women serve as editors include the prestigious journals of *Science, Nature, Journal of Applied Mechanics, Genetics, Molecular Stimulation, Astrophysical Journal, Journal of the American Chemistry Society, Journal of Informational Technology & Politics, Geophysical Journal, SIAM Journal of Computing, Journal of Applied Physics, Analytical Chemistry,* and the *International Journal of Spectroscopy,* among others.

Twelve women who recorded their granting agency leadership work indicated senior-level grant review panel membership. They have consulted for such agencies and foundations as the National Science Foundation (NSF), National Institutes of Health (NIH), U.S. National Committee for Mathematics, National Research Council, National Academy of Sciences, National Sciences and Engineering Research Council of Canada (NSERC), Swiss Natural Science Foundation, Defense Science Board, among many others. Twenty-five women have assumed extensive leadership roles as presidencies and chair positions for national and international academic professional associations. These associations include the Geological Association of American International, the American Astronomical Association, the American Statistical Association, the Institute for Electrical and Electronics Engineers, and the American Chemical Society, among others.

Twenty-four women have served or are serving currently in academic administration leadership roles. These respondents listed specific leadership positions including department heads, department chairs, deans and associate deans of graduate studies, director of university observatories, deans of natural sciences, directors of
research institutes and centers, and deans of schools of engineering, among others. Nine respondents listed other leadership positions including work as members of national research boards and the National Academy of Sciences, members of faculty senates, chair of university governance committees, international astronomy projects, conference organizers and as book editors. Table 15 illustrates the aggregated number and percent of respondents recording leadership roles in these areas.

Table 15 Leadership roles of survey respondents (N=41)

<table>
<thead>
<tr>
<th>Leadership role</th>
<th>Percentage of respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Professional journals</td>
<td>56.1 (23)</td>
</tr>
<tr>
<td>Granting agencies</td>
<td>29.2 (12)</td>
</tr>
<tr>
<td>Professional associations</td>
<td>61.0 (25)</td>
</tr>
<tr>
<td>Academic administration</td>
<td>59.0 (24)</td>
</tr>
<tr>
<td>Other leadership roles</td>
<td>22.0 (9)</td>
</tr>
</tbody>
</table>

Participants were asked to record the number of refereed publications authored/co-authored to date. The range of refereed publications reported by the survey respondents on this question was between 5 and 250+. The mean number of refereed publications reported by respondents was 74, and the median number of publications was 66. More than fifteen respondents had more than 100 refereed publications listed on their curriculum vitae or self-reported. Table 16 lists the mean number of authored or co-authored refereed publications by discipline as reported by respondents. Means were higher in both chemistry and physics, with 85 and 88 publications for each area on average.
Table 16 Mean scores of refereed publications by discipline

<table>
<thead>
<tr>
<th>Discipline</th>
<th>Mean number of publications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Astronomy</td>
<td>60 (3)</td>
</tr>
<tr>
<td>Chemistry</td>
<td>85 (7)</td>
</tr>
<tr>
<td>Engineering</td>
<td>68 (8)</td>
</tr>
<tr>
<td>Geoscience</td>
<td>66 (5)</td>
</tr>
<tr>
<td>Math</td>
<td>66 (7)</td>
</tr>
<tr>
<td>Physics</td>
<td>88 (7)</td>
</tr>
</tbody>
</table>

*External Influences*

*Educational experiences*

Several survey questions were designed to probe various external influences, as illustrated in Gagne's model (1985, 1991), on the talent development experiences of the study participants. These questions specifically addressed Research Question 1 that probed the multiple external influences affecting study participants. Respondents were asked to report when they "first became interested in science." Approximately two-thirds of the respondents indicated that they first became interested in science in either elementary or high school years (evenly divided as 33.3% each). Four participants (10.3%) indicated that their initial interest in science was prior to elementary school, and two respondents (5.1%) indicated they first became interested in science during their college years.
Respondents were also asked to describe the most important influences on their initial interest in science including people, events and experiences and were asked to check as many as applied. The most important groups of people who influenced the respondents' earliest interest in scientific inquiry were recorded as teachers (71.8%), family members (61.5%) and friends/peers (7.7%). Several types of other influences were also included as options, and 17.9% of respondents indicated a primary influence as "burgeoning interest" in science. Survey respondents noted specific influences on their initial interest in science in the comments section of this question. These responses were coded into categories and listed in Table 17.

*Table 17: Other important influences on initial interest in science (N=39)*

<table>
<thead>
<tr>
<th>Category</th>
<th>Frequency of responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Special classes/programs/teachers</td>
<td>9</td>
</tr>
<tr>
<td>Books/puzzles</td>
<td>6</td>
</tr>
<tr>
<td>Visiting planetariums/libraries</td>
<td>3</td>
</tr>
<tr>
<td>Volunteering</td>
<td>1</td>
</tr>
</tbody>
</table>

Respondents were asked to "describe your academic status in high school." Of the respondents, 40 respondents answered this question, with 80.0% (32) stating that they were in the top 5% of their high school class, 15.0 (6) reported that they were in the top 10% of their high school class, and 5% (2) claimed that they were in the top 25% of their high school class.
Participants were asked about the advanced high school programs in which they participated. Thirty-five respondents answered this question, with several checking more than one experience. Of the 35 respondents, 20 reported that none of the listed options were available in their high schools, either due to the respondents' age cohort (10) or due to the locale in which they grew up abroad (10). Of these, several did report different experiences with advanced high school programs. Table 18 illustrates the diverse advanced high school programs described by the study respondents.

Table 18 Advanced high school programs (N=35)

<table>
<thead>
<tr>
<th>Program/opportunity</th>
<th>Percentage of responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advanced placement courses</td>
<td>34.3 (12)</td>
</tr>
<tr>
<td>Attended the Hunter School</td>
<td>8.6 (3)</td>
</tr>
<tr>
<td>Independent study experiences</td>
<td>5.7 (2)</td>
</tr>
<tr>
<td>Dual enrollment</td>
<td>2.9 (1)</td>
</tr>
<tr>
<td>Mentors</td>
<td>2.9 (1)</td>
</tr>
<tr>
<td>Internships</td>
<td>2.9 (1)</td>
</tr>
<tr>
<td>Math Olympiad</td>
<td>2.9 (1)</td>
</tr>
<tr>
<td>Honors coursework</td>
<td>2.9 (1)</td>
</tr>
<tr>
<td>Math team</td>
<td>2.9 (1)</td>
</tr>
<tr>
<td>Advanced music lessons</td>
<td>2.9 (1)</td>
</tr>
</tbody>
</table>

Participants were asked to describe special opportunities that were available to them in high school. Table E6 outlines the special opportunities in which survey
respondents participated in high school. Notably, 20 respondents recorded recognition as national merit finalists or semifinalists while six recorded receiving special major academic awards and three were chemistry, math or physics Olympians. Other special opportunities listed by respondents in high school included receiving medals for academic excellence and the New York State Regents scholarships as well as earning highest rankings in the European University Entrance Examinations.

Asked about the special programs in which they participated in college, almost two-thirds of the respondents (64.7%) reported working in a research position in college. Other special programs reported by participants included academic tutors/graders; internships/teaching assistantships; honors projects; scholars/honors programs, and co-op and study abroad programs. Table 19 illustrates these special college programs.

*Table 19 Special college programs of study participants (N=34)*

<table>
<thead>
<tr>
<th>Special program</th>
<th>Percentage of respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research positions</td>
<td>64.7 (22)</td>
</tr>
<tr>
<td>Academic tutors/graders</td>
<td>38.2 (13)</td>
</tr>
<tr>
<td>Internships</td>
<td>29.4 (10)</td>
</tr>
<tr>
<td>Teaching assistantships</td>
<td>29.4 (10)</td>
</tr>
<tr>
<td>Honors/scholars programs</td>
<td>23.5 (8)</td>
</tr>
<tr>
<td>Co-op programs</td>
<td>1.4 (1)</td>
</tr>
<tr>
<td>Study abroad</td>
<td>1.4 (1)</td>
</tr>
</tbody>
</table>

Study participants were asked about specific honors or awards received in college and encouraged to check all honors/awards that were received during their college years.
Of the total 41 participants, 29 chose to respond to this question, constituting 70.7% of the total study participants. A cross checking of the vitae submitted did not reveal additional honors or awards received in college. Sixteen respondents (55.2%) noted that they received an honors designation; eleven (37.9%) received a national honor society award; eight (27.6%) received Latin honors at graduation; seven (24.1%) received a university research honor or award, and six (20.7%) won a science prize. Survey respondents noted the following special awards and honors under the “Other” designation: (1) Externally sponsored research grants, (2) highest GPA designation, (3) top scholarship awards from U.S. corporations, and (4) athletic awards. See Table E7 for a complete listing of awards and honors received by respondents in college.

Important people

At each level of education probed - including high school, college and graduate school - teachers and/or professors were the most important mentors for the survey respondents. Survey respondents were asked specifically about support from mentors at each stage of their education (high school, college, graduate school). Respondents described the types of mentors (coaches, teachers, etc.) that were most influential to them at each of these educational levels. Table 20 illustrates the role of mentors in the respondents' talent development process and lists the percentages and frequencies for each level of education and type of support received.
Table 20 Support of mentors on the talent development process of survey respondents

<table>
<thead>
<tr>
<th></th>
<th>High school Mentors</th>
<th>College Mentors</th>
<th>Graduate School Mentors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Encouraged interest</td>
<td>93.9 (32)</td>
<td>58.1 (18)</td>
<td>20.6 (7)</td>
</tr>
<tr>
<td>Nominated me for special awards/programs</td>
<td>0.0 (0)</td>
<td>16.1 (5)</td>
<td>8.8 (3)</td>
</tr>
<tr>
<td>Supported my career path</td>
<td>2.9 (1)</td>
<td>25.8 (8)</td>
<td>64.7 (22)</td>
</tr>
<tr>
<td>Helped with financing my education</td>
<td>0.0 (0)</td>
<td>0.0 (0)</td>
<td>2.9 (1)</td>
</tr>
</tbody>
</table>

Respondents were asked to record the most influential person responsible for the development of their science talent. Table 21 illustrates the role of influential people on the development of science talent in the survey participants' lives. Respondents listed spouses/partners and all of the above in the other person category, when asked for comments. They were able to check as many as applied. Teachers were most frequently recorded as influential for the respondents, and parents were also cited as important by many respondents.
Table 21 Most influential persons for development of science talent for survey respondents (N=39)

<table>
<thead>
<tr>
<th>Person of influence</th>
<th>Percentage of responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher</td>
<td>56.4 (22)</td>
</tr>
<tr>
<td>Father</td>
<td>41.0 (16)</td>
</tr>
<tr>
<td>Mother</td>
<td>30.8 (12)</td>
</tr>
<tr>
<td>Other person</td>
<td>20.6 (8)</td>
</tr>
<tr>
<td>Other family member</td>
<td>7.7 (3)</td>
</tr>
</tbody>
</table>

Survey respondents were asked to describe the three most significant people in helping their careers to date, in an open-ended question, and listed a wide range of influential people. Responses were coded into categories and then grouped as illustrated in Table E8. Colleagues as both mentors and collaborators were frequently cited as very influential in helping the careers of respondents. Colleague/mentors were recorded by 23 respondents, and collaborators/co-authors were cited by 8 respondents. Notably, doctoral advisors were noted by 13 respondents as very important to the career development of the respondents.

**Internal characteristics**

Several survey questions were asked to probe Research Question 2 that addressed the internal characteristics of the study participants. Survey questions asked respondents to rate themselves in a professional context on several attributes. The scale for self-
reporting was a Likert scale from 1 – 5, with 1 as "not at all," 3 as "may be" and 5 as "extremely." Nine of the attributes related directly and included the characteristics of temperament and personality and included characteristics associated with adaptability, attitude, competitiveness, independence, and self-esteem, as revealed in the literature review. Four of the attributes related to characteristics associated with motivation. Table 22 lists the means and standard deviations for these attributes. The most notable scores for respondents (mean score of ratings 4 and 5 as greater than 70%) were found in the attributes of motivated (95.1), persistent (90.3), hard working (95.1) and problem solvers (87.5).
Table 22 Self-perceptions of motivational and personality attributes of survey respondents

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not at all</td>
<td>0.0 (0)</td>
<td>2.4 (1)</td>
<td>2.4 (1)</td>
<td>46.3 (19)</td>
<td>48.8 (20)</td>
<td>4.41</td>
<td>0.66</td>
</tr>
<tr>
<td>Self-confident</td>
<td>0.0 (0)</td>
<td>17.1 (7)</td>
<td>19.5 (8)</td>
<td>56.1 (23)</td>
<td>7.3 (3)</td>
<td>3.53</td>
<td>0.87</td>
</tr>
<tr>
<td>Ambitious</td>
<td>0.0 (0)</td>
<td>12.2 (5)</td>
<td>19.5 (8)</td>
<td>51.2 (21)</td>
<td>17.1 (7)</td>
<td>3.73</td>
<td>0.89</td>
</tr>
<tr>
<td>Able to change directions</td>
<td>0.0 (0)</td>
<td>9.8 (4)</td>
<td>26.8 (11)</td>
<td>39.0 (16)</td>
<td>24.4 (10)</td>
<td>3.78</td>
<td>0.94</td>
</tr>
<tr>
<td>Risk-taker</td>
<td>2.4 (1)</td>
<td>17.1 (7)</td>
<td>26.8 (11)</td>
<td>24.4 (10)</td>
<td>29.3 (12)</td>
<td>3.61</td>
<td>1.16</td>
</tr>
<tr>
<td>Patient</td>
<td>2.4 (1)</td>
<td>22.0 (9)</td>
<td>22.0 (9)</td>
<td>34.1 (14)</td>
<td>19.5 (8)</td>
<td>3.46</td>
<td>1.12</td>
</tr>
<tr>
<td>Gifted</td>
<td>2.4 (1)</td>
<td>2.4 (1)</td>
<td>46.3 (19)</td>
<td>34.1 (14)</td>
<td>14.6 (6)</td>
<td>3.56</td>
<td>0.87</td>
</tr>
<tr>
<td>Stressed</td>
<td>0.0 (0)</td>
<td>26.8 (11)</td>
<td>29.3 (12)</td>
<td>36.6 (15)</td>
<td>7.3 (3)</td>
<td>3.24</td>
<td>0.93</td>
</tr>
<tr>
<td>Problem-solver</td>
<td>0.0 (0)</td>
<td>5.0 (2)</td>
<td>7.5 (3)</td>
<td>32.5 (13)</td>
<td>55.0 (22)</td>
<td>4.37</td>
<td>0.84</td>
</tr>
<tr>
<td>Overwhelmed</td>
<td>7.3 (3)</td>
<td>48.8 (20)</td>
<td>7.3 (3)</td>
<td>29.3 (12)</td>
<td>7.3 (3)</td>
<td>2.80</td>
<td>1.17</td>
</tr>
</tbody>
</table>

In order to gauge the personality trait of self-esteem (Gagné, 1991), respondents were asked to evaluate if they feel happy with their career success. Most respondents (39%) reported that they are happy with their career success “all of the time” (16) or “most of
the time” (39% or 16), with several indicating that they have achieved even more than they believed they would at the beginning of their careers. For the 17.1% (7) who are happy with their career success only “some of the time,” 4.9% (2) who are not at all happy, the reasons cited by respondents included that they felt their promotion processes to associate and/or to full professor were a "battle" from which they "are still recovering" or that there were research discoveries for which "they did not get credit." One respondent noted that she has found it difficult to balance family and career demands; so, she is currently less happy in her career.

Relationship between key variables

Correlations were run between the attribute of motivation and study participants’ self-perception of the professional attributes of being hard working, a problem solver, risk-taking, and identifying as gifted found important relationships. Table 23 demonstrates the strong, positive relationships between the self-perceptions of study participants on the attributes of motivation and hard working ($r=.674$, $p<.05$), motivation and problem-solving ($r=.638$, $p<.05$), the moderate-low relationship between motivation and risk-taking ($r=.375$, $p<.05$), and the low relationship between motivation and identifying as gifted ($r=.278$, $p<.05$).
Table 23 Relationships between motivation and professional attributes (N=41)

<table>
<thead>
<tr>
<th></th>
<th>Motivated</th>
<th>Hard working</th>
<th>Problem solving</th>
<th>Risk-taking</th>
<th>Gifted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motivated</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Hard working</td>
<td>.674*</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Problem Solving</td>
<td>.638*</td>
<td>.520</td>
<td>1</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Risk-Taking</td>
<td>.375*</td>
<td>.282</td>
<td>.487</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Gifted</td>
<td>.278*</td>
<td>.083</td>
<td>.236</td>
<td>.173</td>
<td>1</td>
</tr>
</tbody>
</table>

* p < .05.

Respondents were asked to rate their perceptions of their research on six attributes: adaptability, attitudes, competitiveness, independence, self-esteem and values. Those attributes that were most important (where the combined total of Likert scores of 4 and 5 was greater than 70%) are the attributes: creative research (80.0% total of 4 and 5); interdisciplinary research (82.5%); and, cutting edge research (72.5%). Table 24 lists the means and standard deviations of each attribute for survey respondents.
Table 24 Self-perceptions of research attributes of survey respondents

<table>
<thead>
<tr>
<th>Research characteristic</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Not at all</td>
<td>Maybe</td>
<td>Extremely</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Creative</td>
<td>0.0 (0)</td>
<td>2.5 (1)</td>
<td>17.5 (7)</td>
<td>50.0 (20)</td>
<td>30.0 (12)</td>
<td>4.08</td>
<td>0.75</td>
</tr>
<tr>
<td>Marginalized</td>
<td>31.6 (12)</td>
<td>28.9 (11)</td>
<td>28.9 (11)</td>
<td>7.9 (3)</td>
<td>2.6 (1)</td>
<td>2.21</td>
<td>1.06</td>
</tr>
<tr>
<td>Readily accepted</td>
<td>2.6 (1)</td>
<td>12.8 (5)</td>
<td>28.2 (11)</td>
<td>41.0 (16)</td>
<td>15.4 (6)</td>
<td>3.53</td>
<td>0.98</td>
</tr>
<tr>
<td>Interdisciplinary</td>
<td>5.0 (2)</td>
<td>10.0 (4)</td>
<td>2.5 (1)</td>
<td>47.5 (19)</td>
<td>35.0 (14)</td>
<td>3.97</td>
<td>1.11</td>
</tr>
<tr>
<td>Cutting edge</td>
<td>0.0 (0)</td>
<td>12.5 (5)</td>
<td>15.0 (6)</td>
<td>40.0 (16)</td>
<td>32.5 (13)</td>
<td>3.92</td>
<td>0.98</td>
</tr>
<tr>
<td>Risky</td>
<td>7.7 (3)</td>
<td>25.6 (10)</td>
<td>38.5 (15)</td>
<td>15.4 (6)</td>
<td>12.8 (5)</td>
<td>3.00</td>
<td>1.11</td>
</tr>
</tbody>
</table>

In order to determine the level of continued motivation to publish, respondents were asked to record the number of refereed publications they have authored or co-authored. The mean number of refereed publications reported by the thirty-seven respondents who answered this survey question was 74, with fifteen respondents recording more than 100 refereed publications to date in their careers. A correlation was run to determine the relationship between publication record and rank and age. Table 25 illustrates these correlations. There is a moderate positive relationship ($r=.359$, $p<.05$) between rank and publications, while a strong positive relationship appears between age and publications ($r=.649$, $p<.05$). The relationship between rank and age is also moderately positively correlated ($r=.469$, $p<.05$).
Table 25: Relationships between publications, rank and age (N=41)

<table>
<thead>
<tr>
<th></th>
<th>Publications</th>
<th>Rank</th>
<th>Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>Publications</td>
<td>1</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Rank</td>
<td>.359*</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Age</td>
<td>.649*</td>
<td>.469*</td>
<td>1</td>
</tr>
</tbody>
</table>

*p < .05.

