Summer 8-17-2014

The Supply of Female Scientists Conundrum: An International Study Exploring the Predictors of Females' Intentions to Major in Science Postsecondary Education

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The Supply of Female Scientists Conundrum: An International Study Exploring the Predictors of Females' Intentions to Major in Science Postsecondary Education

by

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Submitted in partial fulfillment of the requirements for the degree

Doctor of Philosophy

Department of Education Leadership, Management and Policy

Seton Hall University

July 2014

SETON HALL UNIVERSITY

College of Education and Human Services

Office of Graduate Studies

APPROVAL FOR SUCCESSFUL DEFENSE

Doctoral Candidate, **Susan E. Arrigoni**, has successfully defended and made the required modifications to the text of the doctoral dissertation for the **Ph.D**. during this **Spring Semester 2014**.

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ABSTRACT

The goal of this study was to perform an exploratory analysis of a comprehensive list of independent variables identified from literature to determine which, if any, are effective predictors in forecasting a female's intention to study science postsecondary. This is likely to be indicative of interest to study science when pursing higher education as well as choice of major and possible career. The postulated model guiding this analysis, which was based on prior research, recognized that factors pertaining to students, parents, schools, and peers are all important. This study used logistic regression to analyze data from the 2006 Programme for International Student Assessment (PISA). The findings of this study suggest that external factors, such as those considered from the environment, are indeed important in determining a female's intention to study science postsecondary. The findings of this study provided further refinement by demonstrating that for the 15 countries included in this analysis from the Oceania, Latin America, European, and Asian regions there were some overarching and consistent factors that are positively associated with females' intentions to study science postsecondary. These findings essentially paint a portrait of females who intend to study science postsecondary, which are used to suggest additional research as well as interventions to help mitigate the female scientist conundrum observed worldwide.

KEY WORDS: Female science underrepresentation, Programme for International Student Assessment (PISA), intention to study science postsecondary, logistic regression

DEDICATION

To my family

~To my father-in-law, Walter, and mother-in-law, Joan

~To my brother Jeffrey, his wife Sandra, and their children, my nieces Fenna and Paula

~To my father Hans, and in loving memory of my mother, Marion

~To my husband David, and our children Brian, Lauren, and Matthew

ACKNOWLEDGEMENTS

"We must find time to stop and thank the people who make a difference in our lives."
John F. Kennedy

Giving Thanks

My work is not an end; it is a new beginning. I am thankful this chapter has ended, but the book is not yet complete. The underrepresentation of females in science is an important topic and one I will always pursue to further its understanding. Female underrepresentation has been my passion since working as a microbiologist, and now as a high school science teacher; it has been an area of my formal studies since 2002. I am sincerely grateful to so many people for their insights and encouragement.

For guiding me, I thank many professors at Seton Hall University, including Dr. Rosemary Skeele and Dr. Mary Ruzicka, who were both catalysts in my early graduate work. I also thank Dr. Joseph Stetar for stimulating an international direction in my topic of interest, and Dr. Martin Finkelstein for consistently inspiring my thoughts, especially in the History of Higher Education course during which I studied the underrepresentation of women in greater detail.

I am sincerely grateful to my committee members, including Dr. Eunyoung Kim and Dr. William Miron. Dr. Kim was instrumental in affording initial guidance and crucial commentary, and Dr. Miron offered critique, enthusiasm, and steadfast support.

There cannot be enough gratitude given to Dr. Rong Chen, who as my program advisor and dissertation chair provided the firm foundation needed for me to begin this journey as well as the critical feedback and endless encouragement needed to complete it.

Joshua Weiner, a friend, is given thanks for his kindness and invaluable expertise; his perseverance is a model for all.

Most importantly, my family is given my deepest gratitude and love. My parents, Hans and Marion Weller, instilled in me the values of hard work and dedication, all the while supplying unconditional support. Finally, my husband, David, and our children, Brian, Lauren, and Matthew, supplied enduring love. They are all pillars, providing the strength and inspiration I needed to accomplish this endeavor; without them, my work would mean little.