Facilitators and Barriers

Facilitators

The roles of facilitators and barriers, as outlined in Research Question 3, were probed in several of the survey questions. Survey respondents were asked to rate several primary positive influences on the development of their science talent. Table 26 illustrates the role of various facilitators in the talent development process of these academic women scientists and lists the means and standard deviations for each of these facilitators. Several influences were rated very highly. Those influences that were rated by respondents as more than 50% of the combined ratings of 4 and 5 were "the importance of books in my home growing up" (78%); "academics were highly valued in my home" (74.4%); "teacher recognized my talent" (72.5%); "great teachers" (72.0%); "my family valued science" (68.4%); "my father's recognition of my talent" (61.5%); ability to engage in independent projects" (59.4%);"my mother's recognition of my talent" (56.4%), and "mentors" (51.3%). There were several major influences on these successful women academics.
<table>
<thead>
<tr>
<th>Facilitators of science talent</th>
<th>1 Not at all</th>
<th>2 Maybe</th>
<th>3 Maybe</th>
<th>4 Extremely</th>
<th>5 Extremely</th>
<th>N/A</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher recognized my talent</td>
<td>5.0 (2)</td>
<td>5.0 (2)</td>
<td>15.0 (6)</td>
<td>35.0 (14)</td>
<td>37.5 (15)</td>
<td>2.5 (1)</td>
<td>3.87</td>
<td>1.26</td>
</tr>
<tr>
<td>Accelerated or skipping grades</td>
<td>32.5 (13)</td>
<td>7.5 (3)</td>
<td>5.0 (2)</td>
<td>5.0 (2)</td>
<td>20.0 (8)</td>
<td>30.0 (12)</td>
<td>1.82</td>
<td>1.91</td>
</tr>
<tr>
<td>Taking advanced courses</td>
<td>12.8 (5)</td>
<td>7.7 (3)</td>
<td>12.8 (5)</td>
<td>20.5 (8)</td>
<td>25.6 (10)</td>
<td>20.5 (8)</td>
<td>2.77</td>
<td>1.93</td>
</tr>
<tr>
<td>Great teacher(s)</td>
<td>2.4 (1)</td>
<td>0.0 (0)</td>
<td>17.1 (7)</td>
<td>39.0 (16)</td>
<td>39.0 (16)</td>
<td>2.4 (1)</td>
<td>4.05</td>
<td>1.09</td>
</tr>
<tr>
<td>Mentors</td>
<td>10.3 (4)</td>
<td>7.7 (3)</td>
<td>28.2 (11)</td>
<td>28.2 (11)</td>
<td>23.1 (9)</td>
<td>2.6 (1)</td>
<td>3.38</td>
<td>1.35</td>
</tr>
<tr>
<td>Internships</td>
<td>27.5 (11)</td>
<td>2.5 (1)</td>
<td>10.0 (4)</td>
<td>15.0 (6)</td>
<td>20.0 (8)</td>
<td>25.0 (10)</td>
<td>2.23</td>
<td>1.95</td>
</tr>
<tr>
<td>Importance of books in my home growing up</td>
<td>2.4 (1)</td>
<td>4.9 (2)</td>
<td>12.2 (5)</td>
<td>31.7 (13)</td>
<td>46.3 (19)</td>
<td>2.4 (1)</td>
<td>4.07</td>
<td>1.19</td>
</tr>
<tr>
<td>Ability to engage in independent projects</td>
<td>2.7 (1)</td>
<td>13.5 (5)</td>
<td>18.9 (7)</td>
<td>13.5 (5)</td>
<td>45.9 (17)</td>
<td>5.4 (2)</td>
<td>3.70</td>
<td>1.51</td>
</tr>
<tr>
<td>My mother's recognition of my talent</td>
<td>15.4 (6)</td>
<td>12.8 (5)</td>
<td>12.8 (5)</td>
<td>25.6 (10)</td>
<td>30.8 (12)</td>
<td>2.6 (1)</td>
<td>3.36</td>
<td>1.55</td>
</tr>
<tr>
<td>My father's recognition of my talent</td>
<td>10.3 (4)</td>
<td>5.1 (2)</td>
<td>17.9 (7)</td>
<td>35.9 (14)</td>
<td>25.6 (10)</td>
<td>5.1 (2)</td>
<td>3.46</td>
<td>1.47</td>
</tr>
<tr>
<td>Academics highly valued in my home</td>
<td>5.1 (2)</td>
<td>2.6 (1)</td>
<td>10.3 (4)</td>
<td>28.2 (11)</td>
<td>46.2 (18)</td>
<td>7.7 (3)</td>
<td>3.85</td>
<td>1.55</td>
</tr>
<tr>
<td>My family values science</td>
<td>7.9 (3)</td>
<td>5.3 (2)</td>
<td>13.2 (5)</td>
<td>28.9 (11)</td>
<td>39.5 (15)</td>
<td>5.3 (2)</td>
<td>3.71</td>
<td>1.50</td>
</tr>
<tr>
<td>The role of my current family</td>
<td>16.2 (6)</td>
<td>5.4 (2)</td>
<td>18.9 (7)</td>
<td>18.9 (7)</td>
<td>29.7 (11)</td>
<td>10.8 (4)</td>
<td>3.08</td>
<td>1.77</td>
</tr>
</tbody>
</table>
Due to the number of respondents who noted that their parents were important influences in their talent development process, correlations were run to determine possible relationships between the support/recognition of mothers and fathers with some important professional attributes. The relationships, as illustrated in Table 27, between the support/recognition of talent by the participants’ mothers and publication rates, self-perceived motivation, and the pursuit of opportunities were found to be very low and in some cases, slightly negative; however, there were moderately strong, positive relationships between the recognition of the talent of the respondents by their fathers and publications \((r=.418, p<.05)\), motivation \((r=.518, p<.05)\) and pursuing opportunities \((r=.406, p<.05)\).

Table 27: Relationships of parents to publications, motivation and pursuing opportunities

<table>
<thead>
<tr>
<th>Recognition by Mother</th>
<th>Recognition by Father</th>
<th>Publications</th>
<th>Motivation</th>
<th>Pursue opportunities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recognition by Mother</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Recognition by Father</td>
<td>.404</td>
<td>1</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Publications</td>
<td>-.085</td>
<td>.418*</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Motivation</td>
<td>-.031</td>
<td>.518*</td>
<td>.496</td>
<td>1</td>
</tr>
<tr>
<td>Pursue opportunities</td>
<td>.022</td>
<td>.406*</td>
<td>.251</td>
<td>.586</td>
</tr>
</tbody>
</table>

*p < .05.

Participants were asked to describe the most important factors that served as positive facilitators to their careers. Responses were open-ended and categorized by type. Table E9 illustrates these categories and lists frequencies of responses to each category.
The most frequently noted categories of facilitators included the encouragement of supportive mentors/teachers (11), being persistent/stubborn (9), and having early internships and research opportunities (5). Additionally, recognition and grant funding, having successful former students, being ambitious and working with collaborators were cited by 4 respondents each as important facilitators to their career success.

**Barriers**

Respondents were asked to rate several influences perceived as barriers to the development of their science talent. Table 28 illustrates the role of various barriers to the talent development process of these academic women scientists and lists the means and standard deviations for each of these barriers. The results of this question were important, as only one influence was rated highly as a barrier to talent development. The only influence rated by respondents as more than 50% of combined ratings of 4 and 5 was "career experiences to date." Respondents listed nine major facilitators to their talent development process but listed only one influence as a notable barrier. Further information about the participants' interpretations of "career experiences to date" was illustrated in the comments section of SQ36.
Table 28 Barriers to the development of science talent for survey respondents

<table>
<thead>
<tr>
<th>Barriers to science talent</th>
<th>1: Not at all</th>
<th>2: Maybe</th>
<th>3: Maybe</th>
<th>4: Extremely</th>
<th>5: Extremely</th>
<th>N/A</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not accelerating</td>
<td>52.8 (19)</td>
<td>5.6 (2)</td>
<td>2.8 (1)</td>
<td>2.8 (1)</td>
<td>0.0 (0)</td>
<td>36.1 (13)</td>
<td>0.83</td>
<td>0.88</td>
</tr>
<tr>
<td>Not able to take advanced courses</td>
<td>38.9 (14)</td>
<td>8.3 (3)</td>
<td>8.3 (3)</td>
<td>13.9 (5)</td>
<td>2.8 (1)</td>
<td>27.8 (10)</td>
<td>1.50</td>
<td>1.48</td>
</tr>
<tr>
<td>Poor teacher(s)</td>
<td>36.1 (13)</td>
<td>19.4 (7)</td>
<td>22.2 (8)</td>
<td>5.6 (2)</td>
<td>2.8 (1)</td>
<td>13.9 (5)</td>
<td>1.78</td>
<td>1.27</td>
</tr>
<tr>
<td>Lack of mentors</td>
<td>22.2 (8)</td>
<td>8.3 (3)</td>
<td>22.2 (8)</td>
<td>19.4 (7)</td>
<td>11.1 (4)</td>
<td>16.7 (6)</td>
<td>2.39</td>
<td>1.68</td>
</tr>
<tr>
<td>Lack of internships</td>
<td>47.2 (17)</td>
<td>5.6 (2)</td>
<td>16.7 (6)</td>
<td>5.6 (2)</td>
<td>0.0 (0)</td>
<td>25.0 (9)</td>
<td>1.31</td>
<td>1.19</td>
</tr>
<tr>
<td>Absence of books while growing up</td>
<td>47.2 (17)</td>
<td>0.0 (0)</td>
<td>0.0 (0)</td>
<td>2.8 (1)</td>
<td>0.0 (0)</td>
<td>50.0 (18)</td>
<td>0.58</td>
<td>0.77</td>
</tr>
<tr>
<td>Lack of ability to engage in independent projects</td>
<td>48.5 (16)</td>
<td>12.1 (4)</td>
<td>3.0 (1)</td>
<td>0.0 (0)</td>
<td>0.0 (0)</td>
<td>36.4 (12)</td>
<td>0.82</td>
<td>0.77</td>
</tr>
<tr>
<td>My mother did not recognize my talent</td>
<td>41.7 (15)</td>
<td>0.0 (0)</td>
<td>16.7 (6)</td>
<td>8.3 (3)</td>
<td>0.0 (0)</td>
<td>33.3 (12)</td>
<td>1.25</td>
<td>1.32</td>
</tr>
<tr>
<td>Father did not recognize my talent</td>
<td>47.2 (17)</td>
<td>2.8 (1)</td>
<td>5.6 (2)</td>
<td>5.6 (2)</td>
<td>0.0 (0)</td>
<td>38.9 (14)</td>
<td>0.92</td>
<td>1.08</td>
</tr>
<tr>
<td>Academics not highly valued in my home</td>
<td>50.0 (18)</td>
<td>5.6 (2)</td>
<td>2.8 (1)</td>
<td>0.0 (0)</td>
<td>0.0 (0)</td>
<td>41.7 (15)</td>
<td>0.69</td>
<td>0.71</td>
</tr>
<tr>
<td>My family did not value science</td>
<td>44.4 (16)</td>
<td>2.8 (1)</td>
<td>5.6 (2)</td>
<td>2.8 (1)</td>
<td>2.8 (1)</td>
<td>41.7 (15)</td>
<td>0.92</td>
<td>1.18</td>
</tr>
<tr>
<td>Role of current family Career experiences to date</td>
<td>40.0 (14)</td>
<td>5.7 (2)</td>
<td>2.9 (1)</td>
<td>17.1 (6)</td>
<td>8.6 (3)</td>
<td>25.7 (9)</td>
<td>1.71</td>
<td>1.71</td>
</tr>
<tr>
<td>Career experiences to date</td>
<td>8.6 (3)</td>
<td>5.7 (2)</td>
<td>14.3 (5)</td>
<td>28.6 (10)</td>
<td>25.7 (9)</td>
<td>17.1 (6)</td>
<td>3.06</td>
<td>1.83</td>
</tr>
</tbody>
</table>
Participants were asked to describe the most important events that they perceived acted as barriers to their career paths. Responses were open-ended and categorized by type. Several comments on this question may relate to the answers on SQ35 (influences viewed as potential barriers), as the categories of barriers illustrated in the respondents' answers to SQ36 allude to significant experiences in their "careers to date" with problems of sexism (14), poor mentoring (10), and lack of institutional support (7) as the most frequently named barriers. Table E10 illustrates these categories and lists frequencies of responses to each category.

Concluding questions

Several final survey questions were designed to probe future goals of the participants and advice that they would give to other women interested in careers in academic science. Thirty-two respondents answered the open-ended question related to future goals, with several respondents listing multiple future goals. The responses were categorized and counted for frequencies. Table E11 represents the categorical responses by frequency. The largest numbers of responses gleaned were reported for the categories of continuing research/grant productivity (15), receiving promotion to full professor (6), and obtaining administrative leadership roles (5).

Survey respondents were asked to give advice to a young woman pursuing an academic career in science. Responses were open-ended and categorized by type. Table E12 illustrates these categories and lists frequencies of responses to each derived category. The top three categories of advice the respondents noted were to “love what you do” (12), “cultivate mentors” (7), “work hard” (7), and “take risks” (4).
Survey Question 39 asked participants to attach their curriculum vita, if desired. Seventeen respondents chose to e-mail a copy of their curriculum vita. Of these seventeen, six had also completed the questions on the survey that related to each question. Of the others, responses were coded for the relevant questions and added to the data for each of the relevant survey questions.

The final survey question asked respondents if they were willing to participate in a follow-up interview. Of the total number of 41 survey respondents, 22 answered positively to volunteering to participate in a follow-up interview. Five were selected for interviews for the purpose of this study according to the criterion of being outliers in their responses to key aspects of the survey.
Phase 2 Interview Results

The study consisted of two phases. The second phase involved the use of follow-up interviews with five survey respondents. An interview protocol (Appendix B) was utilized to further probe the influences on the talent development process of the interview participants. The literature search and the survey responses revealed specific categories of environmental influences and internal characteristics that acted as catalysts – as either facilitators or barriers – to the talent development process of successful academic women scientists. These catalysts were probed more deeply in the interviews through specific interview questions for each participant.

Demographics

Each of these interview participants was atypical from the majority of survey participants in her survey responses on one or more of the survey questions. They were each chosen for follow-up interviews in order to further explore these outlier responses and also deepen the perspective of the research. These five women appeared to have different experiences that affected their talent development process than those reported by the majority of the survey respondents. One participant was chosen for a follow-up interview as she listed that she is not happy with her career success. A second participant was selected for a follow-up interview as she has very young children at home, unlike the majority of respondents with teenage or grown children at the current stage of their careers. The third respondent was chosen for an interview, as she listed very positive experiences with mentors throughout her career. The fourth participant was chosen for her career stage (late career, one year from retirement). And, the fifth respondent was chosen due to the exceptional number of early career awards she received. Each of these
interview participants was atypical in her survey responses on one or more questions of the survey. They were each chosen for follow-up interviews to further explore these outlier responses and also deepen the perspective of the research. The interview participants' basic demographic information and identifying participant number (PI 1-5) is represented in Table 29.

Table 29 Demographics of Interview Participants

<table>
<thead>
<tr>
<th>Participant</th>
<th>Discipline</th>
<th>Rank/Positions</th>
<th>Age</th>
<th>Marital Status</th>
<th>Children's Ages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participant 1</td>
<td>Computer Science</td>
<td>Professor</td>
<td>56</td>
<td>Partnered</td>
<td>23, 20</td>
</tr>
<tr>
<td>Participant 2</td>
<td>Engineering</td>
<td>Associate Professor/Dean of Graduate Studies</td>
<td>36</td>
<td>Married</td>
<td>3, 5</td>
</tr>
<tr>
<td>Participant 3</td>
<td>Chemistry</td>
<td>Chaired Professor Department Head</td>
<td>55</td>
<td>Re-married</td>
<td>26, 22</td>
</tr>
<tr>
<td>Participant 4</td>
<td>Chemistry</td>
<td>Professor/Dept. Chair</td>
<td>64</td>
<td>Married</td>
<td>41, 40</td>
</tr>
<tr>
<td>Participant 5</td>
<td>Engineering</td>
<td>Chaired Professor</td>
<td>44</td>
<td>Married</td>
<td>6, 10</td>
</tr>
</tbody>
</table>

The interview participants represent different current levels of leadership in their respective departments. Three respondents have obtained administrative positions. Four of the women are full professors, with two of these respondents currently holding chaired positions. Two of the interview participants currently have young children.

Responses by Interview Questions

The interview questions each probed variables of the Gagné talent development model, specifically the areas of external influences, internal characteristics, important events, facilitators and barriers. Significant statements and phrases were coded (Creswell, 2009; Patton, 2002) by theme, and quotations from the women are utilized to illustrate
the various themes around each interview question. Table E13 shows the questions with accompanying variables from the Gagné model and connecting themes.

*The Talent Development Process*

Respondents were asked to "tell the story" of their talent development process. All five participants seemed hesitant, and three respondents asked for clarification when answering this initial question. The result was that the responses to this question were relatively brief. The coding from this section of the interviews (Question 1) ended up being folded into each of the other question areas and subsequent themes. The primary benefit from this question was the relating of primary plot points or major talent development markers of each respondent as they reflected on their talent development process. Based on the responses to this question, specific markers were identified for each respondent's talent development process, as emphasized specifically by each interview participant. The criteria used for identifying these major plot points in the talent development path of the interview respondents were determined after reviewing the transcripts and listing those major events narrated by the interview respondents to the first interview questions related to the talent development process (see Table 30).
# Table 30 Talent development markers noted by interview participants

<table>
<thead>
<tr>
<th>Interview respondent</th>
<th>Specific talent development markers</th>
</tr>
</thead>
</table>
| IP1                  | 1. High school was fun, a magnet school, and all-girls  
                         2. College was easier than high school  
                         3. Graduate school challenging; advisor was “horrible” |
| IP2                  | 1. Great summer jobs in research  
                         2. Father very motivating (Ph.D. in electrical engineering) |
| IP3                  | 1. Getting accepted to Hunter in 7th grade (all girls)  
                         2. Failed Physics in college  
                         3. Chose Chemistry as major |
| IP4                  | 1. You must have ability and desire; I had both  
                         2. Hunter High School fostered science talent |
| IP5                  | 1. Natural ability for Math and Physics  
                         2. Had really good teachers who challenged me  
                         3. In college, I felt challenged and was successful  
                         4. Post-doc in Africa was important  
                         5. Obtained Named professorship and NSF Early Career Award |
Influencing Internal Characteristics of the Talent Development Process

Interview participants were asked about specific internal characteristics that they perceive to have affected the process of their talent development as scientists and academics. In each of the five participants' examples, the themes of persistence and hard work emerged as important.

**Persistence.** Several respondents specifically noted that having the ability to focus and finish work was very important to their success. One senior academic engineer noted: "I think the biggest [internal characteristic] is the ability to really focus on a problem and work on it for a very long time.... Finishing is really big" (IP5). A chemist related that she believes that stubbornness is one of her most important internal characteristics: "I guess being pig-headed and stubborn helps. You know, I just had the interest and wanted to pursue that direction. That was it" (IP4). Another woman engineer shared that "I am very detail-driven in particular, and when I start something I like to finish it and see it through to the to the next level. I do like finishing things.... I am very passionate about what I do" (IP2).

**Hard work.** The theme of hard work emerged during the conversations about internal characteristics, as several participants acknowledged that working very hard was critical to their career success. One senior chemist summed up her conception of why she has been successful: "I worked my tail off and here I am" (IP4). She added that "you have to have ability and you have to have desire to work hard in order to develop in any field, and I guess I had both of those" (IP4). Several participants shared that they find that hard work – the willingness to put in many hours, dedicated to pursuing a problem and/or
project— is one of the most important internal attributes affecting their success and the success of other academic scientists with whom they have collaborated.

The internal characteristics of temperament and personality were also recorded as very important to the talent development process of the five women. Respondents documented specific ways in which their own temperament and personality traits have influenced the development of their science talent. Themes that emerged in the interviews related to temperament/personality included enjoying and meeting challenges and also taking risks. These characteristics are outlines as part of personality and/or temperament in Gagné’s (1985, 1991) model of talent development and also discussed as important traits of faculty (Baldwin & Chang, 2006; Finnegan & Hyle, 2009). Participants were able to relate why they felt their own personality was best suited both to careers in science and in academia. One senior engineer noted that:

When I finished my Ph.D., I realized that becoming a professor was much more difficult than going into industry. I liked the challenge of that, and when I started out my plan was just to get tenure and then go into industry. I just wanted to prove that I could do it, but then I like the job and I have just kept doing it. I have thought about leaving the academic position and going into industry because I could make a lot more money.... I like the flexibility. There is some self-imposed pressure because you want your work to be high-quality and respected so that you are bringing in the funds for research, but in the end there is nothing that is really going to happen. Nobody will die if my research doesn’t work out. (IP5)

*Enjoying challenges.* The theme of enjoying and meeting new challenges was present in several of the interviews. As one woman explained her career path and the
intrapersonal characteristics that she believes have helped her achieve at a relatively young age, she represented the feeling shared by many interview participants:

The next step was when I was an undergraduate, again I was challenged and was able to meet the challenges and was very successful. Again, I felt that I had really good preparation going to college and so I was able to reinforce my confidence. Even when I went to grad school, I was also successful. And, I was successful at each level and that continued to increase the confidence in myself. (IP5)

*Risk-taking.* Risk-taking was noted by two of the interview participants as a very important factor in their success. One scientist had taken the opportunity to go to South Africa for a year after completion of her Ph.D.; this risk had important dividends for accelerating her career, including the receipt of several early and prestigious young researcher awards and grants primarily due to this unique experience she has pursued as a post-doc:

From the outside, [going to South Africa] might have been viewed as a crazy thing to do because I was going to a place with less resources, when many were coming to the USA. But really, that was a valuable experience for me, and I think in the long run it ended up helping me a lot. I wanted to go and teach at a university in Africa because I wanted a different experience, a different cultural experience and I wanted to see what it was really like over there. There was a position advertised in my professional magazine a year before I finished my Ph.D., and it just jumped out at me. So, I sent my C.V. off and they called me the next week. (IP5)
Her sense was that these early career decisions demonstrated to granting agencies that she was willing to take important, calculated risks in her research and in her career. Another scientist, who also shared that she is not very happy with her career success, felt that her willingness to take risks in her career has been important to her career persistence and trajectory, despite her unhappiness with her career experiences to date:

I guess I must be confident...there must be some inner-place that keeps me going, and enough reward. Possibly, it is because for me it has never been "do or die." I have always been able to jump out there and take risks.... I left a tenured job and went to (the next institution) without tenure, but I don’t recall worrying about getting it back. I just figure what will happen happens. (IP3)

External Influences on the Talent Development Process

Each of the five participants shared examples of ways in which external influences have affected their talent development process. All participants noted the impact of specific environmental catalysts on their talent development process in science. Themes that emerged in the interviews related to external influences on their talent development process included high school experiences, institutional support, and the effects of having children.