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Chapter 1

Introduction

The participation of women in higher education continues to grow although with inconsistencies (Kohlstedt, 2004). Today, the number of female students enrolled in postsecondary or tertiary education exceeds that of male students in almost all developed countries (Altbach, Reisberg, & Rumbley, 2009, p. 2). According to United Nations Educational, Scientific and Cultural Organization (UNESCO, 2007) data, the female enrollment in higher education increased worldwide from 39% in 1988 to 51% in 2005. For the majority of the Organisation for Economic Co-operation and Development (OECD) countries, 59% of all graduates of a first tertiary-type A degree program, also classified as an undergraduate program earning a bachelor's degree (OECD, 2012, p. 62), are now women (p. 73). Despite these gains, women are not equally represented in every field with significant differences among the science, technology, engineering, and mathematic (STEM) disciplines (Altbach, Reisberg, & Rumbley, 2010; Lee, 2002; National Science Foundation, NSF, 2013; van Langen & Dekkers, 2005).

Women are less likely than men to choose STEM as a college major. According to the Survey of the American Freshman by the Higher Education Research Institute (2007), 30% of male students plan to major in a STEM discipline compared with only 15% of women. Internationally and according to OECD (2012), 73% of all graduates of a first tertiary-type A program specific to science, engineering, manufacturing, and construction are men (p. 73). Women tend to enroll predominately in what is thought of as more traditional disciplines, such as psychology and the social science disciplines (NSF, 2013) as well as education (OECD, 2012). Moreover, the participation rates for women for most OECD countries decline as degree level increases (NSF, 2013; OECD, 2012 p. 76). This is also true for women in STEM disciplines

(Hill, Corbett, & St. Rose, 2010; National Science Board, NSB, 2012; NSF, 2013; Ware, Steckler, & Leserman, 1985). The Science and Engineering Indicators 2012 reported that a higher percentage of science and engineering bachelor, master, and doctoral degrees were awarded to men than to women (NSB, 2012).

With a global economy coupled with many current far-reaching global scientific concerns, STEM participation is paramount to all countries. As a result, many education policies have been implemented to improve the number of STEM graduates (OECD, 2012; UNESCO, 2007). The European Union (EU), inclusive of 28 countries, proposed goals to increase STEM graduates with the intention of becoming the "most dynamic and competitive knowledge economy in the world" ("Researchers' Labour Market," 2006; van Langen & Dekkers, 2005, p. 330). In 2010, the European Union specifically proposed a 15% target to increase the amount of students graduating college in a "mathematics, science and technology" field (OECD, 2012, p. 77). STEM participation is likewise a consistent concern and focus of government policy in the United States. In 2010, the President's Council of Advisors on Science and Technology (PCAST) were asked to compile recommendations to "ensure that the United States is a leader in STEM education in the coming decades" (PCAST, 2010, p. vii). The PCAST Executive Report (2010) pointed to the urgency of education in STEM fields:

> In the 21st century, the country's need for a world-leading STEM workforce and a scientifically, mathematically, and technologically literate populace has become even greater, and it will continue to grow - particularly as other nations continue to make rapid advances in science and technology. (p. 2)

In response to the noted underrepresentation of women in the STEM fields, there has also been a call for action worldwide to specifically increase female participation in science. The

United Nations Educational, Scientific and Cultural Organization (UNESCO) asked all countries to help increase the number of female scientists (UNESCO, 2007). As early as year 2000, the European Commission implemented policy to not only increase the number of STEM graduates, but also "reduce the gender imbalance" within the STEM fields (OECD, 2012, p. 77; van Langen & Dekkers, 2005). In addition, the goal of the United States to increase STEM college graduates by one million over the next 10 years includes a focus on women as per PCAST (2012). Despite such initiatives, the underrepresentation in science unfortunately still persists, as acknowledged by the European *She Figures* (European Union, 2009) and the National Science Foundation's biennial report *Women, Minorities, Persons with Disabilities in Science and Engineering* (NSF, 2013). OECD (2012) confirmed that among OECD countries, few females expect to work in a science related field (p. 73). For countries in the European Union as well as others representing a variety of regions, Table 1 shows the proportion of females enrolled in a first university science and technology degree program, earning a first university degree in a science and technology field, and working as a related-science researcher. On average, the percentage of females enrolled in a first university degree program is more than males, yet females comprise a lower percentage of first university degree science and engineering graduates and science researchers (UNESCO, 2007).

The low supply of female scientists warrants further investigation of a woman's experiences that lead up to her educational and career aspirations. In the United States, roughly half of the workforce consists of women with approximately one fourth employed as a scientist or engineer (Lee & Mather, 2008, p. 11). Women represent an underutilized source of potential scientists that can strengthen the nation's workforce and global competitiveness (van Langen & Dekkers, 2005). Jobs requiring degrees in STEM fields and respective professions

Table 1
Percentage of Females Participation by Country

Country	First-university degree enrollment		First-university degree graduates		% Female science researchers
	%Total enrolled	%Total S&E	%Total graduate	%Total S&E	
Austria [a]	52	-	51	26	24
Belgium [a]	51	-	51	27	28
Bulgaria [a]	52	-	57	41	46
Colombia	53	36	57	39	37
Croatia [a]	55	35	59	40	41
Cyprus [a]	78	-	80	63	32
Czech Republic [a]	50	-	54	29	29
Denmark [a]	64	-	67	28	28
Estonia [a]	-	-	70	46	42
Finland [a]	-	-	63	28	29
France [a]	55	-	58	35	28
Germany [a]	47	-	50	29	19
Greece [a]	53	-	64	44	37
Hong Kong-China	53	28	54	31	-
Hungry [a]	57	-	60	23	34
Iceland	66	-	68	38	39
Ireland [a]	57	-	59	35	30
Italy [a]	56	-	56	34	30
Latvia [a]	64	-	71	34	52
Lithuania [a]	59	-	64	36	49
Luxembourg [a]	54	-	-	-	17
Macao-China	33	-	56	-	22
Malta [a]	56	-	58	29	26
Netherlands [a]	51	-	56	17	17
New Zealand	59	-	62	39	39
Poland [a]	55	-	63	32	39
Portugal [a]	-	-	69	44	44
Qatar	73	58	76	67	-
Republic of Korea	37	-	48	31	13
Romania [a]	55	-	57	40	43
Slovakia [a]	52	-	56	34	41
Slovenia [a]	61	-	64	34	33
Spain [a]	54	-	60	36	36
Sweden [a]	61	-	63	35	35
Turkey	43	-	46	34	36
United Kingdom [a]	55	-	56	32	-
Average	55	39	60	36	33

Note. Table constructed from data in UNESCO Science, Technology and Gender obtained from UIS, Education Database and Science and Technology Database, February 2007.
[a] Member country in the European Union

continue to grow (UNESCO, 2007; U.S. Department of Commerce, 2011), and such fields are often needed to sustain a country's economic development (U.S. Congress Joint Economic Committee, 2012). Even though female students are completing many advanced science courses (NSF, 2013; UNESCO, 2007, p. 29), women tend not to pursue a science or engineering major in college. Women, therefore, do not receive the education necessary for these greatly needed, financially rewarding and secure positions (Hill et al., 2010; PCAST, 2010).