Experiences in high school. Three of the women attended the Hunter School, a specialized school in New York City. All three respondents felt that the experience of attending this single-gender school enhanced their ability to feel they could succeed, as they gained confidence and an important feeling of “being special” by attending this prestigious school for gifted young women. One women chemist described: “Hunter High School was the biggest factor, just because of the way it was in those days. It was an
incredible place. There was nothing to dissuade us from anything we wanted to do. In fact, a large percentage of my class ended up going into the sciences” (IP4). A second chemist and Hunter alumna, but ten years younger, entered Hunter in her middle school years and recognized the critical importance of that entry point: "I really think getting accepted to Hunter and going to Hunter in 7th grade, after elementary school in Queens [made a big difference].” (IP3). The feeling of being chosen for this special school with so many opportunities for young women contributed to her academic self-confidence At the time when all three of these women attended Hunter, it was an all-girls gifted school. Hunter is now a co-ed school that is part of the CUNY system. One of the three was a first-generation college graduate. She described the importance of the recognition of her early talent:

I was realizing that I was smarter than others in my classes [when I was accepted to Hunter]…. Only four girls in my class were chosen to take the test [for Hunter High School]; only two of us made it. I think that was the first time I felt really special. And, that was really important to me because I kind of came from an unconventional background where my parents were blue-collar. (IP3)

_Institutional culture_. Another theme that emerged relating to external influences was the importance of the individual departments and institutions of the women faculty, particularly in supporting those women with young children. One participant noted that her “department is great, and they have been very supportive” (IP5), as she has worked to balance her career with raising children. Another scientist who also has young children noted that her department has been “phenomenal with mentoring and supportive, especially when I had kids. I was the first women to go through this, and they just
accommodated me any way I needed.” (IP2) She explained that the members of her department were very understanding when she had children, allowing her to work from home when needed and bring her infant to her office when it was appropriate. Several women noted that they have been the “first” in many different ways in their departments, either as the first tenured woman, first woman chair or first woman to be promoted to full professor. Four of the women stated that their departments and institutions have been very supportive, both informally and through official policies. This connection made by the respondents to the policies of the institution appear to relate to an impression of a more positive institutional culture for the women academics represented in the interviews. An engineer recorded that “we have a parental leave policy [at our institution], and when we first put it into place it was at the forefront in the country. You get a semester off of teaching at full pay, and you can get a second semester off at half-pay if you want. So, it’s pretty good” (IP5).

Children. The effects of having children also emerged as an external influence for their talent development of the women in the interviews, particularly for the two women scientists who currently have children under the age of ten. The way in which these two women described the primary effects of having children on their career was related to efficiency – feeling that they now get more accomplished in a shorter period of time – and the stress inherent in balancing multiple demands on their time. This related to the ability of these respondents to move forward in their careers and thus further their talent development process as scientists.

One related that she waited until after tenure to have her first child and that she is “definitely not able to work as many hours, which is fine. It’s frustrating, I always have
the feeling that I am not doing enough work, and that I am not doing enough for my kids.... My productivity is definitely not at the level that it used to be, but I think it is good enough.” (IP5) The other scientist with young children recorded that she recognizes that having children has affected her career:

Since I had children, I definitely do not have as much free time. I have not read a book in years.... I have been able to manage fairly nicely spending a lot of time working at home at night. I do not work regular hours, and I spend a lot of time at home. I still keep up with my students and their papers and proposals, and I can work strange hours because I don’t need to be in a lab [as a computer scientist]. So, it definitely affected me, but I don’t think it affected my work in terms of slowing down. It has made me a lot more efficient. I am much quicker at doing things. It has not been a career blocker or stopper, it just changed how I do things.

(IP2)

This respondent illuminates an important aspect of the diverse fields of science on the talent development process of established women academics. If women are in scientific fields where working daily in a laboratory is a requirement (e.g., Chemistry, Applied Physics, etc.), then pregnancy and young children are difficult to manage in these circumstances. For women who are theoretical scientists or in fields of science that do not require laboratory work with potentially hazardous equipment, the balancing of childbearing and child rearing is more possible.

Influential significant others. All five of the interview participants noted important people in their lives as very influential in the development of their science talent. Themes that emerged in the interviews related powerfully to the important roles of
parents and teachers/advisors. Parents were noted as powerful influences in contrasting ways. Three of the women reported that their scientist fathers and mothers influenced their interest in science, while two other women reported that their parents' status as high school graduates and/or first generation immigrants was an important factor in their talent development process.

The women with scientist fathers recorded that “I wanted to be an engineer like my father... be out there solving real problems” (IP5), while the other woman remembered that “one of my first experiences was with a game that (my Dad, an engineer) created called the mouse and the maze, back in the 80's, and this was featured at Epcot Center, and we went down there to see it being used” (IP2). She felt that this public recognition of the importance of his talent (particularly noted by a young child going to Disney World) influenced her early on to believe that scientific work was interesting and important. A third respondent, who is now a senior computer scientist, noted that her mother's profession as an engineer was an important external influence for her while growing up: “Growing up...my mom helped with the math homework, she was the one that fixed the washing machine when it broke, that sort of thing” (IP1). Her mother was a role model of a woman scientist whose professional talents also influenced her daughter’s perception of her own career possibilities.

The two women interviewed who were one of the first in their families to attend college had a different perspective on the influence of their parents while they were growing up. One participant shared the ways in which this made her different:

I did not have the kind of background that many of my colleagues have in academia with parents who went to university or are professionals; but, on the
other hand, I think what shaped me and set me up for achievement was the fact
that both of my parents are very smart and much higher achievers than what is
associated with blue-collar workers. (IP3)

This acknowledgment of the role of parents in sharing the value of intellectual
engagement proved particularly important for the women whose parents had not attended
college. The other scientist whose parents were first generation immigrants [and had not
attended college] shared that “in those days, we had a big extended family [as first
generation immigrants], and if your daughters went off to college, it was loco” (IP4).
This woman viewed herself as a trailblazer in her family, going against the family norms
in order to attend college and then graduate school and later work while she had young
children at home. However, her parents did encourage her to pursue her dreams of an
academic career, even though they did not necessarily understand her career goals.

*Mentors.* Teachers and other mentors were important external influences for the
women interviewed, most specifically in high school and in graduate school. This
element was found among the rest of the sample. One of the women, who now works in
a very math-oriented area of engineering, shared that her high school AP Calculus teacher
had an important influence on her as “he just made math fun. And just the way he
presented it, I saw the beauty in it and I thought that was really neat. That was the first
class where I realized how much I really enjoyed doing math” (IP2). Another scientist
commented that her choice of advisor in graduate school was critical to her success.

I had an amazing graduate school advisor; he was a very down to earth, friendly,
approachable person. He was a major influence in me sticking with it and
deciding then to follow the career path that I started because he did such a good job at providing advice and encouragement when needed. (IP2)

She also shared that she believes that science students should pursue advisors based on personality fit, instead of purely based on academic interest. She feels strongly that advisors have a very important effect on whether young scientists persist (or not) in academia.

*Important events that influenced the talent development process*

Events that influenced the development of their science talent were noted as important by four of the interview participants. Themes that emerged from the events shared included critical opportunities and important milestones including failures, recruitment, and promotion experiences.

*Critical Opportunities.* The opportunities cited by participants included encounters with both success and failure. One chemist recalled the reason she chose to focus on a career in chemistry: "I graduated at 16 because I had skipped some grades. I failed physics my first semester [in college] and had a real reality check. That set me on a certain path, and eventually I switched to chemistry" (IP3). Another woman related the events that led her to the only institution at which she has worked and from which she will soon retire. She related how the need to immediately hire chemists in this department in order to meet the state standards led to her initial hire as a faculty member.

I got [to my current institution] under very strange circumstances…. Back in 1976, the state of New York decided to evaluate every doctoral program in the state and they started with chemistry…. I happened to be in the right place at the right time because they had to fill gaps, and that is how I got hired! (IP4)
She shared that other events during her career led to important opportunities for her advancement and talent development process including a story of how she was offered a senior academic administrative position that proved an important opportunity for her career:

When he came in as Dean, he asked me [to serve as Associate Dean] after getting some advice from another upper-level female administrator. He asked her advice, and her comment to him was “I don’t know, she can be tough.” At the same time, I asked one of [my colleagues] about him and he said to me ”I don’t know, he is harsh”. I told one of my buddies, and he said it was a marriage made in heaven.

(IP4)

The experience of being asked to take on an academic administrative position enhanced the talent development for this chemist as she was given opportunities to see the larger picture of her institution’s policies and goals. She believes this greatly enhanced her ability to secure more funds for her department when she returned to the faculty. One computer scientist recalled the important opportunities that were created by her earliest choices in her career and related the role that her spouse, who is also an academic scientist in her field, played in helping create opportunities for both of them at critical decision points:

[My husband] and I hooked up at the end of grad school and...we had several choices. His first choice was [our current institution] because it was the best program in the country, and he felt we should do the best post-doc we can before we go somewhere else for jobs. I never would have trusted myself to do that. This is the best place in the country. (IP1)
Her spouse’s willingness to take a chance on starting their mutual careers at a top-ranked institution did have important long-term affects for her own talent development as a scientist, as she was able to secure better funding for her research due to the prestige of her institution. Another woman chemist recalled that important opportunities opened up for her when she was offered a department head position at her current research institution. She described the important event of being recruited to a new institution in an administrative position as an expansion of her career opportunities: “My research has gotten so much more interesting, so much more current. Opportunities have opened up that I never would have had at [former institution]. That is the most exciting thing about coming here” (IP3). She believes that the move to the new institution has led her to feel more valued. She also enjoys more resources for her research than she had at her former one.

One computer scientist revealed the impact that the powerful evolution of the computer industry had on her career trajectory as an important external event, as she observed her “weird field became more popular, and the area became more important” (IP1) later in her career. She explained that this change in the interest in her field also led the way to critical opportunities for grant funding, major awards and recognition at her university, all of which had been struggles for her prior to her field becoming viewed as important since funding opportunities were more prevalent when her area of computer science research became important.

*Milestones.* The importance of being the "first" woman to achieve significant accomplishments in the department of their institutions was a major theme for many of the respondents in the interviews. “Being first” seemed to open doors of opportunity for
these women. As one engineer shared: "I was the first [woman in my department] to
make it to full professor." (IP5) She related that this was a major impetus for her career at
the university, as her promotion to professor as "the first" also raised her profile at the
university, and she has since been asked to participate in several high-level university and
regional initiatives.

This engineer explained that receiving important awards in the early stages of her
career were important milestones for her talent development process. She described the
significance for academic scientists in receiving young investigator awards early in their
careers, as particularly related with later prominence in the scientific communities. She
related the importance of receiving such an award for her own career: "I also got a young
investigator award in my first year from NSF and those things put me on the right starting
position. It could not have been a better position for a new professor to be in" (IP5).

A different scientist noted that her recognition by peers at other institutions was a
very important milestone for her talent development. She described the experience of
being recruited to her current position as head of a large university department where she
oversees a very large department and significant budget: "when I was approached by [my
current institution] to be department head, I got excited because someone was interested
in me, unlike [my former institution] where my name never even came up as a possibility
for department head" (IP3). This experience of barriers at her prior institution to her
talent development process were contrasted with her current institution (to which she was
recruited) where she has experienced multiple facilitators including enhanced resources,
more budgetary discretion and the ability to serve in a leadership role.
Specific Facilitators of or Barriers to talent development

Interview participants were asked about specific facilitators and barriers that acted as positive or negative catalysts on their talent development process as scientists and academics. Each of the five participants shared different ways in which certain facilitators or barriers affected their talent development process. Several themes emerged in the interviews related to facilitators of talent development for the interview participants, including the important roles of parents, mentors/teachers and school/program opportunities.

Parents. Four of the five participants noted that their parents were a primary facilitator to their talent development, particularly in science. One engineer explained that her father has a “Ph.D. in electrical engineering, and so he was all for this, and I know he had a great career. I saw what he got to do with his career and so that was motivating for me as well” (IP2). Another noted that her father "encouraged me to go on to graduate school and told me that I could always be an engineer, even with a Ph.D., if that is what I decided” (IP5). One scientist who identified as first-generation explained that, even though her parents were not college-educated, they created a home environment centered on the value of education. She believed that her family’s valuing of education was the primary facilitator of her talent development. She shared that “[my parents] read all the time; they did not watch television.” This same respondent also explained that her parents were always openly supportive of her career and personal goals: “I think one of the amazing factors for me was that...I had the backing of my family. They retired young and moved to help me raise my kids,” and they were “non-judgmental and there when I
needed them. I always believed [throughout my life and particularly during difficult times] that I had that safe place to go” (IP3).

The valuing of education by parents was an important facilitator of the science talent of several of the interview participants, as one engineer explained that “education was really highly valued in my family...My dad is an extremely talented engineer. That affected me a lot. I went to him a lot for advice” (IP5). Parents also played a role in persistence, even when barriers were present. A senior computer scientist described some difficulties she faced with poor mentors during her graduate program but noted that her “parents keep suggesting that I stick it out and get the Ph.D. I was so close....it would help to have a Ph.D. no matter what I did. They definitely thought that it would be a good idea” (IP1).

Teachers and mentors. Mentors and teachers also served as important facilitators of talent development. The theme of the role of teachers (and later professors and advisors) in facilitating talent development was a consistent presence in the narratives of the interviewees, as the women described the importance of teachers as supporters: “anybody who supported me with what I was interested in...I had an 8th grade science teacher who real inspired me” (IP4). Another participant recalled, “having some really good teachers who pushed me and challenged me, and really prepared me well. They encouraged me and helped me to believe that I could do this stuff” (IP5). Others noted the role of advisors in graduate school as major facilitators. One engineer explained her belief in the importance of good advising: “I still think a good relationship for students with their advisor is what propels them to move forward” (IP2).
Program opportunities. Specific school experiences and program opportunities were also viewed as important facilitators of the talent development process for the interview participants. One computer scientist shared that “I would say high school was fun, there were high expectations, and it was an all-girls school” (IP1). For this respondent, the impact of an all-girls school was very important and she frequently referenced its impact during the interview. Another engineer recalled her experiences with summer research opportunities that were connected with her undergraduate institution and how important they were to her sense that she could propel herself forward in a science career:

I had some great summer jobs [science research opportunities working in labs with faculty] that were very exciting and so those kind of made me really want to go more into the research area because, when you are in school, you get to see the book side of things but you don’t get much chance to put it into practice, and what you do can be used and... So, I think one of the things that convinced me I wanted to go to graduate school were some of the people I worked with. (IP2)

Several themes emerged in the interviews related to barriers to the talent development for the interview participants including the roles of poor advisors, problematic institutions/sexism, and discouraging spouses.

Poor advisors. The impact of poor advisors was noted as important for two of the interview participants. One computer scientist commented on the barrier that her graduate school experiences -- particularly her advisor -- had on her career early. She felt strongly that these experiences almost led to her dropping out of science completely. She described her graduate school experience dramatically: “The advisor was pretty horrible.
The students were pretty horrible. Grad school itself was pretty horrible – very competitive, very elbowing each other out of the way atmosphere” (IP1). The effect of these negative interactions in graduate school was to make this woman feel that she wanted to drop out of her program. She noted that it was only her parents’ encouragement to stay and complete her degree that resulted in her finishing the program. As with this participant’s response, the issue of both poor advisors and institutional culture were reported by many participants beyond those interviews.

Sexism/institutional culture. The perceptions of sexism in science and in institutional cultures were primary and related themes emerging from the interviews. One engineer, who noted that she is beginning to do work on issues of gender inequity in science at her institution, recorded a recent experience she had at a conference on this topic that related to institutional culture and sexism:

The hard thing in the U.S. is that it is always the hidden stuff that you don’t know. We had some women talking yesterday…and one was from Austria. They don’t hide their discrimination over there, so we know she had a harder path and she definitely earned it. So, when she got her position…many people congratulated her, while others told her she got it because they needed to hire a woman. Interestingly, one of the women knew someone who changed genders and went from female to male. Someone actually went up to him and told him that he was much smarter than his sister. (IP5)

This interview participant related this story as an example of the ways in which women are discriminated against in science simply because they are women. This same
respondent also shared the recent issues at her institution related to women not being promoted.

We have had some problems with women not making it through tenure.... We are trying to get the President to get a policy that will hopefully prevent the problems we have had, but hopefully earlier on so that women do not have trouble making it through the process.... One of the big problems we have had with our junior women is excessive amounts of service, and that ends up creating a problem because it does not really count for much; yet, it takes up a lot of time. So, that is one of the big things, telling them to say no.

Based on this comment, one of the barriers to talent development is the lack of formal or informal policies and the practices within the institutions in terms of tenure. These women share the concern that younger women faculty are not advised to stay away from too much service. These younger colleagues are not mentored by senior faculty to be productive in their research, and they are not discouraged from taking on too much service. So, their research talent is not cultivated. One respondent related her own struggles with her current institution where both she and her spouse have worked for their entire careers. Even though she has received more grant funding and awards than her spouse, their institution has consistently treated them inequitably. She shared that her husband received multiple opportunities at their current institution while she had a "horrible postdoc" and was then not offered a tenured position. She believes they only hired her originally because they "wanted" her husband. However, she asserted: "in the end, it all worked out for them, because I ended up being successful [tenured and later promoted] and they had hired me" (IP1).
One chemist shared that her frustration with the academic culture for women, particularly at her own institution, has led her to take action in specific ways. She related an experience she had last year where she helped another woman with an appeal of her tenure decision and worked to mentor another woman:

I actually served as an advocate for a woman who did not receive tenure for ridiculous reasons, and there is an appeal process where you have a formal advocate. She was not even in my department, but she asked me if I would and I won the case simply because the reason she was denied tenure were completely fake…. (IP3)

The women all shared that they felt a sense of being exploited by their institutions in the area of service. Each of these women reported that they are one of the only senior academic women in science on their campuses, and this lack of numbers has led to a feeling that they are overburdened with committee work. A computer science interviewee shared that she is “sick of being here on every single committee. Every single committee needs their share of women, even though there are 10% of the women in [this] workforce; so, it’s very annoying…. I think now it is time to stop” (IP1). Many respondents noted that there must always be a certain number of senior women on committees at their institutions but that this ends up affecting women disproportionately, as there are very few women in top positions at their universities. The ends up as an unfair burden of service on women, particularly those in senior level faculty positions.

A senior chemist who shared that she has been reflecting lately about the different experiences of women in science commented about the perception of sacrifice that she thinks is widely acknowledged for women in science careers:
The women who are celebrated in science, and what some women feel is the standard, is still like the Marie Curie model, where you need to die for your science and men don’t have to.... Kind of this model of sacrifice, and I don’t think it has changed as much as it needs to. It is expected that women will sacrifice to have a career in academics, and men don’t have to. It troubles me that women feel they have to die and sacrifice to be recognized in science. (IP3)

This perception of sacrifice for women in science appears to serve as a very significant barrier for the talent development of women academics as the burden for service results in not having as much time to devote to research, working with graduate students, and writing grants.

Combined with this perception of institutional sexism, one participant also noted that she feels isolated from other senior women in her area of science. She views this as part of the culture of sexism in science that forces women into groups or “cliques.” She felt this has served as a barrier in her career development, as she believes that the women who are “in these cliques” end up with more awards, grants and other recognition based on the networks created by these groups. She described her own experiences:

I have always just felt outside the cliques that form.... I don’t keep my mouth shut. I just don’t blend well with others. I don’t think I fit in those circles. I don’t think I fit into the group of women in science. I have not been invited.... Sometimes it can be isolating but other times it is liberating. I think that this has sometimes hurt my career in things that would have been acceptable like funding opportunities. Certain inner groups are more likely to get the awards and prizes,
not just in funding. I have never been into that, and I guess where this hurt the most is not being accepted by my female peers [in my area of science]. (IP3)

Spouses. Although three of the women believed that their spouses were helpful to their careers, two of the others felt that their spouses had served as a barrier at one point or another during their careers. One senior chemist, who is now nearing retirement, described how her husband originally tried to stop her from returning to work, attempting to create roadblocks to her re-entry to her career. She shared that her husband "didn’t want me to go back to work after the kids were born. I just said ‘tough, I can’t stay home with kids, I am going back.’ And I just did it and after a while he realized there is nothing he could do" (IP4). Another woman described that the lack of assistance from her spouse with children and home responsibilities has slowed her career progress and the further development of her talent, at least in the timeframe she had anticipated. She had expected that he would share in the child care but now realizes that “having kids postponed when I ended up going up for full professor. It may be pushed it back by one or two years….my productivity definitely went down after I had my first child” (IP5).