Many educational and policy researchers attributed underrepresentation of women in STEM education to education and experiences prior to postsecondary schooling. A study, using data from the Longitudinal Study of American Youth, found that although there is an overall positive science attitude among male and female students, this attitude "declines over the middle and high school years" (George, 2000, p. 222). This continues to supports study findings, using the National Assessment of Educational Progress (NAEP), which have reported a decline in positive science attitude, from students 9 years of age to students 13 and 17 years of age (Kahle & Lakes, 1983; Yager & Yager, 1985). In fact, as students progress from primary through middle and high school, science classes are considered to be "less fun", "less interesting" as well as not as exciting and more boring according to Yager and Yager's (1985) study using NAEP data (p. 352). Also using NAEP data, Kahle and Lakes (1983) reported that students ages 13 and 17 reported less science confidence and interest. Similar findings were observed among international primary school aged students (OECD, 2007). The 2011 Trends in International Mathematics and Science Study (TIMSS) showed that 4th grade students had a more positive science attitude than 8th grade students (TIMSS; Martin et al., 2012). Existing literature has highlighted that the "late elementary and early middle school" years, in particular, seem crucial to developing career aspirations in a science-related field (AAUW, 1992; Yanowitz and

Vanderpool, 2004, p. 353). While most data show many students lose science interest from grammar to middle school, additional research has shown that this loss of science interest and decline in science attitude is higher among females and has continued to deteriorate from middle school to high school (George, 2000; Kahle & Rennie, 1993; Lupart, Cannon, & Telfer, 2004; Taasoobshirazi & Carr, 2008; VanLeuvan, 2004). As a result, a potential source of science majors develops by the beginning of high school in Grade 9 and is essentially finalized by the end of high school in Grade 12, when many choose an intended college major (Maple & Stage, 1991, p. 40). Several studies substantiated that high school students decide their college major based on earlier influences (Maple & Stage, 1991; Sax & Harper, 2007; Turner & Bowen, 1999). High school female students who do not select science as an intended major represent an important untapped source of possible science majors. Due to the "perceived shortage of students following science in higher education in many countries" (OECD, 2007, p. 146), this pool of woman (NSB, 2012) represents not only a "net loss" to higher education (Hilton & Lee, 1988, p. 523; Smyth & McArdle, 2004), but also a loss worldwide of prospective and greatly needed scientists (Turner & Bowen, 1999).

Purpose of the Study

Females' intentions to choose science as a major appear to result from experiences in their developmental process, which is often depicted as a pipeline (Hill et al., 2010, p. 17; Hilton & Lee, 1988; Xie, 2005). The pipeline metaphor was a common perspective in the literature on women in science (Xie, 2005). It is symbolic of the process of becoming a scientist and is, therefore, inclusive of a female's educational ladder through the primary, middle, and secondary school years, which ultimately concludes in choosing an intended major based on career interest. This pipeline metaphor can be extended to comprise postsecondary learning, which would include committing to a major and career field. Looking at a female's educational science pipeline, there appears to be "two moments" of science choice (van Langen & Dekkers, 2005, p. 330). One is intention to choose a college major when in high school, and the other is commitment to major when in college (van Langen & Dekkers, 2005). Since intention to major in a field is usually indicative of subsequent major when in higher education and likewise career choice, and given that the majority of precollege females do not intend to major in a science related field (Hilton & Lee, 1988), it is essential to understand what influences this decision. It is crucial to understand what is happening prior to or during secondary studies, which is upstream from those two critical moments of science choice (van Langen & Dekkers, 2005, p. 330) when considering the female educational science pipeline. It appears that what is done early in the pipeline, long before college years, influences decisions, such as intended major selection and subsequent decisions to participate in a science career or pursue another field perhaps in what is thought of as a more traditional area. OECD reported that males select majors in engineering-related fields and females select a major predominately in the social sciences (OECD, 2012). According to Sikora and Pokropek (2011), 15-year-old females in 20 OECD countries identified "authors, journalists and writers" as a top career interest, and females in 25 OECD countries mentioned a career in law most often (as cited in OECD, 2012, p. 76). The concern of females choosing to enter a science career at a lower rate than men and an apparent leakage in the pipeline being more pronounced precollege necessitates early intervention (Hilton & Lee, 1988; Maple & Stage, 1991). A thorough examination of influences leading up to a female's intention to study science postsecondary would provide insight on why females are not choosing to major in science when in college and potentially mitigate the leakage upstream from the critical moments of science choice (van Langen & Dekkers, 2005) including intention and commitment.

Underrepresentation of women in science is a frequent inquiry of research. Many studies specific to science participation disparities focused on the population of women who decided to major in science but later leave the field of study or related career due to a variety of reasons many centering on several hypotheses, including the "chilly climate" reference as per Genova (as cited in Sax & Harper, 2007) in addition to other authors (Constantinople, Cornelius, & Gray, 1988; Hall & Sandler, 1982; McDade, 1988; Rayman & Brett, 1995) as well as the discriminatory workforce "glass ceiling" or "maternal wall" once in a science career or academe (Kohlstedt, 2004; Williams, 2005). While many studies evaluated attrition when in college or in the science field, fewer studies focused on the influences affecting a female's intention to major in a science discipline precollege (Maple & Stage, 1991). The time period precollege has been recognized in literature to be critical in developing a female's career aspiration in a science (Sax & Harper, 2007; Ware & Lee, 1988). This group of precollege females represents a possible pool of science majors. When considering the metaphor of the female science educational pipeline, an analysis of this group of precollege females and the factors that influence their decision to intend to major in a science could provide important information upstream from a pipeline that is essentially leaking (Hilton & Lee, 1988, p. 523; Maple & Stage, 1991; Smyth & McArdle, 2004, p. 354).

There are several gaps observed in prior research that are worth noting. One gap included the fact that most related studies did not focus on intention to major in science, and most related studies concerning female science participation focused on minimal predictors. In fact, few studies examined the noted factors of influence from a comprehensive perspective, which is critical to understand how they may act as a group. Tatsuoka (1973) in his article "Multivariate Analysis in Educational Research" discussed how studies that still look at variables in "isolation" do not account for how the variables act collectively (p. 273). According to Tatsuoka, this overlooks the fact that multivariate analyses "can throw light on how each one contributes to the relation" (p. 9).

Moreover, the factors identified as possible predictors of female intention to study science were primarily from data involving the United States, and as a result it is difficult to infer if those same factors are important across various countries or regions without evidence. Therefore, another gap in prior research included the lack of a cross-country comparison. With a shortage of students studying science acknowledged worldwide (OECD, 2007) and globalization, countries are concerned with providing an education that will create a workforce able to compete in the international marketplace. Respective concerns have led to countries implementing related educational policies, such as those previously mentioned by the European Commission to increase STEM graduates and address associated gender differences ("Researchers' Labour Market," 2006; van Langen & Dekkers, 2005). Given the persistent female underrepresentation in science, it is important to explore the factors influencing female students' intentions to choose science as a college major. Also, in light of globalization and the fact that this concern is apparent worldwide, an examination of these factors is important to gain an understanding of STEM field participation from an international perspective.

Women are less likely than men to choose science as an intended college major, and as a result, there is a concern for the supply side of female scientists. Several studies have focused on biological characteristics driving achievement as a root cause of the difference. However, now that the achievement gap is closing and participation disparities remain, environmental influences must be critically considered (Bleeker & Jacobs, 2004; Tindall & Hamil, 2004).

To address the several gaps in the literature as reviewed above, the present study was an international exploration of predictors influencing a female student's intention to major in science. The purpose of this study was to explore the effect of various factors on a high school female's decision to intend to major in a science field. An advancement over the previous literature, this research utilized data from multiple countries and provided an international perspective about how a comprehensive set of factors could shape females' future science study. The study was guided by the following research questions:

- What factor(s), if any, contribute(s) to high school female students' decision to choose an intended college major of study in a science field?
- How do contributions of these factors differ by country?