Summary

The interviews allowed the researcher to understand at a deeper level the external and internal influences that served as both facilitators and/or barriers to the study participants’ talent development process. These selected interviews served to garner more detailed information about the views and opinions of the interviewees’ perspectives regarding the most important influences on the journeys along their talent development paths. The external influences of important significant others supported the results of the surveys while the impact of surroundings and culture were expanded in the interviews
and added depth of perspective to the survey data, particularly around the barriers of institutional culture and sexism. Most importantly, the voices of the interview respondents were reflected in the quotes cited from the interviews and expanded the understanding of the study participants' experiences as successful women academics.
Summary of Findings by Research Question

Summary of Findings for Research Question 1

What are the environmental catalysts of surroundings, opportunities, people, and events that have contributed to the talent development process of the study participants?

Findings from the study related to Research Question 1 are the following:

1. The majority of respondents (63.4%, N=26) reported being first-born children in their families of origin.

2. Parental education and occupation influenced the respondents as 56.1% (23) of survey respondents report that one or both of their parents earned a graduate degree, and 48.8% of respondents (20) report that one or both of their parents are scientists and/or academics.

3. The most important early influences on the development of the respondents' science talent were teachers (71.8%) and family members (61.5%).

4. Due to the number of respondents who report growing up overseas (9) combined with those who report cohorts over age 50 (24), 48.9% of respondents reported not having access to special educational opportunities in their high schools. Of those that did report advanced high school opportunities, Advanced Placement (AP) courses were the most prevalent (36.1%)
(5) The influences of the current home and family structure were important for respondents. Most of the survey respondents are responsible for more than 50% of both household and dependent care duties. Also, a majority (5.3%) of the respondents’ spouses/partners were reported as working as either scientists and/or professors.

(6) The respondents reported serving as the only or one of very few tenured women in their departments. This finding related directly to the surrounding element in Gagné's model. Tenured women represented less than 10% of the number of full-time members of the respondents’ departments (Mean number of tenured women: 2.1; mean department size: 24.53).

(7) Mentors are reported as extremely important, both in relation to support growing up, at each educational level and also as both facilitators and barriers to the talent development process.

(8) High school experiences were important for the interview participants. Three of the five participants interviewed specifically noted the impact of Hunter High School in New York City (at that time an all-girls school) on their talent development in the sciences.

(9) All of the interview participants noted that the presence and/or absence of institutional support effected their talent development.

(10) The most influential people in the lives of the interview participants included parents and teachers/mentors.
Important events in the lives of interview participants included key educational and life opportunities and major milestones such as early awards/honors, grants, promotions, partner choices, and the birth of children.
Summary of Findings for Research Question 2

What are the intrapersonal catalysts or internal characteristics that have contributed to the talent development process of the study participants?

Findings from the study related to Research Question 2 are the following:

1. Early interest in science was a primary characteristic for study respondents. A majority of respondents indicate that they first became interested in science in elementary school (33.3%) or in high school (33.3%).

2. Early motivation to achieve was an important finding, as 80.1% of survey respondents reported graduating in the top 5% of their high school class and receiving honors at all stages of their early development in high school and college.

3. Motivation to persist in leadership roles was reported by more than 60% of respondents, with 56.1% recording a top leadership role in a professional/academic journal, and 60.9% reporting a leadership role in academic administration.

4. On attribute scales, 95.1% of respondents report being highly or extremely (mean scores of 4 and 5 on a 5-point Likert scale) "motivated" while 95.1% report being highly or extremely "hard-working." The majority of respondents also rated themselves highly or extremely “problem solving” (87.5%), and 53.7% regard themselves as highly or extremely "risk-taking."

5. Motivation, persistence and hard work were most frequently recorded by interview participants as acting as the most important internal catalysts for their success.
Themes that emerged in the interviews related to temperament/personality included enjoying challenges and taking risks. The interview participants expressed the importance of enjoying continued levels of challenge and the ability to take risks in their careers.
Summary of Findings for Research Question 3

What are the primary facilitators and barriers that were encountered in the talent development process of the study participants?

Findings from the study related to Research Question 3 are the following:

(1) Primary facilitators of talent development for the survey respondents included the recognition of their talent by a teacher, with 72.5% of participants recording this facilitator as highly and/or extremely important.

(2) Taking advanced courses was a notable factor for the majority of respondents, with 78% recording this as highly or extremely important to their talent development process.

(3) The importance of books in their homes growing up was highly or extremely important for 78% of respondents.

(4) The value of science by the respondents' families of origin was also important, as 68.4% recorded this factor as a 4 (28.9%) or a 5 (39.5%) on the 5-point Likert scale.

(5) When asked to provide open-ended survey responses to the question of primary facilitators to their talent development process, respondents listed several facilitators with the most frequently noted as having supportive mentors/teachers (11), being persistent/stubborn (9), and having early internships/research opportunities (5).

(6) The only notable barrier to the development of science talent for survey respondents in the forced choice question was "career experiences to date," recorded as a highly or extremely influential barrier by 54.3% of respondents.
When asked to provide open-ended responses to the question of primary barriers, respondents listed several perceived barriers with the most noted as "being a women/perception of sexism" (14), "poor mentoring" (10), and "lack of support for raising children/caring for dependents" (7).

Survey respondents were probed for advice for young women pursuing careers in academic science and cited several primary important facilitators including to "love what you do" (12), to "cultivate mentors" (7), to "work hard" (7) and to "take risks" (5).

Themes emerged in the interviews related to facilitators of talent development for the interview participants. Interview respondents discussed the critical role of parents, teachers, and schools/program opportunities as most important to the development of their science talent, affirming the survey respondents.

The most pervasive theme that emerged in the interviews related to barriers was the role of problematic institutions/sexism to inhibiting talent development for respondents.
A discussion of the findings of this study and the relationship of the findings to the current literature is presented in this chapter. The results from the current study are discussed, and the conclusions are presented. Based on the findings of this study, implications for current practice in both gifted and higher education are suggested, and the need for future research studies is delineated.

Discussion of the Findings

Research that examines the primary influences on the talent development of successful academic women scientists is limited (Ceci & Williams, 2007; Wasserman, 2000; Yewchuk & Schlosser, 1995). The findings in this study regarding the talent development process of successful women scholars serve to further refine both Gagné's model of differentiated talent development (1985, 1991) and add to the literature base about gifted women and female faculty. The findings, discussions and conclusions presented should not be considered as either theories or conclusions, as this area of research is still in its infancy.

Gagné's model of differentiated talent development

Gagné’s model (1985, 1991) demonstrates the talent development process in which domain-specific talents are influenced by intelligence, creativity, socio-affective, sensory-motor and others, while simultaneously following a developmental process that is inherently affected by external influences and internal characteristics. Gagné’s model
was transformational for its emphasis on the end product of the talent development process, stressing a deeper evaluation of the factors that may significantly influence the talent development process over the lifespan. This model of talent development served as the primary framework for the current study as it illustrates the multiple and complex areas of influence – both as facilitators and barriers – that are present in the talent development process for gifted individuals.

Gagné’s model highlights the role of intrapersonal factors that act as internal catalysts (motivation and temperament/personality) on the talent development process for individuals with giftedness in specific talent domains. He also accounts for the equally significant role of environmental influences as external catalysts (surroundings, persons and events) on the talent developmental process. Exploring the effects of specific areas of the Gagné model on the successful women scientists in the current study revealed that these women perceive that there were important relationships between these elements of Gagné’s model (external and intrapersonal catalysts) to their talent development process and later success.

Since the survey instrument was created by the researcher and has not been tested previously in other studies, inferences from this instrument have not been evaluated for construct validity or reliability due to the relatively restricted range of responses. While the study did not intend to test the Gagné model of differentiated talent development (1985, 1991), the findings of the current study have added to an understanding of the role of the specific internal and external influences illustrated in Gagné’s model.

VanTassel-Baska (1996) asserts that an examination of the lives of highly successful individuals should lead to an understanding of common patterns in the
experiences of talented individuals who fulfill their potential. These common patterns are shaped by the variables of both external and internal influences (as explicated by Gagné’s model) in the lives of gifted women. The current study does illustrate some common themes across experiences for the participants. Evidence suggests that those who become highly successful in any talent domain have not reached this level of esteem through ability alone. Utilizing the framework of Gagné’s well-established model of the talent development process (1985, 1991), this study explored the talent development process, including the primary catalysts that act as facilitators and/or barriers to talent development for successful academic female scientists in the most traditionally male-dominated of the science disciplines. It is clear that these variables represent key factors in the road to success for the participants in this study.

External influences

The results obtained in this study related to the external influences revealed in other studies (Bloom, 1985, Csikszentmihalyi et al., 1993; Maines, 2007; VanTassel-Baska & Olszewski-Kublius, 1989). Consistent themes of external influences were found throughout the current study. For example, the majority of respondents in this study believed that the role of their parents in encouraging them, combined with the value of education, books and science in their homes, was influential in their later success, as their parents encouraged their early interest in science and supported their further talent development process. This finding supports the conclusions of Csikszentmihalyi, Rathunde, and Whalen (1993) in their study of 200 gifted and talented teenagers which revealed that the talent development process is fostered in families that value learning and also balance stability with the encouragement of taking on challenges. The findings
of this study related to the importance of families support these earlier findings and those of Yewchuk and Schlosser (1995) in their study of 197 eminent women in Canada whose families are described as work-oriented, loving, consistent, and supportive (p.79). Since many study participants stressed the critical influences of the support and encouragement of their parents in their talent development process, correlations were run to determine possible relationships between recognition of talent of the respondents by their parents and other attributes related to talent fulfillment for these participants. Interestingly, the fathers' talent recognition of their daughters had a moderately strong positive relationship to the publications record and self-perceived motivation of participants. This finding also supports Hellerstein and Morrill's (2008) recent study that found that women are significantly influenced by their father's support for their career choices. The importance of parental education and occupation also appeared related to the career choices of this sample, as a majority of study participants had highly educated parents and many also had one or more parents who were academics and/or scientists, a finding consistent with the Bloom study (1985). Those study participants whose parents were not highly educated also acknowledged the important role of their parents in their talent development process, adding another important element regarding the influences on first generation academics that was not shown in Bloom's study.

The role of mentors (specifically teachers and professors as mentors and advisors) was also prevalent throughout both phases of the current study, upholding the importance of this factor for the talent development process for women scientists (Xie & Shauman, 2003; Young et al., 1980). A specific finding of the current study that adds to the literature is the frequently noted importance of colleagues who also serve as mentors.
These colleague-mentors were noted by many of the respondents in this study, both as important collaborators and peers who provided guidance at critical career junctures. This was not a theme found consistently in the literature regarding mentors and adds a new perspective on the important role of both collaboration and peer networks for academic women in science (Farrell, 2002; Rimer, 2005).

There were clear similarities between the role of important teachers and professors in the lives of the participants and those explicated in Bloom's (1985) description of teachers whose influence on the gifted students in his study was profound. Bloom described three developmental levels of teachers: those who make you fall in love with the subject; those who give you skills to move to the next level; and finally, master teachers, who help you become the best possible in your talent domain. These same levels of important teachers were reflected in the responses of the study participants about teachers and professors. Many study participants described the elementary school teachers as those who first encouraged their interest in science, causing them to “fall in love” with the discovery inherent in scientific inquiry. The high school teachers described by several participants helped the respondents acquire the science and math skills that made them academically competitive in college and graduate school. And, the graduate school advisors and senior collaborator-mentors then guided the participants in this study to very high levels of achievement in science. This last group of advisors and professors were comparable to the master teachers described by Bloom who demanded high levels of effort from their students.

The importance of the home surroundings, as illustrated in Gagné’s model, was also a notable influence on the women in this study. Home demands on study participants
were demonstrated clearly, with the vast majority having 50% or more responsibility for both household duties and dependent care. Although a few women have spouses who do more of the home- and child-care, they were certainly rare instances. In these specific cases, most have spouses who are also faculty members with more flexible schedules than their female partners. However, these cases were the exception. Many women commented that these disruptions limit their focus on their careers—in order to balance raising children or caring for a household—and distracted them from their work projects and goals. This disruption of their careers resulted in a postponement of their talent development process as scientists, at least temporarily.

This finding upholds the strong literature base relating the difficulties that professional women face in reaching the highest levels of their profession when they continue to shoulder primary responsibility for caring for dependents and/or for a household (Daniell, 2006; Kantrowitz, 2007; Monosson, 2008; Olsen, 1999; Wasserman, 2000). These responsibilities may be particularly true for academic work, as faculty members need time and space to do the intellectual work required to research and publish. The demands of home and dependent care typically cause frequent interruptions to intellectual pursuits and may place women at a disadvantage in publishing productivity, one of the critical elements to success for an academic. The women in this study shared that the need to balance these multiple demands in their lives focused their ability to be even more efficient with their time and enabled them to “say no” to projects that were outside the realm of their current work focus. This finding supports the recent work by Finnegan and Hyle (2009) that found that the senior faculty they surveyed had learned to limit their service commitments over time in their careers.
However, although comments by participants did reveal some home and child-care related stresses, no significant relationships were found when correlations were run for those participants who do have children on critical markers of career success including rank and number of refereed publications. Additionally, specific attributes were examined through these correlations to determine if there is any relationship between the attributes of risk-taking and pursuing opportunities and having children. For this group of respondents, having children appears to have no or a very low relationship to these important professional attributes. This is an important finding of this study, as the perception exists that women's career progress is limited by having children. Although many respondents commented that they felt their progress was slowed, the correlational statistics run on these possible relationships between having children and rank and publications did not reveal any negative relationships.

Institutional culture and perceptions of sexism, as defined in Gagné's model through the surroundings and culture variables, were often named by study respondents as the difficulty of "being a woman in science" and described by examples of women who did not earn tenure at their institutions and by those who felt they were not valued by their universities, was also a prevalent external influence on the talent development process for a critical mass of women in this study. This theme was specifically revealed in the interview phase of the current study, as women shared the stories of their talent development process. This also supports earlier findings of a perception of a "chilly climate" for women in academia (Doerrer, 2001; Farrell, 2002; Sandler & Hall, 1996). This finding was not consistent for all of the women in the study, as several noted that they received important support for their careers through established policies at their
institutions and also from their departments. Two women scientists recorded that, since they were the first woman in their department to ever give birth, they believed that their departments went "over and beyond" in trying to accommodate them at this stage in their lives as new mothers. This finding also strengthens the literature base regarding the differences faced by academic women when they are one of the only women in their departments, which may be a relatively recent phenomenon (Kettle, 1996; McGinn, 2005; Schneider, 2000; Wilson, 2003).

Program opportunities (as defined in Gagné’s model as schools/opportunities) were clearly very important for the women who had these opportunities available to them, either due to growing up in the United States and/or due to their age cohort. Those who had access to program opportunities with advanced coursework, honors programs, science enrichment programs, and independent study experiences (particularly research opportunities in high school and college) believed that these special and advanced opportunities were very influential in the development of their science talent. However, almost half of the respondents recorded that they did not have access to these types of programs (at least those listed in the survey questions), due to their experience growing up overseas or because of their age cohort (generally over 50). This finding in the current study is important as it may skew the results of those women who were not able to access program opportunities in the same ways that current young women growing up in this generation in the United States are able to do. The importance of program opportunities for gifted young women, particularly those interested in science careers, was supported by the experiences of the half of the respondents in the current study who were in
younger generations raised in the U.S. These findings corroborate similar themes revealed in the literature (Black-McGrath, 2005; Farrell, 2002; Subotnik et al., 2001).

Important events in the lives of the study participants also served as critical milestones and experiences for their success. Supporting the literature related to birth order, this study also found that the majority (63.4%) of respondents were the first-born in their families (Galton, 1875; Gross, 2003). Additionally, critical events for the study respondents that served as milestones or critical opportunities (e.g., awards, grants, and recognition by the university and/or the discipline) were very important to the accelerated talent development of the study participants. This public recognition of their talent and achievements supported their belief in their own abilities early in their educational and professional experiences and served to propel them forward on their career trajectories in science.

*Internal Characteristics*

Many of the respondents' internal characteristics of motivation and personality/temperament, the critical intrapersonal catalysts described in Gagné's model, were similar to those observed in previous studies of successful gifted individuals (Reis, 1996; Roe, 1951; VanTassel-Baska & Olszewski, 1989). The ability to focus on work and finish problems/projects was cited by several of the respondents as a crucial personality characteristic they believed facilitated their success. This finding is similar to the findings of Roe (1951) in her study of eminent scientists, and by VanTassel-Baska and Olszewski (1989) in their volume examining patterns of influence in the lives of gifted learners. Similar findings were also reported by Reis (1996) in her ethnographic study of twelve eminent women in various fields.
The importance of motivation (one of the two most primary elements of intrapersonal catalysts in Gagné's model) was revealed in the findings about internal characteristics and intrapersonal catalysts in this study and upholds the earlier call for further research made by Tomlinson-Keasey (1998), when she traced the various influences in women’s lives and highlighted the need for further research on the roles that motivation and goal-setting play in the fulfillment of gifted women's potential. Bloom (1985) also specified that two of the most important factors needed for success are focus and continuous self-direction. The current study upheld the critical importance of these traits in the career success of the respondents as they overwhelmingly ranked themselves very highly on attributes connected to motivation, focus on tasks, and independence. Due to the importance of these internal characteristics in the lives of the women in this study, correlations were run between the attribute of motivation and respondents’ self-perceptions of professional attributes. Strong positive relationships were found between the attributes of motivated and hard working and between being motivated and being a problem solver. These findings suggest that motivation and hard-work are perceived as related traits, while motivation appears directly related to the self-perception of being a problem solver, an important characteristic for scientists.

The traits of persistence, risk-taking and competitiveness were upheld as uniformly very important to the women in this study. Connections were made in the interviews with participants that characteristics of perseverance and risk-taking serve as critical elements to the success of academic scientists. These same findings were also noted by Cox (1926) in her study of 300 eminent historical figures and continues as a theme in the literature on gifted individuals (Filippelli & Walberg, 1997; Piirto, 1991).
The need for self-confidence and seeing oneself as intellectually able also supports prior research on academics that emphasized the role of self-esteem and "worthiness" in the success of scholars (Baldwin & Chang, 2006; Cattell & Drevdahl, 1955; Heward, 2006; Hill, 2008). This concept of feeling "special" was cited by several respondents in this study and seems particularly important for the self-recognition of potential for high achieving gifted women.

*Facilitators and Barriers*

There are many important ways in which environments and intrapersonal catalysts work together to serve as catalysts that can act as important facilitators to the talent development process; however, these same catalysts can also work against gifted women, functioning as strong barriers to the fulfillment of their potential. Primary facilitators of talent development for the survey respondents included the early influences of parents and teachers who encouraged the participants' early interest in science and academics. This encouragement for academic achievement in the lives of the study participants reinforces the literature in this area of the critical role of significant others in the lives of gifted individuals (Bloom, 1985; Piirto, 1991; Rimm, 2002; VanTassel-Baska, 1996).

Program opportunities in high school and college were cited as a notable factor for those study participants for whom these opportunities were available as they expanded the opportunities for advanced studies and further exposure to important mentors and/or teachers. The importance of "doing what you love" and "loving the science" were frequently cited by study participants as among the most important factors to their success as academic scientists. The role of mentors, as previously mentioned, was cited as both an extreme facilitator as well as a barrier for those who had "horrible"
advisors/mentors and also by those who felt they had very few mentors or lacked them completely. Themes that emerged from the interviews that related to mentors were that (1) mentors make the subject approachable, (2) mentors are approachable for and interested in students and mentors give relevant advice. Sustained creative productivity was also crucial to the success of the women in this sample whose refereed publication rates, grant funding, leadership roles and patents all contribute to advancement in their careers and served as an accumulative advantage in their career progress.

Due to the recognition that over time it is assumed that academics will publish more and reach higher levels of academic rank, correlations were run on these relationships. Important (and expected) positive relationships were found between rank and publications (.359), between age and publications (.649) and also between rank and age (.469). This finding also supported decades of prior research into the importance of sustained productivity and the accumulative advantage that can result from early career success (Isaac, 2007; Kanter, 1977; Simonton, 2004; Walberg et al., 1978). Certainly, as Piirto (1991) recorded in her study of creativity, women often become more productive as they age and move out of the childbearing and child-rearing years that may slow their talent development process and productivity.

The only barrier to the talent development process that was perceived by study participants as notable on the forced-choice question related to barriers was recorded as "career experiences to date" (cited as highly or extremely important by 54.3% of survey respondents). This was one of the most interesting findings of the study. When asked in a forced-choice query to name barriers, this was the only barrier that was recorded over 50% as highly or extremely important (as opposed to the many perceived facilitators in
earlier questions). When participants were asked to name perceived barriers in an open-ended question on the survey (just after the forced-choice question) and during the interview question related to barriers, more examples of barriers were revealed as 31 respondents reported specific barriers including many who recorded “being a woman/perception of sexism,” “poor mentors,” and a “lack of support for raising children/caring for dependents” as barriers. These same barriers are also those most often described in the literature on women's academic careers (Daniell, 2006; Glenn, 2007; Preston, 2004; Rosser, 2004; Rossiter, 1995). These all appear to be attempts by the respondents to define “career experiences to date” in their own lives. Certainly, each of these participants had a different perception of perceived barriers to her own talent development process.

**Faculty career development**

Although many studies recount the challenges that academic women may face to earn tenure and discuss reasons why some women leave academic science for industry (Daniell, 2006; Fassinger et. al, 2004; Hermes, 2007; Monroe et. al, 2008; Rosser, 2004; Rossiter, 1982; Rossiter, 1995; Sandler & Hall, 1996; Williams, 2008; Xie & Shauman, 2003), very few studies have explored the common experiences and characteristics shared by successful academic women in science. The effects of institutions on faculty development – specifically the roles of departments in supporting women’s multiple roles and institutions in providing policies that support women faculty - were noted in the current study, supporting the literature in higher education that acknowledges the important role that academic culture, policies and individual departments (Heward, 2006;
Hill, 2008; MIT, 1999; NSF, 2007; Philipsen, 2008; Rosser, 2004) have on the success (or not) of academic women.

Women in the current study frequently acknowledged the importance of collaborations in research and grant-writing to their career development, supporting the critical role that mentors and colleagues – both at the same institution as well as those at other institutions – have on the continued productivity of scholars. This finding of the need for supportive mentors – whether senior colleagues or peers – also supports the literature that discusses the relationships between retention and success of women faculty and the presence of good mentors in their professional lives (Rossiter, 1982, 1995; Wunsch, 1994). The role of peer-collaborators as mentors and guides along the talent development journey expands on the value of individuals who may serve as mentors and illustrates the importance of having academic colleagues in the academic sciences (Glenn, 2007; Williams, 2008; Wood, 2008; Xie & Shauman, 2003).

Conclusions

The current study explored the role of the influences illustrated in Gagné's differentiated talent development model (1985, 1991) as catalysts on the process of the development of talent for the participants in this study. Due to the inquiry of this study, the environmental catalysts of home, school, community/culture, people, opportunities and events combined with the intrapersonal catalysts of motivation and temperament/personality were shown as active facilitators and/or barriers to the process of talent development for the 41 successful women scientists in this study. All of the variables from the Gagné model worked together with the learning, training and practice experienced by the study participants along the long road to their current success in
academic science. The most important conclusions resulting from the findings of this study are the specific talent development markers that acted as key factors along this talent development journey that appear most frequently for the successful academic women scientists in this study.

From early in their lives, these women shared many common experiences that served as primary markers along their talent development paths. The majority (63.4%) of the respondents are first-born children, born into families that valued learning, regardless of parental education or profession. Early interest in science was an important finding for the majority of study participants and demonstrates that the initial motivation to pursue interest in science provides an early indicator for the probability of later success. Almost half of the women in this study shared that they first became interested in science either prior to or during elementary school.

The parents of the participants - whether highly educated and involved in academia and/or science or not college educated or involved in academics or science – had important influences on their daughters. The creation of a home environment where education was valued, books were present, and the academic potential of daughters was recognized, was very important for the study participants. Additionally, the encouragement of teachers in elementary, middle and high school were influential in the later success of the study participants. Several respondents concluded that this early mentoring by teachers in their primary and secondary years was among the most important influence in their belief in their own abilities and potential.

High school and college opportunities were also critical for those participants able to access these special programs. For those women in the sample who were in younger
cohorts (under age 50) and raised in the U.S., participation in AP courses and research programs were cited as primary programmatic opportunities for the development of their science talent. This access to opportunities was not available for most of the older women in the study (over age 50) and for those women who grew up overseas. These women shared that particularly important opportunities for them in high school and college included special science/math competitions and university entrance examinations. The effect of these special programs combined with the early important events of receiving awards, honors and scholarships, served as gateways to higher levels of education in graduate schools and/or post-doctoral positions and stimulated a belief that they were special and capable of high achievement.

Important internal characteristics shared by most of the study participants that served as catalysts were motivation, the importance of persistence and hard work in achieving goals, and the critical effect of calculated risk-taking on the talent development process of the study participants. The motivational and personality attributes of persistence and hard work were also important findings of this study. More than 90% of the women in the study indicated that they graduated in the top 10% of their high school class with the remaining 10% recorded that they graduated in the top 25% of their high school class. This early academic success serves as an early marker for later achievement, as the women in the study believe that their ability to pursue challenges, work to completion of projects, and seek leadership roles in every aspect of their careers, was a consistent theme in their talent development process. Results from the attribute scale indicated that the self-perception of individuals in the study was that motivation was strongly correlated with working hard and being a problem solver. Additionally, the
willingness to take risks was a theme of both the survey and interview data, with several women commenting that their inclination to take risks in their careers served them well in moving their careers forward at critical junctures. For the women in this study, these internal characteristics of persistence, hard work, and intelligent risk-taking were the most important internal factors for their success as academic scientists.

The multiple facilitators to their talent development process coupled with the perception of very few barriers was an extremely important finding of this study and also served as a talent development marker. The respondents ranked many facilitators as highly influential, including the recognition of teachers, support of parents, value of academics and science in their homes, and participation in advanced courses. However, when asked to rate various barriers in a forced-choice question, participants only rated one influence highly: “career experiences to date.” This lack of pervasive barriers to their talent development may be one of the most important commonalities shared by the successful women academic scientists in this study. These talent development markers create a “story line” for the women in this study that may serve as a model for those interested in encouraging girls and women in careers in science.

Implications for practice

The importance of science in our society is continually reinforced by policymakers, as the needs of the global culture and the problems of the world's growing populations continue to affect resources internationally (DeLisi, 2008; Fischman, 2007; Hermes, 2007; Kantrowitz, 2007; Park, 2008). The work of scientists to solve the world's most critical dilemmas of widespread poverty, global climate change, diseases, and technology has never been more critical. Therefore, a deeper and documented
understanding of the talent development influences on the current and future pool of scientists is of particular importance to our society.

The United States needs more highly qualified and experienced scientists to solve the complex problems of the future. Strategies for recruiting and retaining valuable and highly trained individuals as problem-solvers and contributors to new knowledge in academic science are critical to the future of the nation. When well-trained and educated women scientists with significant potential do not reach the top levels in their profession, especially as scholars who serve as contributors of new knowledge, the result is talent wasted. Models of success should prove critical to improve the recruitment and retention of women in academic science.

Implications for gifted education

For gifted education, the current study adds to the literature by providing important markers of success and achievement in an area of the literature that has been dominated by accounts of why gifted women and girls often fail to reach their full potential due to barriers to achievement. The findings indicate the importance of families, mentors and program opportunities, the impact of surroundings, and the critical need for the presence of personality characteristic like resilience, persistence and risk-taking, to the promotion of talent development. Emphasizing and encouraging these specific personality characteristics in girls that appear to relate to success in professional women is particularly important for parents and educators to foster early. The participants in this study serve as important examples of successful women who exhibit persistence and appropriate risk-taking while working exceptionally hard. Studies, such as the current one that locate key factors for the fulfillment of potential, provide critical information for
educators and policy-makers regarding the key variables in the positive career
development of gifted girls and women in the sciences.

Since 22% of the women in this study -- all successful academic women scientists -- reported that neither of their parents had attended college, this study provides important
guidance to families supporting children who may be the first in their families to graduate from college: success is possible for first generation students. Although parents who work as a scientist and/or academic may be helpful to young girls interested in science, the participants in this study who were one of the first in their families to attend college recorded throughout their responses to both relevant survey and later, in specific cases, interview questions, the importance of having parents who stressed academic achievement, provided books and resources in their homes while their daughters were growing up, and modeled intellectual behavior through their own interests. These parents, although not college educated, also succeeded in advancing their daughters' talent development. All children clearly benefit from being read to and seeing their parents engaged in reading and other intellectual pursuits while they are growing up.

Additionally, music lessons and opportunities for enrichment provided by parents and/or by schools and communities are important as many study participants reported that these were important experiences of advanced coursework and academic/arts opportunities for them early in their lives. This context of supporting academic achievement and valuing education was an important finding of the current study and can be advanced by many families, regardless of parental education and/or profession.

The role of teachers and mentors/advisors was also upheld throughout the findings of this study. Many participants became interested in science prior to or during
elementary school. As most elementary schools do not have dedicated daily time for science, the ability of teachers (who are often more comfortable with language arts and social studies) to make science and math interesting during the earliest years of education may prove important (Committee on Prospering in the Global Economy, 2007; Gonzales et al., 2008; Wood, 2008). Providing teachers with training to learn how to make science and mathematics educational experiences both real and enjoyable for children is an important implication of this study. Also, ensuring that girls have access to enrichment opportunities in both mathematics and science during elementary and secondary years of schooling should work to encourage more girls and young women to pursue interests in scientific careers.

That teachers act as mentors to young girls and women is also an important implication of this study, as many of the participants recorded the importance of the early encouragement of teachers who acted as mentors for them during their elementary, middle and high school years. In the current era of “No Child Left Behind,” there is clear evidence that classroom time for science education and instruction has been reduced. Due to this concern, it is even more important to add opportunities for science education since language arts receives the bulk of the instructional time, particularly at the elementary levels Committee on Prospering in the Global Economy, 2007; Gonzales, 2008). Schools should provide incentives for those teachers who take an active role in encouraging girls in developing advanced academic interests, particularly in mathematics and science. These incentives could include tangible rewards like extra pay, reduction of the number of classes taught, and further professional development opportunities.
Although personality characteristics are to some degree fixed early in life, the willingness to work hard and persevere to complete projects, and take risks (all self-reported strong descriptors by the participants in this study) can be fostered by parents, teachers and schools through programming that explicitly supports the value of taking risks in academic work, rewards the completion of projects, and recognizes the importance of hard work in achievement. Helping girls learn that intellectual and career success is not the product of luck alone but rather the result of very hard work (Howe & Berenson, 2003; Wasserman, 2000; Xie & Shauman 2003) is an important implication of the current study. Study participants appeared to attribute hard work to taking on new challenges, finishing projects, and publishing. Many girls and women are quick to attribute their success to luck; however, only two respondents in the current study mentioned luck in any answer to the study's questions. Rather, the theme of working hard was present throughout both the survey and interview findings. Additionally, helping girls and young women understand the importance of finishing tasks and projects is also an important emphasis for schools, parents, and teachers to stress and reward throughout primary and secondary education. Many of the study participants shared their joy in taking on new challenges and finishing projects. This strategy of self-motivation needs to be developed and can be encouraged with early reinforcement at home and at school.

Finally, the importance of taking risks as scientists (Kantrowitz, 2007; Philipsen, 2008; Pugel, 1997; Xie & Shauman, 2003) was shared by the respondents of this study. The rewards for calculated risks and also learning from failures due to thoughtful risk-taking were a theme of the findings of this study as several participants in both the survey and interview responses - recorded the benefits to their careers from learning from early
failures and taking risks. In the arena of science, discoveries and important research are only accomplished when scientists take intellectually-grounded risks (Andreason, 2005; Simonton, 2004; Wasserman, 2000). Therefore, the importance of helping girls and young women learn to be more comfortable with intellectual risk-taking is very important for the early education of future female scientists.

*Implications for higher education*

The current study documents reasons for the success of the participants and discusses the factors that appear to contribute to the achievement of those women who do achieve the highest ranks at elite research institutions in academic science. This study should add to the national debates about the representation of women in higher education and the importance of recruiting and retaining more scientists in academia, particularly in the STEM disciplines.

For higher education, the current study adds to the growing literature on the best means by which institutions can recruit, retain and support outstanding female faculty (Fischman, 2007; Hermes, 2007; Tilghman, 2005). Although many women appear on the faculty rosters of departments in social sciences, humanities, arts, and medical sciences at many institutions, the senior positions in each of these areas are predominately occupied by men (Hermes, 2007; Kantrowitz, 2007; Park, 2008). This is particularly true in traditionally male-dominated fields like the sciences where encouraging young women to pursue scientific careers early in their educational experiences may prove critical to later success as scientists, particularly in academia (Ambrose et al., 1997; Xie & Shauman, 2003; Wasserman, 2000).
The findings for this study acknowledge the continued importance of mentors, particularly in graduate school, post-doc positions and early in an academic scientist's career. Several respondents recorded the important facilitator to their talent development that occurred when an advisor in graduate school or during their first tenure-track position actively advised and mentored them. Additionally, collaboration is the norm for most research in science (Berger, 1994; Bystydzienki & Bird, 2006; Ceci & Williams, 2007); so, understanding the critical role that senior collaborators play in fostering the career development of their younger female research collaborators is also an important implication for academic science and higher education institutions to recognize. The critical role of senior collaborators who also act as mentors proved important for the women scientists in this study and could guide future emphases in higher education on the roles of mentors as models and research collaborators.

Finally, perhaps the most important finding of the current study for higher education is the role that the institution and department – through both official institutional policies and through informal institutional and department culture – can perform in recognizing and encouraging academic women scientists. Half of the women in the study recorded that the most notable barrier to the development of their talent was "career experiences to date." Several respondents defined their individual experiences in the open-ended responses to a similar question about barriers. This finding, combined with the comments of several participants that institutional or departmental culture and/or sexism in science have inhibited their career trajectory is important to recognize. If the barriers most perceived by study participants are related to institutional and department culture, then higher education institutions need to address these concerns at the macro
(university) and micro (individual department) levels in order to retain and support their women colleagues.

Implications for Future Research

Research that enumerates the "complex...interweaving of many factors" (VanTassel-Baska, 1996) that comprise talent development for successful academic women scientists is important. Further research is needed that continues to probe the multiple effects of the combination of external influences, internal characteristics, educational experiences and significant events that lead to success in certain populations of gifted individuals. This study seeks to add to the paucity of literature available on successful models of female achievement, notably for women in the academic sciences. Determining how both external and internal influences can serve as barriers and/or facilitators to the development of talent is important in promoting a further understanding of what internal characteristics and external factors are most conducive to fostering ability and encouraging talent in gifted individuals. A further recognition of the different experiences of highly successful women in specific disciplines can also more directly guide educators and families in cultivating the talent development process for gifted females who may significantly contribute to scientific inquiry and discovery in the future.

Based on the findings of this study, more research into generational differences for successful female scholars is needed. Since more than half (22) of the survey respondents report being in the "mid-late" (21-24 years as a faculty member) or "late" career (25 or more years as a faculty member) stages, the ability to "look back" is important for the majority of respondents. More research that examines differences between groups of generational cohorts would assist in understanding generational
differences. Due to the small numbers of sub-groups in the current study, statistical interpretations of differences and similarities between these groups of generational cohorts were limited. Larger groups of successful academic women in science have the potential to provide significant numbers for such comparisons.

Past studies looking at successful gifted individuals have focused on examining biographies and autobiographies (Albert, 1987; Bateson, 1989; McGrayne, 1993; Simonton, 2004). Though there are limitations to this type of research including the fact that all of these highly successful women are inherently outliers, the findings in the interviews of the selected participants in this study did reveal the importance of more in-depth qualitative studies of successful women. Further research that probes the ethnographic perspectives of larger groups of successful academic women could provide a deeper understanding of several of the key findings of this study, notably the roles of collaborators/colleagues and institutional support on the talent development process.

Future studies exploring the talent development experiences of women academics are needed to continue the research in this area. Several studies that could prove to further the findings of the current study include replication of the current study using the survey instrument created for the purposes of examining this population with other groups of successful women scientists, at liberal arts colleges and/or in states other than New York.

Another study that could prove important would be an investigation of the role of specific school environments. The current study revealed an interesting subset of three women who self-identified as having attended Hunter School when it was all-female. A study of women who attended Hunter when it was all-girls versus those who attended since it went co-ed (in 1974) could prove important to a further exploration of different
did complete an initial study of the school and alumna, and a further examination of this
unique and top-ranked school for high potential students could serve to expand this
literature on the importance of the schooling context to the talent development process.

In the current study, 22% of the participants identified as first-generation college
graduates. The influences of their families and mentors while growing up and moving
into careers in academic science were clearly very important to their talent development
process. Further investigation of the patterns of influence on the talent development
process of first generation successful academic women may highlight differences in the
importance of certain facilitators and barriers on successful academic women who are
first generation college graduates.

Although the current study determined that the women in the study are high
producers of professional work, such as publications, grants, patents, etc., Piirto’s (1991)
suggestion that gifted women may have different peaks of creative productivity than their
male counterparts would also be interesting to explore to determine if this is the case. A
research study with matched pairs of similarly ranked and educated male and female
successful academics could reveal such a pattern of differences for successful academics.

My final comment about future research rests with the limitations of my study. In
future research studies on this topic, I plan to do several elements differently. First, I
intend to validate my survey instrument in advance to ensure construct validity. Second,
it is my intention to continue the process of interviews with those women who indicated
they were willing to participate in interviews. Since each participant in this study was an
individual with unique experiences, each is deserving of more in-depth probing of the
story of their talent development process. Also, as the women participants in the study are very busy scientists, the limitation of time was significant. Most of the interviews represented in this study were limited to 30-45 minutes, which truncated possible responses. There were many valuable lessons learned from the process of conducting this study, and I intend to use this critical learning in future studies on this important topic.
References


Doerr, L. (2001). Where have all the women gone? The lack of female science faculty. Speech to the Trustees at Columbia University, New York City.


APPENDIX A

Survey Instrument
A Survey of the Talent Development of Academic Women Scientists

Section 1: Introduction

This survey is designed to collect information about the influences on your career as a successful woman in academic science. This survey is conducted as part of a study of the primary talent development influences for successful women with well-established careers in academic science. All participant answers will be kept confidential and anonymity will be protected and assured.

Your responses to this survey will be utilized to assist Lisa Kaenzig in the completion of her dissertation examining the talent development influences for successful academic women in the sciences. For several questions, you may wish to answer "see c.v.," and you may attach your curriculum vita at the end of this survey.

Explanation of procedures:

You are being asked to participate in a research study to explore the talent development process of successful academic women scientists. This research includes the life experiences and internal characteristics of the study participants. The approach of the research study is the use of a survey. You will complete the on-line survey that contains 40 questions. You may answer all of the questions, and you may choose to not answer any of the survey questions. This survey should take approximately 20-25 minutes to complete. Before agreeing to participate in this research study by completing this survey, it is important that you read the following explanation of the study. This statement describes the purpose, procedures, benefits, risks, discomforts, and precautions of this study. You have the right to withdraw from the study at any time.

Confidentiality:

The survey questions do include identifying information for the purposes of follow-up by the researcher. However, there will be no identifying information shared at any time during the research, including in any future publications of the researcher. No names of participants or any identifying information will be shared at any time during the research or once the study is competed. All responses will be kept completely confidential. All information gathered from the study will remain confidential. Your identity as a participant will not be disclosed to any unauthorized person. Only the researcher, the research supervisor (faculty advisor Dr. Joyce VanTassel-Baska), and the College of William and Mary's Protection of Human Subjects Committee will have access to the research materials. Any references to your identity that would compromise your anonymity will be removed or disguised prior to the preparation of any publications of this research.
Risks and discomforts:

You will not be at physical or psychological risk and should experience no discomfort from answering the survey questions.

Benefits:

There is very little research directly addressing the factors that may contribute to the success of academic women scientists. Although there are no direct benefits to you (i.e., payment) from participating in this study, the research collected from this study is expected to yield knowledge about the factors that may contribute to success for academic women scientists. You will have access to the study findings after the research is complete.

Questions:

Participants may contact the researcher, Lisa Kaenzig, at (315) 781-3467 or via e-mail at Kaenzig@hws.edu, with any questions concerning this research project. Participants may also contact Dr. Joyce VanTassel-Baska (faculty advisor for this research study) at (757) 221-2347 or via e-mail at JLVant@wm.edu. Participants may also contact Dr. Deschenes of the College of William and Mary's Protection of Human Subjects Committee at mrdesc@wm.edu.

This project was found to comply with appropriate with ethical standards and was exempted from the need for formal review by the College of William and Mary Protection of Human Subjects Committee (Phone 757-221-3966) on 2009-02-16 and expires on 2010-02-16
Section 2: Demographic Information

1. Please fill in the following (all responses will be kept anonymous and confidential).

Names are requested only for the purpose of tracking responses.