Conceptual Framework

A high school female's intention to major in science seems best explained by a combination of theoretical frameworks. The first is the biopsychosocial model theorized by Diane Halpern (2000). This framework suggests that cognitive differences among genders are likely the result of both biological and environmental factors that continuously influence one another (Halpern, 2000, 2004, 2005). Another framework concerns the Getzels-Guba model put forth by Jacob Getzels and Egon Guba, which is representative of social systems theory. Their work involved a social system model inclusive of the nomothetic and idiographic dimensions (Fiore, 2004). The nomothetic dimension includes indirect factors or "forces that constitute the environment for the individual", while the idiographic dimension includes direct factors or the individual's "personality, individual beliefs, and need disposition" (Bess & Dee, 2008, p. 111).

Previous research evaluating female underrepresentation in science participation has focused on a variety of factors including biological characteristics driving achievement.

Although biological differences clearly exist, research has not shown that these inherent differences correspond to a predisposition leading to an intellectual advantage, which may ultimately influence intention to major in science (Halpern, 2004; Spelke, 2005). Further evidence that biological differences do not appear to be the direct cause of female underrepresentation in science can be found in the international standardized tests, such as the Trends in International Mathematics and Science Study (TIMSS) and the Programme for International Student Assessment (PISA). Both show that females are improving their achievement scores in respective assessments, and gaps have narrowed or no longer exist (OECD, 2007, 2012; TIMSS; Martin et. al., 2012). According to OECD (2012), "no gender gap in science performance" is observed (p. 45) and as per Martin et al. (2012), minimal gender difference in science achievement was reported in the TIMSS 2011 assessment (p. 65).

The noted science achievement increases among females and persisting underrepresentation of women in science suggest that "sex-linked cognitive differences", as discussed by Archer (1996), are not alone significant in affecting or even precluding a female's choice to major in science and other factors, such as those with an environmental origin, may be important attributing agents (as cited in Brownlow, Smith, & Ellis, 2002, p. 136). A review by Tindall and Hamil (2004) suggest female science underrepresentation is the result of factors "environmental in nature" (p. 282). It was also further acknowledged in a study on choice of major that males and females with similar ability "may differ dramatically in their preferences for different types of occupations or courses of study" (Turner & Bowen, 1999, p. 295). Moreover, OECD (2012), examining females with the highest performance on the PISA 2006 science assessment, noted that these females did not expect to major in a science or engineering field, and in fact, their career aspirations were similar to females who did not score in the highest tier (p. 75). The question is why, and can the factors that are influencing females to choose science as an intended major of study be identified and evaluated so that the supply side of female scientists can increase or, at least, be on par with males?

From literature, specific experiential factors emerged as influential in a female's intention to choose science as a major in college. It appears that a female's intention to major in science is the result of several direct or internal factors that are shaped by indirect or external factors involving parent, teacher, and peer influence. The direct factors concern the female student herself inclusive, for example, of her science self-concept, science attitude, and science interest. It is also possible that the direct and indirect factors interact with one another. From literature, there appears to be a host of experiences that girls have that constitute a collective "transforming experience," inclusive of parental support, teacher encouragement, hands-on science activities, peer acceptance, and having had a science role model (Besecke & Reilly, 2006, abstract). Ultimately, a female's intention to major in a science field appears to be the outcome of a multitude of experiences, from as early as birth up to and including 12th grade, that form a female's sense of self comprising her "conceptions, predispositions, and expectations" (Turner & Bowen, 1999; Ware et al., 1985, p. 82).