Name
Current Institution
Department/Program
Current Academic Rank

2. Please fill in the following about your place of birth:

Town/City
State/Province
Country
Year of birth

3. Please describe the family in which you were raised:

Parent/Guardian #1
Relationship to you
Gender
Race/Ethnicity
Occupation/Profession
Highest level of education

Parent/Guardian #2
Relationship to you
Gender
Race/Ethnicity
Occupation/Profession
Highest level of education

4. Please indicate your birth order in your family:

First Second Third Fourth Other

If Other (please specify)
5. Please indicate your marital/partner status:

Single/Never Married
Partnered/Married (see below)
Separated
Divorced/Remarried (see below)
Divorced/Not remarried
Widowed
Other
Occupation/Profession of partner/spouse (if applicable)

6. Do you have any children?

Yes  No

If yes, please list their ages

7. Please indicate the percentage for which the following individuals carry out the following:

You (%/100)  Spouse/Partner (%/100)  Other (%/100)

Primary care of household duties
Primary care of dependents (if applicable)
Section 3: Educational Experiences

8. When did you first become interested in science? (please check one)
   - Prior to elementary school
   - Elementary school
   - Middle school
   - High school
   - College/University
   - Graduate School
   - Other

9. What were the most important influences on your initial interest in science (please check all that apply)?
   - Family member(s)
   - Friend/Peer(s)
   - Teacher(s)
   - Life experiences
   - Special educational program
   - Science fair/competition
   - Burgeoning interest

   Please describe any of the above:

10. How would you describe your academic status in your high school class?
    - Top 5%
    - Top 10%
    - Top 15%
    - Top 25%
    - Other

11. In which of the following advanced high school programs did you participate?
    (Please check all that apply):
    - Advanced placement (AP)
    - International Baccalaureate (IB)
    - Dual enrollment (in college)
    - Mentors
    - Internships
    - Independent Study
    - Specialty school for math/science
    - Other
    - None of the above were options in my high school

    Please give a brief description of any of the above
12. Were you a (check all that apply):

- National Merit Scholar/semi-finalist
- Participant in university talent searches
- Chemistry or Math or Physics Olympiad
- Westinghouse Science Competition Finalist
- Other major academic award:
  None of the above were options for me in high school
  If Other (please specify)

13. Did you participate in any of the following programs in college (please check all that apply)?

- Honors or scholars program
- Internships
- Research positions
- Honors project
- Teaching Assistantship
- Academic Tutor/Grader
- Other (please specify)

14. Did you receive any of the following special honors or awards in college (please check all that apply)?

- Science award or prize
- Math award or prize
- Latin praise at graduation
- Honors designation
- University research award or prize
- National honor society award
- Other (please specify)
Section 4: Professional Information

15. At which stage of your career are you currently working?

Career Entry (Post-doc position, first year in tenure track position)
Early Career (First 6 years in tenure-track position)
Early-Mid Career (7-11 years in tenure-track position)
Mid Career (12-20 years in tenure-track position)
Mid-Late Career (21-24 years in tenure-track position)
Late Career (25+ years in tenure-track position)

16. At how many institutions have you taught, including your current position?

1
2
3
4
5
6+

17. For each of the following that are applicable to you, please provide your (1) Major(s),
(2) University or college name, and (3) Years of attendance/employment. You may
choose to place an “X” in the “see c.v.” box and e-mail your curriculum vita to the
researcher at the completion of this survey.

See C.V.
Bachelors'
Masters'
Doctorate
Post-doc
Other Positions

18. Please indicate whether you have held any leadership positions for any professional
journals.

Yes
No
See C.V.

Please give a brief description of the position(s) you have held/currently hold.
19. Please indicate whether you have held any leadership positions for any granting agencies.

Yes
No
See C.V.

Please give a brief description of the position(s) you have held/currently hold.

20. Please indicate whether you have held any leadership positions for any professional associations.

Yes
No
See C.V.

Please give a brief description of the position(s) you have held/currently hold.

21. Please indicate whether you have held any academic administrative leadership positions.

Yes
No
See C.V.

Please give a brief description of the position(s) you have held/currently hold.

22. Please list any other leadership positions, in addition to those listed above.

23. How many refereed publications have you authored/co-authored to date?

24. Please list any significant grants, awards or fellowships you have received since receiving your doctorate. You may also choose to place an “X” in the box marked “see c.v.” and e-mail your curriculum vita at the completion of this survey.

See C.V.
1.
2.
3.
4.
5.
25. Department Faculty

How many permanent full-time faculty members are in your current department?

How many of those faculty members are women?

How many of those faculty members are tenured women?

26. Are you involved with any associations that specifically support women in science? (Check all that apply):

ACM-W (Committee on the Status of Women in Computing Research):
WISE (Women in Science and Engineering):
COACH (Committee on the Advancement of Women in Chemistry):
AWIS (Association for Women in Science):
WiTEC (Women in Science, Engineering and Technology):
AWM (Association for Women in Mathematics):
CWSE (Committee on Women in Science and Engineering):
SWE (Society of Women Engineers):
WIPHYS (Women in Physics):
ACS-WCC (American Chemical Society Women Chemists Committee):

If Other (please specify)
Section 5: Important people

27. Mentors

Please list the relationship to you and type of support provided:

Primary mentor in high school
Primary mentor in college
Primary mentor in graduate school

Please feel free to elaborate on any of the above:

28. The most influential person(s) responsible for the development of your science talent?

(Check all that apply):

Mother
Father
Other family member (please describe below)
Teacher (please specify grade level and subject taught below)
Other person (please describe below)
If necessary (please specify)

29. Who have been the most significant people in helping your career to date?

Person 1/Describe their relationship to you:
Describe the ways in which they have been significant:

Person 2/Describe their relationship to you:
Describe the ways in which they have been significant:

Person 3/Describe their relationship to you:
Describe the ways in which they have been significant:
Section 6: Internal Characteristics

30. Please rate yourself in a professional context on the following attributes:

1 Not at all   2 Sometimes   3 Maybe   4 Most of the time   5 Extremely

Motivated
Self-confident
Pursue all opportunities
Ambitious
Able to change directions
Persistent
Risk-taker
Patient
Gifted
Stressed
Hard-working
Problem-solver
Overwhelmed

Please elaborate on any of the above

31. Do you currently feel happy with your career success?

Yes   Most of the time   Some of the time   No

Comments:

32. For each characteristic below, indicate the extent to which you consider that your current research could be described as:

1 Not at all   2   3 Maybe   4   5 Completely

Creative
Marginalized
Readily accepted
Interdisciplinary
Cutting edge
Risky
Other (please specify)
Section 7: Important events

33. How important were any of the following to the development of your science talent?

1 Not at all 2 3 Somewhat 4 5 Extremely  Not applicable

I had a teacher who encouraged my interest in science
Being accelerated or skipping grades
Taking advanced courses
Great teacher(s)
Mentors
Internships
Importance of books in my home growing up
Ability to engage in independent projects
My mother’s recognition of my talent
My father’s recognition of my talent
Academics were highly valued in my home
My family valued science
The role of my current family

Please feel free to elaborate on any of the above:

34. What have been the most significant factors that have positively affected your career to date?
35. Please indicate to what extent any of the following experiences affected the development of your science talent.

1 Not at all   2  3 Somewhat   4  5 Extremely   Not applicable

- Not being allowed to accelerate or skip grades
- Not having the opportunity to take advanced courses
- Poor teacher(s)
- Lack of mentors
- Lack of internships
- Absence of books in my home growing up
- Lack of ability to engage in independent projects
- My mother did not recognize/encourage my talent
- My father did not recognize/encourage my talent
- Academics were not highly valued in my home
- My family did not value science
- The role of my current family
- My career experiences to date

Please elaborate on any of the above (if applicable)

36. What have been the most significant events that you perceived as barriers to your career path?
Section 8: Conclusion

37. What are your current career goals?

38. Given all that you have learned in your career, what guidance would you give a young woman interested in a career in academic science?

39. If you wish to e-mail your c.v. to me, please attach it to the following link: Email Me

40. Would you be willing to be interviewed either via phone or in person about your career experiences?
   
   Yes   No

If yes, please list best contact information:
APPENDIX B

Interview Protocol
Interview Protocol

**Project:** Talent Development Experiences of Successful Women Academic Scientists

**Time of interview:**

**Date:**

**Phone or in person:**

**Interviewer:**

**Interviewee:**

**Current Position/Institution of Interviewee:**

**Questions:**

1. Please tell me the story of your talent development process.

2. What do you now believe were the most significant internal characteristics that affected your success as an academic woman scientist?

3. What do you now believe were the most significant external influences that affected your career success?

4. What do you believe were the most significant events that affected your career path?

5. Do you believe there were any additional facilitators or barriers to your career success?

**Additional Questions:** Additional questions related directly to the responses of the particular interviewee that were atypical of most respondents to the survey.
APPENDIX C

Informed Consent for Survey
Informed Consent Form for Survey

Title of Research: An exploration of the talent development process of successful academic women scientists

Investigator: Lisa Kaenzig, Ph.D. Candidate, College of William and Mary

Before agreeing to participate in this research study, it is important that you read the following explanation of the study. This statement describes the purpose, procedures, benefits, risks, discomforts, and precautions of this study. You have the right to withdraw from the study at any time.

Explanation of procedures:

You are being asked to participate in a research study to explore the talent development process on successful academic women scientists. This research includes the life experiences and internal characteristics of the study participants.

The approach of the research study is the use of a survey. You will complete the on-line survey that contains 40 questions. You may answer all of the questions, and you may choose to not answer any of the survey questions. This survey should take approximately 20-25 minutes to complete.

Confidentiality:

The survey questions do include identifying information for the purposes of follow-up by the researcher. However, there will be no identifying information shared at any time during the research, including in any future publications of the researcher. No names of participants or any identifying information will be shared at any time during the research or once the study is completed. All responses will be kept completely confidential. All information gathered from the study will remain confidential. Your identity as a participant will not be disclosed to any unauthorized person. Only the researcher, the research supervisor (faculty advisor Dr. Joyce VanTassel-Baska), and the College of William and Mary's Human Subjects Committee (the committee that approved this research study) will have access to the research materials. Any references to your identity that would compromise your anonymity will be removed or disguised prior to the preparation of any publications of this research.
Risks and discomforts:

You will not be at physical or psychological risk and should experience no discomfort from answering the survey questions.

Benefits:

There is very little research directly addressing factors that may contribute to the success of academic women scientists. Although there are no direct benefits to you (i.e., payment) from participating in the study, the research collected from this study is expected to yield knowledge about the factors that may contribute to success for academic women scientists. You will have access to the study findings after the research is complete.

Questions:

Participants may contact the researcher, Lisa Kaenzig, at (315) 781-3467 or via e-mail at Kaenzig@hws.edu, with any questions concerning this research project. Participants may also contact Dr. Joyce VanTassel-Baska (faculty advisor for this research study) at (757) 221-2347 or via e-mail at JLVant@wm.edu. Participants may also contact Dr. Deschenes, of the College of William and Mary’s Human Subjects Committee, at mrdesc@wm.edu.
APPENDIX D

Informed Consent Form for Interview
Informed Consent Form for Interview

**Title of Research:** An exploration of the talent development process of successful academic women scientists

**Investigator:** Lisa Kaenzig, Ph.D. Candidate, College of William and Mary

**Explanation of procedures:**

You are being asked to participate in an interview for a research study to explore the talent development process on successful academic women scientists. This research includes the life experiences and personality traits of the study participants.

The approach of this phase of the research study is the use of an interview. The researcher will contact you to schedule a phone or in-person interview. The interview should take 15-20 minutes of your time. The interview will be scheduled at a time that is conducive to your schedule. You may answer all of the questions asked by the researcher during the interview, and you may choose to not answer any of the interview questions.

**Confidentiality:**

All information gathered from the study will remain confidential. Your identity as a participants will not be disclosed to any unauthorized person. Only the researcher, the supervisor (Dr. Joyce VanTassel-Baska) and the College of William and Mary Human Subjects Committee (the committee that approved this research study) will have access to the research materials. Any references to your identity that would compromise your anonymity will be removed or disguised prior to the preparation of the research publications.

**Withdrawal Without Prejudice:**

Participation in the study is voluntary. Refusal to participate will involve no penalty. You are free to withdraw consent and discontinue participation in this study at any time without prejudice.
Questions:

Participants may contact the researcher, Lisa Kaenzig, at (315) 781-3467 or via e-mail at Kaenzig@hws.edu, with any questions concerning this research project. Participants may also contact Dr. Joyce VanTassel-Baska (faculty advisor for this research study) at (757) 221-2347 or via e-mail at JLVant@wm.edu. Participants may also contact Dr. Deschenes, of the College of William and Mary's Human Subjects Committee, at mrdesc@wm.edu.

Agreement:

This agreement states that you have received a copy of this informed consent form. Your signature below indicates that you agree to participate in this research study.

________________________________________________________________________
Name of study participant

________________________________________________________________________
Signature of study participant

________________________________________________________________________
Date

________________________________________________________________________
Signature of researcher
APPENDIX E

Supplementary Tables
**Table E1 Women, Minorities, and Persons with Disabilities in Science and Engineering**

Full-time natural science and engineering doctorate holders employed in 4-year colleges or universities, by sex, race, disability status, and number of refereed publications and patents since 1998

<table>
<thead>
<tr>
<th>Sex, race/ethnicity, &amp; disability status</th>
<th>Publications since 1998</th>
<th>Patents since 1998</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
<td>None</td>
</tr>
<tr>
<td>----------------------------------------</td>
<td>------------------------</td>
<td>------</td>
</tr>
<tr>
<td>Total</td>
<td>357,900</td>
<td>30,400</td>
</tr>
<tr>
<td>Female</td>
<td>110,300</td>
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<tr>
<td>Male</td>
<td>247,600</td>
<td>19,700</td>
</tr>
<tr>
<td>White</td>
<td>270,200</td>
<td>23,900</td>
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<tr>
<td>Asian</td>
<td>55,100</td>
<td>3,800</td>
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<tr>
<td>Black</td>
<td>16,500</td>
<td>1,600</td>
</tr>
<tr>
<td>Hispanic</td>
<td>12,900</td>
<td>1,000</td>
</tr>
<tr>
<td>American Indian/Alaskan Native</td>
<td>2,100</td>
<td>S</td>
</tr>
<tr>
<td>No disability</td>
<td>333,500</td>
<td>27,700</td>
</tr>
<tr>
<td>With disability</td>
<td>24,400</td>
<td>2,800</td>
</tr>
</tbody>
</table>

S=Suppressed because fewer than 50 weighted cases.

Notes: Numbers rounded to nearest 100. Detail may not add to total because of rounding. Natural sciences includes biological, life, computer, mathematical, & physical sciences. Total includes Native Hawaiian/other Pacific Islander and multiple race not show separately. For disability status, those who reported any difficulty (from moderate to unable to do) in any category of seeing (with glasses/contact lenses), hearing (with hearing aid), working, or lifting are classified as 'with disability'.

*Note.* From The National Science Foundation, 2007, Division of Science Resources Statistics, Scientists and Engineers Statistical Data System (SESTAT).
**Table E2 Categories and codes for the significant statements and phrases in the interviews**

<table>
<thead>
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<th>Categories of responses</th>
<th>Corresponding Code</th>
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<tr>
<td>Environmental Catalysts</td>
<td>E</td>
</tr>
<tr>
<td><strong>Level 2</strong></td>
<td></td>
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<tr>
<td>Surroundings</td>
<td>ES</td>
</tr>
<tr>
<td><strong>Level 3</strong></td>
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<td>Culture</td>
<td>ES-Cult</td>
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<td>EP-Peer</td>
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<td><strong>Intrapersonal Catalysts</strong></td>
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<td>Self-esteem</td>
<td>ITP-Self</td>
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<tr>
<td>Values</td>
<td>ITP-Value</td>
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<tr>
<td>Attitudes</td>
<td>ITP-Att</td>
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</table>
### Table E3 Country of birth for the survey respondents (N=41)

<table>
<thead>
<tr>
<th>Country of birth</th>
<th>Number of respondents</th>
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<tbody>
<tr>
<td>Canada</td>
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</tr>
<tr>
<td>Germany</td>
<td>1</td>
</tr>
<tr>
<td>Great Britain</td>
<td>1</td>
</tr>
<tr>
<td>Greece</td>
<td>1</td>
</tr>
<tr>
<td>Hungary</td>
<td>1</td>
</tr>
<tr>
<td>Israel</td>
<td>1</td>
</tr>
<tr>
<td>Italy</td>
<td>1</td>
</tr>
<tr>
<td>Korea</td>
<td>1</td>
</tr>
<tr>
<td>Netherlands</td>
<td>1</td>
</tr>
<tr>
<td>United States</td>
<td>32</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>41</strong></td>
</tr>
</tbody>
</table>

### Table E4 Occupations of spouse/partners of survey respondents (N=32)

<table>
<thead>
<tr>
<th>Profession</th>
<th>Percentage of respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Professor</td>
<td>31.3 (10)</td>
</tr>
<tr>
<td>Scientist</td>
<td>25.0 (8)</td>
</tr>
<tr>
<td>Computers/Software</td>
<td>18.8 (6)</td>
</tr>
<tr>
<td>Finance/Accounting</td>
<td>9.4 (3)</td>
</tr>
<tr>
<td>Writer/Editor</td>
<td>3.1 (1)</td>
</tr>
<tr>
<td>Photographer</td>
<td>3.1 (1)</td>
</tr>
<tr>
<td>Government</td>
<td>3.1 (1)</td>
</tr>
<tr>
<td>Musician</td>
<td>3.1 (1)</td>
</tr>
<tr>
<td>Physician</td>
<td>3.1 (1)</td>
</tr>
</tbody>
</table>
Table E5 Survey respondents' involvement in women in science associations (N=21)

<table>
<thead>
<tr>
<th>Association</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>WISE (Women in Science and Engineering)</td>
<td>6</td>
</tr>
<tr>
<td>SWE (Society of Women in Engineering)</td>
<td>6</td>
</tr>
<tr>
<td>AWIS (Association for Women in Science)</td>
<td>5</td>
</tr>
<tr>
<td>ACS-WCC (American Chemical Society Women Chemists Committee)</td>
<td>4</td>
</tr>
<tr>
<td>AWM (Association for Women in Mathematics)</td>
<td>3</td>
</tr>
<tr>
<td>NSF-Advance (National Science Foundation – Project Advance)</td>
<td>2</td>
</tr>
<tr>
<td>CSWAST (Committee on Status of Women in Astronomy)</td>
<td>2</td>
</tr>
<tr>
<td>WIPHYS (Women in Physics)</td>
<td>2</td>
</tr>
<tr>
<td>Other</td>
<td>4</td>
</tr>
</tbody>
</table>

Table E6 High school special opportunities (N=32)

<table>
<thead>
<tr>
<th>Special opportunity</th>
<th>Percentage of responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>National Merit Finalist/Semi-finalist</td>
<td>62.5 (20)</td>
</tr>
<tr>
<td>Major Academic Awards</td>
<td>18.8 (6)</td>
</tr>
<tr>
<td>Chemistry/Math/Physics Olympiad</td>
<td>9.4 (3)</td>
</tr>
<tr>
<td>University Talent Searches</td>
<td>6.3 (2)</td>
</tr>
<tr>
<td>Other opportunities</td>
<td>31.3 (10)</td>
</tr>
</tbody>
</table>
### Table E7 Special college awards/honors of study participants (N=29)

<table>
<thead>
<tr>
<th>Special awards/honors</th>
<th>Percentage of responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Honors designation</td>
<td>55.2 (16)</td>
</tr>
<tr>
<td>National honor society</td>
<td>37.9 (11)</td>
</tr>
<tr>
<td>Latin honors</td>
<td>27.6 (8)</td>
</tr>
<tr>
<td>University honor/award</td>
<td>24.1 (7)</td>
</tr>
<tr>
<td>Science prize</td>
<td>20.7 (6)</td>
</tr>
</tbody>
</table>

### Table E8 Most significant people in helping careers of survey respondents (N=39)

<table>
<thead>
<tr>
<th>Categories of persons of influence</th>
<th>Percentages of responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colleague mentors</td>
<td>58.9 (23)</td>
</tr>
<tr>
<td>Doctoral advisors</td>
<td>11.6 (13)</td>
</tr>
<tr>
<td>Collaborator/co-authors</td>
<td>20.5 (8)</td>
</tr>
<tr>
<td>Spouse/partners</td>
<td>15.3 (6)</td>
</tr>
<tr>
<td>Mothers</td>
<td>7.7 (3)</td>
</tr>
<tr>
<td>Fathers</td>
<td>5.1 (2)</td>
</tr>
<tr>
<td>College advisors</td>
<td>5.1 (2)</td>
</tr>
<tr>
<td>Masters advisors</td>
<td>2.6 (1)</td>
</tr>
<tr>
<td>College professors</td>
<td>2.6 (1)</td>
</tr>
<tr>
<td>High school teachers</td>
<td>2.6 (1)</td>
</tr>
<tr>
<td>Post-doctoral advisors</td>
<td>2.6 (1)</td>
</tr>
<tr>
<td>NSF staff</td>
<td>2.6 (1)</td>
</tr>
</tbody>
</table>
Table E9 Primary facilitators of career success for survey respondents \((N=28)\)

<table>
<thead>
<tr>
<th>Categories of facilitators</th>
<th>Percentage of responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supportive mentors/teachers</td>
<td>39.3 (11)</td>
</tr>
<tr>
<td>Persistent/stubborn</td>
<td>32.4 (9)</td>
</tr>
<tr>
<td>Early internships and research opportunities</td>
<td>17.9 (5)</td>
</tr>
<tr>
<td>Recognition and funding through grants</td>
<td>14.3 (4)</td>
</tr>
<tr>
<td>Successful former students</td>
<td>14.3 (4)</td>
</tr>
<tr>
<td>Ambition</td>
<td>14.3 (4)</td>
</tr>
<tr>
<td>Collaborations</td>
<td>14.3 (4)</td>
</tr>
<tr>
<td>Family support</td>
<td>10.8 (3)</td>
</tr>
<tr>
<td>Luck</td>
<td>7.1 (2)</td>
</tr>
<tr>
<td>Attended top institutions</td>
<td>7.1 (2)</td>
</tr>
<tr>
<td>Extroverted</td>
<td>7.1 (2)</td>
</tr>
<tr>
<td>Participated in team sports</td>
<td>3.8 (1)</td>
</tr>
</tbody>
</table>

Table E10 Primary barriers to career success for survey respondents \((N=31)\)