Since the factors identified through a broad literature review seemed best described through a combination of the biopsychosocial model and the Getzels and Guba model, the present study proposed an integrated model that combined the components of both models. In this proposed conceptual model, the system includes the female high school student and direct or internal factors inclusive of her science self-constructs along with the indirect factors or "forces" considered to be external to her, comprising her environment, which encompasses her parents, school, and peers (Bess & Dee, 2008, p. 111). All components of the system are interconnected

(Fiore, 2004, p. 119); therefore, in this case, they affect the observed behavior of the female high school student, which is intention to major or not to in science (Fiore, 2004). Getzel also subsequently worked with Herbert Thelen, and together they suggested the idea of culture and its possible influence on a system (Fiore, 2004). In the revised model, this idea can be further extended in the contemplation of a country's influence on an individual's behavior. More specifically, a female's country of origin and therefore culture may "mediate the nomothetic and idiographic dimensions" and as a result, affect an individual's observed behavior, which involves the choice to intend to major in science (Fiore, 2004, p. 119). An extension of this suggested cultural influence includes the idea that for a particular country or region of countries, the nomothetic (external or indirect influences) or idiographic (individual's self or direct influences) dimension could be emphasized and more strongly influence a female's intention to choose science as a major. The conceptual framework is further discussed and the revised model is presented in Chapter 2.

Research Design

Based on the proposed conceptual framework, the constructs used in the research model include parent, school, peer, and personal influences. Similar to the Ware and Lee study (1988), each construct is inclusive of a "group of variables" (p. 596), which the literature has shown are important factors that could be influencing a high school female's intention to major in a science field. This study explored the factors that influence a female's intention to major in a science field by analyzing the secondary dataset of the Organization for Economic Co-operation and Development (OECD) 2006 PISA. PISA included students 15 years of age and therefore near the end of required education (OECD, 2007, p. 16). Science was a major domain in the 2006 PISA. In addition to science performance, the 2006 PISA collected attitudinal data specific to science, regarding students, parents, schools, and peers (OECD, 2007, p. 122). This study's direct and indirect factors were aligned with PISA 2006 indices. The PISA 2006 data set is also a large international data set inclusive of approximately 400,000 students from 57 participating countries (OECD, 2007, p. 19), which facilitates a global analysis. Regression analysis was performed to determine the relationships among variables within the constructs on the response variable, which is a female's intention to study science in postsecondary school.

Significance of Study

The findings of this study will provide a better understanding of the factors that influence a female's intention to major in science and provide valuable insight on how these factors may develop as a female progresses through her science educational pipeline. This information can help parents, educators, and policymakers gain needed awareness of the factors that affect a female's intention to major in a science and assist in the development of specific strategies to facilitate female science choice as well as increase field participation and subsequent number of female scientists. Findings will also address factors influencing a female's intention to major in science globally. For those countries reporting low female science participation rates, this information could provide additional knowledge on contributing factors that will help develop strategies to remedy the underrepresentation that may persist in science. According to the OECD, "policy makers need to pay due attention to ensuring that their countries are well prepared to be in the best position to achieve scientific excellence in the future" (2007, p. 113). This means recognizing fields of study and most needed jobs, such as in the sciences, and cultivating full participation by all, including women (UNESCO, 2007).

Ultimately, findings from this study may contribute to remedying the gender imbalance that persists among STEM fields in higher education and respective careers, which could assist countries seeking to fulfill respective labor shortages as well as remain scientifically competitive (OECD, 2007). In addition to identifying potential predictors of female science major choice, previous related studies do not appear to include a wide reaching international perspective. Evaluating a cross-country comparison will help determine if the factors influencing a female's intention to major in science are common and "applicable" across countries or perhaps, completely distinct (Hagger et al., 2010, p. 307). If country variation is noted, future studies may want to include an in-depth qualitative analysis inclusive of focus groups and individual interviews in one or more countries as determined by this study.