<table>
<thead>
<tr>
<th>Categories of barriers</th>
<th>Percentages of responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Being a woman/perception of sexism</td>
<td>45.1 (14)</td>
</tr>
<tr>
<td>Poor mentoring</td>
<td>32.2 (10)</td>
</tr>
<tr>
<td>Lack of support for raising children/caring for dependents</td>
<td>22.6 (7)</td>
</tr>
<tr>
<td>Poor recent funding for science</td>
<td>12.9 (4)</td>
</tr>
<tr>
<td>Isolation</td>
<td>12.9 (4)</td>
</tr>
<tr>
<td>No perceived barriers</td>
<td>12.9 (4)</td>
</tr>
<tr>
<td>Heavy service and/or teaching duties</td>
<td>9.7 (3)</td>
</tr>
<tr>
<td>Sexual orientation</td>
<td>3.2 (1)</td>
</tr>
</tbody>
</table>
Table E11 Career goals of survey respondents (N=32)

<table>
<thead>
<tr>
<th>Categories of career goals</th>
<th>Percentage of responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continue my research and/or grant productivity</td>
<td>46.8 (15)</td>
</tr>
<tr>
<td>Receive promotion to full professor</td>
<td>18.8 (6)</td>
</tr>
<tr>
<td>Obtain administrative leadership roles</td>
<td>15.6 (5)</td>
</tr>
<tr>
<td>Have others replicate my research</td>
<td>9.4 (3)</td>
</tr>
<tr>
<td>Get elected to the National Academy of Sciences</td>
<td>6.3 (2)</td>
</tr>
<tr>
<td>Help other women have productive careers</td>
<td>6.3 (2)</td>
</tr>
<tr>
<td>Do another big thing before retirement</td>
<td>6.3 (2)</td>
</tr>
<tr>
<td>Make my current job manageable</td>
<td>3.1 (1)</td>
</tr>
<tr>
<td>Become a great teacher</td>
<td>3.1 (1)</td>
</tr>
<tr>
<td>Obtain the rights to my patents</td>
<td>3.1 (1)</td>
</tr>
<tr>
<td>Found my own company</td>
<td>3.1 (1)</td>
</tr>
</tbody>
</table>

Table E12 Categories of advice for career success (N=33)

<table>
<thead>
<tr>
<th>Categories of advice</th>
<th>Frequency of responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Love what you do</td>
<td>36.6 (12)</td>
</tr>
<tr>
<td>Cultivate mentors</td>
<td>21.2 (7)</td>
</tr>
<tr>
<td>Work hard</td>
<td>21.2 (7)</td>
</tr>
<tr>
<td>Take risks</td>
<td>15.1 (5)</td>
</tr>
<tr>
<td>Choose an environment where your work is valued</td>
<td>12.1 (4)</td>
</tr>
<tr>
<td>Have persistence</td>
<td>12.1 (4)</td>
</tr>
<tr>
<td>Avoid/ignore &quot;bullies&quot;</td>
<td>9.1 (3)</td>
</tr>
<tr>
<td>Balance your family/personal life</td>
<td>9.1 (3)</td>
</tr>
<tr>
<td>Seek collaborations</td>
<td>9.1 (3)</td>
</tr>
<tr>
<td>Choose your spouse/partner carefully</td>
<td>6.0 (2)</td>
</tr>
<tr>
<td>Get involved in professional organizations</td>
<td>6.0 (2)</td>
</tr>
<tr>
<td>Question</td>
<td>Variable(s)</td>
</tr>
<tr>
<td>-----------------------------------------------</td>
<td>------------------------------</td>
</tr>
<tr>
<td>1: Story of talent development process</td>
<td>All</td>
</tr>
</tbody>
</table>
| 2: Internal Characteristics                   | Intrapersonal Catalysts     | Motivation  
 |                                               |                               | Persistence  
 |                                               |                               | Hard work  
 |                                               |                               | Ability to focus and finish  
 |                                               | Personality                  | Enjoying and meeting challenges  
 |                                               |                               | Risk-taking  
 | 3: External Influences                        | Environmental Catalysts     | Surroundings  
 |                                               |                               | High school experiences  
 |                                               |                               | Department/institutional support  
 |                                               |                               | Effects of having children  
 |                                               | Important People             | Parents  
 |                                               |                               | Teachers/Advisors  
 | 4: Events                                     | Environmental Catalysts     | Important Events  
 |                                               |                               | Critical opportunities  
 |                                               |                               | Milestones  
 | 5: Facilitators and Barriers                  | Significant Environmental & Internal Characteristics | Facilitators  
 |                                               |                               | Parents  
 |                                               |                               | Mentors/teachers  
 |                                               |                               | School and program opportunities  
 |                                               | Barriers                     | Poor advisors  
 |                                               |                               | Problematic institutions/sexism  
 |                                               |                               | Discouraging spouses  

APPENDIX F:

Results for Survey Question 17
### Undergraduate majors represented by the survey respondents

- Astronomy (2)
- Biology
- Chemistry (4)
- Civil Engineering
- Comparative Literature
- Computer Science (3)
- Electrical Engineering
- Feminist Studies
- French
- Geology (4)
- History
- Math (2)
- Mathematics (3)
- Mechanical Engineering (3)
- Physics (6)

### Undergraduate institutions represented by the survey respondents

- Brooklyn College
- Brown University (2)
- Bryn Mawr College
- Caltech
- Carleton College
- Colgate University
- Cornell University (2)
- Davidson College
- Duke University
- Hungarian Academy of Sciences (Hungary)
- Hunter College
- Kapteyn Astronomical Institute (The Netherlands)
- Massachusetts Institute of Technology
- Oberlin College (2)
- Princeton University
- Rensselaer Polytechnic Institute (3)
- Seoul National University (Korea)
- Stanford University
- State University of New York – Binghamton
- State University of New York – Buffalo
- University of California - Berkeley
- University of Delaware
- University of Florida
- University of Illinois, Champaign-Urbana
- University of London
- University of Michigan (2)
- University of Puget Sound
- Wayne State University
- Yale University

### Masters institutions represented by the survey respondents

- Fordham University
- MIT (3)
- New York University
- Penn State
- Stanford University (3)
- State University of New York – Albany
- University of California - Santa Cruz
- University of Illinois, Champaign-Urbana (2)
- University of Massachusetts
- University of Michigan
- University of Minnesota
- University of Pennsylvania (2)
- University of Rochester
- University of Wisconsin – Madison
- University of Wuerzberg (Germany)
Doctorate institutions represented by the survey respondents

Brown
Caltech
Cornell
Eotvos University, Budapest (Hungary)
ETH – Zurich, Switzerland
Fordham University
Indiana University (2)
Kapteyn Astronomical Institute (The Netherlands)
Massachusetts Institute of Technology (4)
New York University
Oxford University
Penn State
Princeton
Stanford (5)
University of California – Berkeley
University of California – Santa Cruz
University of Chicago
University of Florida
University of Illinois, Champaign-Urbana
University of Massachusetts
University of Michigan
University of Pennsylvania (2)
University of Washington
University of Wisconsin – Madison
Vanderbilt University
Post-doc positions held by the survey respondents

Bell Labs
Cornell University (2)
Howard Hughes Medical Center
Indiana University
Lawrence Berkeley National Laboratory
Los Alamos National Lab
National Science Foundation (NSF)
New York University (2)
Stanford
Tokyo University
University of California – Davis
UCLA
University of Michigan
University of Virginia

Other Professional Positions Held By Survey Respondents

Binghamton University
Cerro Tololo Interamerican Observatory
Cornell University
Duke University
Environmental Defense Fund
Exxon Research
GEOMAR/Christian Albrechts University (Germany)
Lund Institute of Technology (Sweden)
Math/Science Research Institute
NASA Research Center
National Science Foundation, Sao Paulo Brazil
Pace University
Rensselaer Polytechnic Institute (3)
South Pole Research, Antarctica
SUNY College at Purchase
Texas A&M
U. S. Geological Survey
U. S. House of Representatives
University of Hamburg
University of Michigan
University of Natal, Durban, South Africa
Yale Astronomy
APPENDIX G

Interview Transcripts
Transcription of Phone Interview with IP1

LK: Thank you very much for sending me your consent form. I really appreciate that. My intent is to keep every response anonymous; so, you won’t be identified by name or institution in any way. And, again, this is for the purpose of my dissertation. If there are any questions that you just do not want to answer, that is fine. You can just say that. Okay?

IP1: Okay.

(Q1) LK: The first question is sort of in your survey, but when you think back on the story of your own talent development/career development process, how would you describe that?

IP1: I would say high school was fun, it was a magnet school, there were high expectations, it was an all girls school, I think that changed. Colleges was easy, easier than high school, and grad school really took a lot of effort

LK: Why do you think you persisted? I noticed that you noted a horrible advisor in grad school and a horrible post-doc experience. What was it that made you keep going?

IP1: Well my parents keep suggesting that I stick it out and get the Ph.D. I was so close I….it would help to have a Ph.D. no matter what I did. They definitely thought that it would be a good idea and I guess I didn’t have anything that I liked doing more, but I certainly would have been open to it if I had found something.

LK: But you felt like there were not many other options, you had gone so far down the path?

IP1: Once you have gone so far, to quit before the end, you don’t know if you are going to find something better.

LK: What happened with that adviser in graduate school?

IP1: Well, the adviser was pretty horrible, the students were pretty horrible, grad school itself was pretty horrible, very competitive, very elbowing each other out of the way atmosphere.

LK: Were there other women?

IP1: A couple. Very few.
(Q2) LK: So, having persistence was one of your more significant personality traits that led you to or having the family influences?

IP1: Persistent, yes. Being forced to give in is another story.

LK: I noticed that you did attend Hunter high school, which I am very familiar with and it's amazing how many of the women that I surveyed indicated that they attended Hunter high school. It's a remarkable coincidence or pattern.

IP1: Many of us in science at (my current institution) have also discovered that.

LK: What do you think it was about that place that helped you so much?

IP1: It was both things, the expectations were high and it was all girls.

LK: And the all girls was pretty significant for you?

IP1: Well, how would I know except that what goes on in other high schools the girls don't speak up and the girls are starting to date. I didn't go through that.

LK: College was a lot easier than Hunter?

IP1: Yes, but the guys were really irritated with a girl at the top, but I was a great student there, and it was not hard to show them.

LK: That was a different experience I imagine, different from Hunter.

IP1: Yes, because they were all idiots.

(Q4) LK: Well, I noticed that your significant other also has a Ph.D. and you noted that they were a primary facilitator to your development process. Is there anymore more that you can share about that?

IP1: Well, okay. Here is a story. We hooked up at the end of grad school, so we were fine for post-docs, and my favorite place to go, we were very lucky with the two body problem, we had several choices. My favorite was in Colorado, not a high-pressure school, lovely place to live, stuff like that. His first choice was (our current institution) because it was the best program in the country and he felt we should do the best post-doc we can before we go somewhere else for jobs. I never would have trusted myself to do that. This is the best place in the country.

LK: I think that you said in one of your comments that you are way more successful than you thought you would be?

IP1: Well, things were not easy here and I really hated it here, and I wanted to leave after the postdoc. They hired me for all the wrong reasons here, they hired me because they
wanted my husband, but in the end it all worked out for them, because I ended up being successful and they had hired me. I didn’t like it here for many years.

LK: What changed for you? Did it change?

IP1: Yes, First of all, getting tenure takes a lot of pressure off so I was able to actually enjoy the work instead of worry all the time. But until then, I had the horrible postdoc, they did some mean things like offering my husband a job on the faculty and me ...not a tenured job, and we had a two-week deadline so that would force us to decide before other schools. So then we took that for one year, went on the job market the year after, so now I’ve been here three years, and they ...I was going to leave, because I was not going to stay in a crummy job, and that’s when they offered me a faculty job here also. So then they were not going to give me credit for my three years here toward tenure. So then after six years here which would have been the “normal” time, then we got a counter offer from an actual competitive school and that one had tenure. So, that’s when they came to the tenure “early.” So all of that was you know, not exactly encouraging, so I ended up with a job here and then tenure here, and that took a lot of the pressure off and then slowly my weird field became more popular, and the area became more important and stuff like that.

LK: So you were a part of all of that.

IP1: Successful.

(Q3) LK: I noticed on your survey that your mother was an engineer. Did that affect you and your career choice?

IP1: I think surely it must have. Growing up doing the math homework, who helps you edit your essays. My mom helped with the math homework, she was the one that fixed the washing machine when it broke, that sort of thing.

LK: That was just normal?

IP1: Yes. It was totally normal to think doing math was fun.

LK: Right. And probably for your mom also to think that you could also finish the Ph.D., even though it was pretty tough.

IP1: I don’t know, she does not have a Ph.D. so I don’t know if she thought it was tough or not. But, both of my parents were encouraging that should do it.

LK: So you stuck it out?

IP1: Yes.
LK: I noticed that you are only one of 2 tenured women at (your current institution) in your discipline. How has that experience been for you? Have you ended up being a mentor to other younger faculty whether they are men or women? How has that affected you?

IP1: Yes, I am really not that good at mentoring. I have to have a relationship, I have some friendly basis of a relationship, I am not really good at mentoring if I do not have a friendship. I am sick of being here on every single committee. Every single committee needs their share of women even though there are 10% of the women in the workforce so it's very annoying.

LK: I hear that a lot about women being over-taxed on service and committees, especially senior women.

IP1: Yes. So, I think now it is time to stop.

(Q3) LK: I also noticed that you became interested in science in elementary school. You were one of a few women that responded in this way to the survey. I also noticed that you did puzzles and games and talked about them over dinner conversation. Were there any other influences during that time that spurred that interest?

IP1: Well, there was a friend of my parents who came over a lot. He taught us chess, do the next number in the sequences, stuff like that, which was fun for little kids.

LK: That's great. Do you recall what he did for a career?

IP1: I think he was an accountant. I don't remember.

LK: I really liked many of your responses, but one that really stood out to me was the idea that you would like to do another big thing before you retire. Do you have any ideas about what that might be?

IP1: Well, yes, I am working on it. I mean to develop a method that's in use to solve an important problem.

(Q5) LK: Is there anything else you think I should be thinking about in terms of how it is different for women in science, particularly in academics.

IP1: Well, I think the fact that my husband took half with the kids, for instance. It is still the women who work a disproportionate amount of time with the kids, and to have someone who was going to do their half. Of course, you have to get used to the fact that they are not going to do it the way you do, you have to let go. You have to give up lots of stuff, we had out of the can dinners when the kids are young that's what you do be because you are exhausted, I did not go to the gym for ten years, that was key.
LK: Well thank you. I will be transcribing our conversation and will send it to you to check. If you would not like me to use anything just let me know.

IP1: That's totally fine, and good luck to you.

LK: Thank you for your time, I really appreciate it.
Interview with IP2

LK: I appreciate you signing the consent form.

(Q1) The first question is, in your own words tell me the story of your talent development process.

IP2: What do you mean by that? Do you mean school?

LK: When you think back, what are the major milestones that helped you to get to where you are?

IP2: I guess one of the things would be that I had some great summer jobs that were very exciting and so those kind of made me really want to go more into the research area because when you are in school you get to see the book side of things but you don’t get much chance to put it into practice, and what you do can be used and... So, I think one of the things that convinced me I wanted to go to graduate school were some of the people I worked with. The other thing, as I mentioned in my survey, is that my father is a Ph.D. in electrical engineering and so he was all for this, and I know he had a great career, and I saw what he got to do with his career and so that was motivating for me as well.

(Q2) LK: When you think about internal characteristics (personality traits), what do you think are those that you have had since you were young, especially as an academic woman scientist?

IP2: That’s a tough question to answer. I am very detailed driven in particular and when I start something I like to finish it and see it through to the to the next level. I would not say that I am a really driven person, I don’t see myself as a Type A personality person, but I do like finishing things, so I don’t know what personality trait that would be. The other thing I would say, especially about academia, I am very passionate about what I do, especially for teaching and this is something I like to pass on to students. That is probably another characteristic that has served me well, getting people excited about my research, because a lot of what you do is communication and trying to convey your ideas, and I would say that is one of my strengths.

(Q3) LK: I would call that first characteristic persistence. You said that your father was a major external influence. Were there any other external influences that you can think of?

IP2: When I was in high school, there was a math teacher (AP calculus), kind of a very dry personality, but I loved him for some reason, and he just made math fun, and just the way he presented it I saw the beauty in it and I thought that was really neat. That was the first class where I realized how much I really enjoyed doing math. Science I was good at, but I never really enjoyed it.
(Q4) LK: And that is why you are an engineer....When you think about significant events, are there any major ones that also affected your career path, either positively or negatively?

IP2: The summer positions were definitely big. I would say also that I had an amazing graduate school advisor, he was a very down to earth, friendly, approachable person, and I went to (university) where there are a lot of high Type A personalities that can make it a very stressful situation. He was a major influence in me sticking with it and deciding then to follow that career path that I started because he did such a good job at providing advice and encouragement when needed, but then letting you go off on you own as well, so he was a major influence.

LK: That is one of the reasons I wanted to interview you. You were one of the few who had a great grad school advisor. Most others noted they had a horrible advisor.

IP2: One of the things to note is that I sought out someone who would fit my personality so I decided that even though he was not directly in my field, he would be a good fit. I think that I connected with him when I met, and I still think a good relationship for students with their advisor is what propels them to move forward.

LK: I agree, and the fact that you still do that is really important. One of the things I am interested in is how can we help young girls and women to move forward.

(Q3) Were there any other things growing up in addition to your father that affected you growing up? Were there any other specific ways, I guess seeing him enjoy his work was probably a major one?

IP2: He went fairly far up, and by the time he retired he was the VP of Research and so he moved up the chain so he worked at all different levels (e.g., research, management). I remember one of my first experiences was with a game that he created called the mouse and the maze, back in the 80's, and this was featured at Epcot Center and we went down there to see it being used, so that was a major driving factor. I never really thought I was going to be an engineer, but now I have a son who is building bridges and taking things apart, I was never like that. I did get to see my dad go on business trips and to conferences and to travel all over the world for his job and share his work and meet interesting people.

(Q4) LK: I noticed that you are the only tenured women in your department at (your current institution). Has that affected you in any way?

IP2: It's been kind of a positive, not that I would mind other women. My department has been phenomenal with mentoring and supportive, especially when I had kids, I was the first woman to go through this and they just accommodated me anyway I needed.

LK: Do you find yourself being a mentor to younger people either in your area or others at the university?
IP2: Yes, a lot of times. I have students in other departments come up and talk to me because they have no female faculty members in their departments. For example, I had one student come and talk to me because her parents were not engineers, not even college grads, so she came to talk to me about career choices and what it was like to be a women in this field. That was really neat to be able to share those experiences. I do try to support a lot of things to encourage women to go into the field. For instance, once a semester I take a group of undergraduate women out to dinner with another untenured female faculty member, so that they can meet one another. Also, for the graduate students, we have a gathering of all female engineering students to get them to meet each other and the female faculty so that they can meet mentors.

(Q3)LK: I would think that you have had great mentors, it would make you feel positive doing that for others?

IP2: Right. Absolutely.

LK: You were one of the few who responded that you currently have young children. I have to think this has affected you in terms of your career?

IP2: I definitely do not have as much free time, I have not read a book in years. But, I have been able to manage fairly nicely spending a lot of time working at home at night. I do not work regular hours, and I spend a lot of time at home. I still kept up with my students and their papers and proposals, and I can work strange hours because I don’t need to be in a lab. So, it definitely affected me, but I don’t think it affected my work in terms of slowing down.

LK: I did not see any slow down on your vita.

IP2: It has made me a lot more efficient. I am much quicker at doing things. I spend time from the minute I get home until 8:30 pm with my kids, and then from 8:30 - midnight working. So, I get a lot less sleep and chill time, but it works for me since I get to spend time with my kids. It has not been a career blocker or stopper, it just changed how I do things.

LK: Sure. Do find yourself saying no to stuff that you don’t have to do anymore?

IP2: No. When the kids were first born I said no a lot and I was really worried, but people were very understanding. For example, I said no to reviews and all the service stuff, but I always wrote back that I just had a child. People always wrote back congratulating me, and they were just great and wonderful about it. I said no to things for six months to a year when my kids were born, and, I never felt any repercussions about that. Now, don’t say no as much because when I really needed it I said no, so now I feel like I need to not say no.
(Q5) LK: Is there anything else you think is really important that I look at in my research as I move forward?

IP2: One thing that I think of that is really important, especially for the question about career and family, is institutional support. It is really hard to get back to work 2-3 weeks after you have a baby, you are not sleeping at night, and you physically can’t do it. I think one of the things that has been really important to me is the support of my institution to take time off when I needed it. And, I kind of I feel like because of that, I give a lot more back. So, one of the questions to look at is “are women getting the support they need?”

LK: I agree. That has been a recurring theme.

Thank you very much for your time!
Interview with IP3

(Q1) LK: Tell me the story of your own talent development process. What have been some of the critical things that have changed the course for you, and that have really made a difference in the course of your career?

IP3: I really think getting accepted to Hunter and going to Hunter in 7th grade, after elementary school in Queens. The year I graduated from Hunter, they went co-ed the following year. So, I am curious about the other women, were they all my generation?

LK: Yes, your generation and older. They all commented on the fact that it was all-girls while they attended.

IP3: Absolutely. In sixth grade I was realizing that I was smarter than others in my classes. I never felt stupid, it is just that I never felt unusually special. I tended to travel with a bunch of other kids in the highest level of the classes in elementary school, but I never felt particularly distinguished. Only four girls in my class were chosen to take the test, only two of us made it, and all of a sudden I think that was the first time I felt really special. And, that was really important to me because I kind of came from an unconventional background where my parents were blue-collar.

LK: I noticed that your mom did go back to college later.

IP3: I did not have the kind of background that many of my colleagues have in academia with parents who went to university or are professionals, but on the other hand I think what shaped me and set me up for achievement was the fact that both of my parents are very smart and much higher achievers than what is associated with blue-collar workers. They read all the time, did not watch television. That's what we did when we grew up.

LK: A lot of science fiction if I recall correctly?

IP3: Lots of science fiction on my dad’s side, my mom had much more of a classical side (Jane Austen). Then when I got in to Hunter it made me feel like I could achieve even more. That is probably the biggest thing that got me on the track of thinking academics. Science came much later, I did not think of going into science until college, and even then it was this weird thing, where I wanted to combine physics and writing. I did not know exactly what I wanted, and going to Hunter did not help me with the science. Hunter was much more liberal arts, and I thought I was going to major in physics. I graduated at 16 because I had skipped some grades, I failed physics my first semester and had a real reality check. That set me on a certain path, and eventually I switched to chemistry, and transferred to a SUNY school. After that things settled down and I started following more of a path.

(Q2) LK: What do you think were some of the significant internal characteristics that kept you going on your career path? What personality traits kept you going?
IP3: Persistence to keep doing it. I guess I must be confident, although I do not think of myself that way. On the other hand, there must be some inner-place that keeps me going, and enough reward. Possibly, it is because for me it has never been “do or die.” I have never felt that if something did not happen it would be the end of me. I have always been able to jump out there and take risks, not intentionally, but I do in my career. I do not do this outside of my career. One might think that this is weird since most would want career security, but I have just done it. I left a tenured job and went to (another institution) without tenure, but I don’t recall worrying about getting it back. I just figure what will happen happens. I think one of the amazing factors for me that was my parents, since I had the backing of my family. They retired young and moved to help me raise my kids.

LK: So they have been somewhat of a safety net?

IP3: Absolutely. Non-judgmental and there when I need them. I always believed that I had that safety place to go.

(Q4) LK: I also noted that you had a very interesting answer to whether you are happy in your career to date. You noted that you often feel disconnected from the big names and networks of women in my field.

IP3: I have always just felt outside the cliques that form. I think this may be part of my upbringing, this may be from me being from Queens, I don’t keep my mouth shut. I just don’t blend well with others. I don’t think I fit in those circles. I don’t think I fit into the group of women in science. I have not been invited. Sometimes I wonder why I am not, and other times I feel like I don’t want to be part of it either.

I have never felt part of any social circle, sometimes it can be isolating but other times it is liberating. I think that this has sometimes hurt my career in things that would have been acceptable like funding opportunities.

Certain inner groups are more likely to get the awards and prizes, not just in funding. I have never been into that, and I guess where this hurt the most is not being accepted by my female peers.

(Q3) LK: What has it been like to be at your current institution? It seems like there are a lot of women in different departments in the sciences.

IP3: My (former institution) was awful and it was a terrible place for women. So, when I was approached by my (current institution) to be department head, I got excited because someone was interested in me (unlike my (former institution) where my name never even came up as a possibility for department head). So, coming to this institution has been good and bad, it certainly has a lot of controversy. You know our president has caused controversy, and sets a certain tone here, but women are still having problems like they have everywhere. In my first year here, in addition to being department head I actually
served as an advocate for a woman who did not receive tenure for ridiculous reasons and there is an appeal process where you have a formal advocate. She was not even in my department, but she asked me if I would and I won the case simply because the reason she was denied tenure were completely fake. I mean, untrue. So, that got me on a high note.

So, there are women here. There are also men here who are delightful to talk to. My research has gotten so much more interesting, so much more current. Opportunities have opened up that I never would have had at my former institution. That is the most exciting thing about coming here.

As far as my role as department head, I do try and mentor women in particular. The women in my department just glom onto me and want to talk for hours on end. The drama and neediness is amazing, and I do not know where that is coming from. There are all brilliant, but there are also so much more eccentric, quirky...I don’t know if they would be doing this if the dept head was not a woman. Kind of interesting.

LK: There is a little bit of that everywhere. Is there anything else that you think I should be thinking about as I move forward with my research about successful academic women in the sciences?

IP3: I think that the generational difference would be real interesting and something that I thought about a lot during the Presidential campaign, because I totally identified with Hillary. She has become in a way irrelevant, and she never would have gotten the positions she got without the positions she has held. She missed opportunities that were available to people like Obama. Things that you have to do to hold on and the sacrifices that need to be made, she represented a woman who could do it. I think it is interesting that many women my generation just sit back...

The women who are celebrated in science, and what some women feel is the standard, is still like the Marie Curie model, where you need to die for your science and men don’t have to. For men it is possible to have it all, and I still find so many women who marry older men, and that is kind of a paradigm. Kind of this model of sacrifice, and I don’t think it has changed as much as it needs to. It is expected that women will sacrifice to have a career in academics, and men don’t have to. It troubles me that women feel they have to “die” and sacrifice to be recognized in science.

LK: Thank you very much.
Interview with IP4

(Q1) LK: Tell me the story of your own talent development process. What are some of the major things that have led to you being successful today as a woman scientist?

IP4: You have to have ability and you have to have desire in order to develop in any field, and I guess I had both of those. Of course, Hunter High School was the biggest factor, just because of the way it was in those days, it was an incredible place, there was nothing to dissuade us from anything we wanted to do. In fact, a large percentage of my class ended up going into the sciences. We have a lot of reunions and keep in touch.

(Q2) LK: When you think about internal characteristics, what do you think has helped you become successful?

IP4: I guess being pig-headed and stubborn helps. You know, I just had the interest and wanted to pursue that direction, that was it.

(Q3) LK: In terms of external influences, I know you mentioned several different ones, but what are the ones that have helped you get to where you are in your career.

IP4: I guess anybody who supported me with what I was interested in. Going back to the survey, I had an 8th grade science teacher who really inspired me.

LK: I noticed that neither of your parents had attended college, and I was wondering if that affected you at all growing up, in college, and then moving into your career?

IP4: First of all, they are first generation immigrants. My parents were born here, but my grandparents were not. In those days, we had a big extended family and if your daughters went off to college, it was "loco." That is how I ended up staying in NYC and going to Hunter College. My sister also went to Hunter High School (she is younger than I am), and there were a lot of siblings there.

As I went through and ended up in graduate school, I don’t know if my sister realized that I had to do a lot more work than she did (she is a high school teacher). My mother did not realize that I had to work harder, and I think there was a lack of depth of knowledge. Even today, people ask me what grades I teach, and they think that I get summers off, etc.

LK: I noticed that you are the only tenured women in the chemistry department at (current institution). Has that always been the case?

IP4: Well, let's back up a bit. My (current institution) used to be all male until the late 60’s and at that time I was starting grad school. They admitted their first class of women in 1968, and that was actually a separate school. A woman had taught there, but I do not think she got tenure, because if she did I don’t think she would have left.
I got there under very strange circumstances… Back in 1976, the state of NY decided to evaluate every doctoral program in the state and they started with chemistry. This was very interesting because this is what turned things around, and in the process, they were trying to figure out what they were doing. They put (current institution) chemistry department on probation for two reasons. One, they wanted a minimum of 15 faculty, and the graduate student stipends were not keeping up. To make a long story short, the university decided to terminate the doctoral program. What happened was there were five faculty (males) who were just been hired, really good guys, and they all left, either to go somewhere they could have graduate students or to go into industry where they could make three times as much so that left a big gap. I happened to finish graduate school at (current institution), and I happened to be in the right place at the right time because they had to fill gaps, and that is how I got hired. I worked my tail off and here I am.

LK: That is a great story.

IP4: Yes, and the funny part too is that the people who are still on the faculty were my professors when I was a student. I was the only woman, because there were no women on the faculty prior to the early sixties.

LK: How has it been for you being one of the only women?

IP4: At first it was a blast, I loved it. There were things I thought I could get away with because I was a woman.

LK: Like what?

IP4: Like weaseling my way into getting certain pieces of equipment, but of course I had to do the work to prove I deserved what I wanted. I think I am also coming from a slightly different perspective than most of the women you are talking to. All my life, I have been one of the guys. I was a tomboy who grew up in the streets of the Bronx, and nobody saw me as a threat.

LK: You are pretty scrappy?

IP4: Yes, I am.

LK: Do you find yourself serving as a mentor to other younger men or women?

IP4: Yes, definitely. In fact, my rude awakening is that two of my colleagues are younger than my own children, and they both come to me a lot because I have a lot of experience as well as because I also spent some time in administration so that made an awfully big difference in how I handled things.

(Q5) LK: Sure. I can only imagine as an administrator myself. How did that change things for you?
IP4: Number one, it gave me the opportunity to learn so much more about the workings of the college and university. What to look for, what to emphasize when I had to put in requests for my department. How to go about stressing what was important, prioritize what I needed and that kind of stuff.

(Q3) LK: I think you mentioned the former Dean (now president of current institution) was pretty significant in getting you involved in administrative work.

IP4: He was the one who asked me to be the Associate Dean. Here the Deans get to choose their Associates and Assistants. When he came in as Dean, the person he inherited and he did not get along; so, he asked me to go over after getting some advice from another upper female administrator. He asked her advice, and her comment to him was ‘I don’t know, she can be tough’. At the same time, I asked one of the Jesuits about him and the Jesuit said to me ‘I don’t know, he is a harsh…’ I told one of my buddies, and he said it was a marriage made in heaven.

LK: Sounds like it worked out well. Did you ever want to move up and become a Dean yourself?

IP4: I don’t know, yes. At one time I applied for Dean of Faculty at later years, and I look back on it now, and I think I am in the right place. I went back as Department chair anyway, and I felt that by going back to the department I was able to help them more than not going back. And I think it was very important to move the science as much as we could. I was one voice among many who kept saying we needed to do more for the sciences, and now they finally are.

LK: What made the difference?

IP4: The university? I think they finally came to the realization that without the sciences you can’t really move up academically, without giving the sciences a place of prominence in the university.

(Q3) LK: I hear that a lot from other scientists as well. I really enjoyed all of your responses on the survey, and one of them was the idea that you had to convince your husband that this is what you should be doing, but now he works for you as a retired chemistry professor. Is that correct?

IP4: That’s right.

LK: How was that for you in the beginning?

IP4: Let me explain, looking back on it, why it was that way. Let’s just say we come from two different cultural backgrounds. I am from NYC, he is from (the south). He is an only child, I am used to an extended family, and my sister and I are quite competitive.
Where he came from the mother stayed home with the kids, and up here that is not the case. He was one of my professors by the way.

(Q5) LK: So how did you convince him?

IP4: I just said “tough, I can’t stay home with kids, I am going back.” And I just did it and after awhile he realized there is nothing he could do.

LK: He had probably just started there then as a faculty member.

IP4: Yes, he started when I was a junior and we got married after senior year.

LK: It is funny how many of you have partners/spouses that are either scientists and/or professors.

IP4: I don’t see it as being funny.

LK: Not funny, it is an interesting pattern.

IP4: It is interesting, but I don’t think it is unusual because this is what is going to bring people together to being with, having the same interest.

LK: It is interesting because that is not typical of women in the USA, marrying people in the same career area.

IP4: It’s interesting, because I am a whole generation (at least) older than you are. Don’t forget, there was less mobility back then.

LK: That is a good point. I think you are right. It seems pretty normal to you.

IP4: Yes. Now, people are much more mobile and go places when they want.

LK: You meet where you work.

IP4: I recall one of my high school teacher’s telling me that when I went to college I would probably meet my husband, she probably meant another student, but I would like to go back now and tell her she was right.

(Q5) LK: Is there anything else you think I should be exploring when I am looking at successful academic women scientists? It sounds like there is a generational difference.

IP4: Keep in mind that you might have to have some kind of factor that takes into account the time-span of people you are studying. And, also the cultural background.

LK: Correct. Thank you so much. I really appreciate it.
Interview with IP5

(Q1) LK: Can you tell me the story of your own talent development process?

IP5: I always had a natural ability for math and physics, and I think a major milestone started back in high school. Having some really good teachers who pushed me and challenged me, and really prepared me really well. They encouraged me and helped me to believe that I could do this stuff.

The next step was when I was an undergraduate, again I was challenged and was able to meet the challenges and was very successful. Again, I felt that I had really good preparation going to college and so I was able to reinforce my confidence. Even when I went to grad school I was also successful and I was successful at each level and that continued to increase the confidence in myself. Finally, when I finished my Ph.D. I decided to go overseas to teach at a university in another country for a year. From the outside, that might have been viewed as a crazy thing to do because I was going to a place with less resources, when many were coming to the USA. But really, that was a valuable experience for me, and I think in the long run it ended up helping me a lot. When I came back, I took the position at (my current institution), and before I came to (current institution) they had nominated me for a Clare Booth Luce professorship, and I provided materials for that. I don’t know for sure, but I think my professorship in (another country) probably made my application stand out.

LK: That really stood out to me, and I wondered why (that country)?

IP5: I wanted to go and teach at a university in (that country) because I wanted a different experience, a different cultural experience and I wanted to see what it was really like over there. There was a position advertised in my professional magazine a year before I finished my Ph.D., and it just jumped out at me. So, I sent my C.V. off and they called me the next week. And, it turned out that there were connections.

Then I got the Clare Booth Luce professorship and that took a lot of pressure off of me, especially regarding funding. Because of that I think that I was a little more careful in pursuing opportunities. Then I also got a young investigator award in my first year from NSF and those two things put me on the right starting position. It could not have been a better position for a new professor to be in.

LK: You did not have to panic then. You could choose your opportunities more carefully.

IP5: Yes. Is that enough about my talent development?

LK: I think that is perfect, kind of how you see the path. And, this idea of teachers challenging and encouraging is a theme that I am hearing from folks, and the different
that that makes. Being challenged and then meeting the expectations, and then having this be earned self-confidence that is highly valued.

IP5: Yes. The other thing is that education was really highly valued in my family.

(Q3) LK: I noticed that your father is an engineer. I imagine that had to affect you.

IP5: That affected me a lot. I went to him a lot for advice. He is an extremely talented engineer, finished to top of his class as an undergrad, through out his career he has been able to solve problems that nobody else could, so he is really amazing.

LK: He is probably thrilled that you ended up getting your doctorate in engineering I would think.

IP5: Yes, I think he is. He encouraged me to go on, but it wasn’t what I thought I would do when I started.

LK: What did you think you would do?

IP5: I wanted to be an engineer like my father, but be out there solving real problems, and not being on the faculty floor in that regard. He encouraged me to go on to graduate school and told me that I could always be an engineer even with a Ph.D. if that is what I decided. He would have continued if he could have but financially it was not feasible for him.

When I finished my Ph.D., I realized that becoming a professor was much more difficult than going into industry. I liked the challenge of that, and when I started out my plan was just to get tenure and then go into industry. I just wanted to prove that I could do it, but then I like the job and I have just kept doing it. I have thought about leaving the academic position and going into industry because I could make a lot more money.

LK: Yes you could, but it is a different lifestyle isn’t it.

IP5: Yes, and I like the flexibility. To be honest, there is no real pressure. I mean there is some self-imposed pressure because you want your work to be high-quality and respected so that you are bringing in the funds for research, but in the end there is nothing that is really going to happen. Nobody will die if my research doesn’t work out.

LK: That is a good point. The stakes are a little different.

IP5: But with real problems, there are a lot of consequences. I look at the stuff my father does (he is retired now), and there are a lot of people depending on him. You are doing things that have much bigger consequences and a lot of responsibility. Not to say that I don’t have consequences with my research and responsibility with my students, but it is really a different level.
(Q3) LK: Right. So your dad was probably a pretty major facilitator and influence on you, and teachers. Is there anything else you can think of that were major things that pushed you forward or helped you?

IP5: No, not really.

(Q2) LK: What about your internal characteristics or personality traits that have helped you be successful?

IP5: I think the biggest is the ability to really focus on a problem and work on it for a very long time.

LK: Someone else said the ability to focus and to see a task finished.

IP5: Finishing is really big. I have had a couple of students who couldn’t finish and I cannot understand that. They were really capable, but they would go so far and I could not get them to do anything beyond a certain point. I don’t understand that, but I have seen it a couple of times, the inability to finish something.

LK: It’s persistence really, isn’t it? Some people just cannot persist all the way to the end. I don’t know if it is fear of failing or what it is, but it is one of the reasons I was interested in studying all of you, who would be viewed as being successful women in academic science. This leads me to another question, which is about children. I believe you mentioned that you have two young kids, is that correct?

IP5: Yes.

(Q4) LK: Can you share with me how that has affected your career path? About how you decided when you wanted to have children, etc.

IP5: Yes. I definitely waited until after tenure until I had my first child, but I was fortunate because I finished my Ph.D. when I was twenty-six and started as an assistant professor at twenty-seven. Many people have to wait until much later.

LK: Has it changed anything for you?

IP5: Yes. I definitely am not able to work as many hours, which is fine. It’s frustrating, I always have the feeling that I am not doing enough work, and that I am not doing enough for my kids. I used to work most of the weekends, and evenings, and I do almost no work on the weekends now. My productivity is definitely not at the level that it used to be, but I think it is good though. I think productivity expectations are a little ridiculous, I think people could be a little less productive but higher quality so that they are not working all the time.
LK: Right, well there is sort of an efficiency that you have to have when you are juggling your work and kids, in a way that makes you then kind of focus on the stuff that really matters.

IP5: That’s right. I think that having kids postponed when I ended up going up for full professor. It maybe pushed it back by one or two years, but I was still able to go up in a reasonable amount of time.

LK: And feel pretty confident about that?

IP5: Yes, but my productivity had definitely went down after I had my first child. It is different at different ages, especially when they are really little. But, as they get a little older it gets a little better, and now, with my kids and all of their activities, my evenings and weekends are completely booked.

LK: I understand completely as my kids are about the same age. I feel like I am cultivating their social lives much more than my own. But, you do get more sleep than when they were little. I noticed that you are only one of two tenured women in your department, is that right?

IP5: That’s right, and I was the first one to make it to full professor. It’s fine, actually my department is great and they have been very supportive. In fact, when I had each of my kids I had a crib in my office and a swing in my office when they were really little, and I was bringing them in all the time, and everybody was really helpful. I thought it was a really supportive environment in the department.

LK: How is (your institution)? How are the institutional policies?

IP5: We have a parental leave policy, and when we first put it into place it was at the forefront in the country. You get a semester off of teaching at full pay, and you can get a second semester off at half-pay if you want. So, it’s pretty good.

LK: And the perception of that is that it does not really hurt you down the road?

IP5: Yes, it really does not.

LK: There are other places where people have noted that they don’t take leave because it is held against them. But, that is not how you feel at (your current institution)?

IP5: It really depends on the department. My department has been really supportive, and now men are starting to take it. There is one man who will be taking it next semester (full professor), but most of the younger men in my department (assistant professors) have not taken it. I don’t know why they have not taken it. I think there may be some perception in that regard.
LK: You have had some very good mentors all along. Do you find yourself serving as a mentor to other junior members in your department? Or other women at (your current institution)?

IPS: Yes, I have been. I have been putting together meetings with the women faculty in my department, and I have also been working with another faculty member at (my current institution). We have a women faculty coach at the school of engineering who is in the materials science department, and she has been organizing group mentoring meetings for all the women faculty. She and I and the dept. head of biomedical engineering have been taking turns leading that.

I also have an ADVANCE grant (here). We have had some problems with women not making it through the tenure process in the past few years. This happened last year, and I organized a meeting with the president, and the senior women faculty on our campus went last June. We also went again in November, with the plan to meet once a semester. We are trying to get the President to get a policy for (my current institution) that will hopefully prevent the problems we have had, but hopefully earlier on so that women do not have trouble making it through the process.

I bring the information back to the junior faculty and then we discuss what junior women need to be concerned with and focus on. One of the big problems we have had with our junior women is excessive amounts of service, and that ends up creating a problem because it does not really count for much yet it takes up a lot of time. So, that is one of the big things, telling them to say no.

LK: I really appreciate your time, and I have been really interested in this for a long time having a mother and sister who are in academics and an organic chemist. And, I am wondering, what other questions do you think I should be thinking about as I move forward with this research?

IPS: It's not easy. The hard thing in the U.S., is it is always the hidden stuff that you don't know. We had some women talking yesterday about creativity in their research, one doing stem-cell research and the other a physicist. One was from Austria because they don't hide their discrimination over there, so we know she had a harder path and she definitely earned it. So, when she got her position, many people congratulated her, while others told her she got it because they needed to hire a woman. I also got some of this response with the Clare Booth Luce myself, so it is something you always have to deal with. Interestingly, one of the woman knew someone who changed genders and went from female to male. Someone actually went up to him and told him that he was much smarter than his sister.

LK: Wow, the same person!

IPS: Yes, the same person.

LK: Wow, that is a great example. Thank you so much for your time.