Dissertation Organization

Chapter 2 includes a broad and extensive review of literature over several decades to comprehensively identify the potential factors that influence a female's decision to intend to major in science. Based on reviewed literature, related frameworks are discussed, and a new conceptual model is presented. Chapter 3 includes the methodology, which employs the 2006 Programme for International Student Assessment (PISA; OECD, 2007) data set in which science was a major domain. Specific variables were identified to examine how the factors recognized in literature are related to a female's intention to major in science. Results of this quantitative study are compiled and presented in the results section in Chapter 4, which also includes a summary of findings. Lastly, Chapter 5 concludes with future research recommendations and implications for policy makers, inclusive of strategies to promote female participation.

CHAPTER 2

Literature Review

The underrepresentation of women in STEM fields is noteworthy given the fact that: (a) women constitute nearly half of the global workforce according to the International Labour Organization (2009), (b) few women are choosing a STEM field as a major of study in postsecondary education evident in many countries, (c) jobs requiring advanced degrees in the STEM fields continue to increase, and (d) respective professions are needed to address many of the problems facing societies worldwide. Specific to science, the root cause(s) facilitating the overall underrepresentation of women is presumed to have occurred early in females' educational experiences prior to postsecondary schooling (Muller, Stage, & Kinzie, 2001; Rayman & Brett, 1995; Sax & Harper, 2007; Ware & Lee, 1988; Ware et al., 1985). Studies have identified that although originally nearly equal with males when in grammar school, females' positive science attitudes lessen in middle and high school (Adams, 1996; Catsambis, 1995; George, 2000, 2003). Ware and Lee (1988) suggested that a "precollege orientation toward science" has an effect on whether a student will intend to choose science as a college major (p. 603). It is also of importance to note that student outflow from the science pipeline metaphor is far greater just before entering college than when in college (Hill et al., 2010, p. 5; Hilton & Lee, 1988, p. 523), making college science attrition seemingly a less significant factor when attempting to understand female science underrepresentation.

The critical question includes what factors influence this "precollege orientation toward science" prior to postsecondary studies (Ware & Lee, 1988, p. 603). Examining a female's pipeline symbolic of her science education and experiences through the primary, middle, and high school or secondary years is imperative to determine the factors of possible influence in regard to a female's intention to major in science (Maple & Stage, 1991). Given the persisting gender difference in science participation across many countries, it is critical to explore if factors causing the difference specific to intended science career aspiration could be determined. This would provide the understanding needed to formulate specific support, which has been called for by education policies worldwide (European Commission, 2002; OECD, 2007, 2012; PCAST, 2010; Sahlberg, 2006; UNESCO, 2007; van Langen & Dekkers, 2005). The purpose of this literature review, therefore, was to identify all possible factors influencing a high school female student's intention to major in science, which was completed by a broad literature review comprising an extensive review of literature over the past four decades. Choosing the previous 40 years as a frame of reference may seem wide-ranging; however, it is the 1970s, with the enactment of Title IX, which stimulated significant interest in women's studies as well as an increase in related research. Drawing upon a significant body of research, this chapter presents a discussion on gender differences in science, citing contributing factors that affect a female's intention to major in science and highlights relevant data from well-respected international assessments to shed light on the closing achievement gap in science. It also includes a framework by which the influencing factors can be explained.

Females' Intentions to Major in Science: Influencing Factors

Internal factors inclusive of female student herself. Descriptors of "self" include self-concept, attitude, interest, perception, efficacy, and anxiety. Self-constructs include a variety of self-descriptors that may not be easily discernible due to their close association with one another and their interconnectedness (Lee, 2009). Self-concept appears to develop early in a child's life. Studies have shown that parents' expectations in their child's ability are significant and can determine the children's self-concept of their own science ability (Bleeker & Jacobs, 2004;

Eccles, 1994; George, 2000). This is compounded by the fact that parents may not expose their daughters to as many science experiences that they may offer to their sons (Burkam, Lee, & Smerdon, 1997, p. 302; Simpson & Oliver, 1990). Young girls, therefore, lack many of the early childhood science experiences that boys have and may feel insecure about science later in adolescence. Chapman, Tunmer, and Prochnow (2000) inferred that the construct of self-concept is formulated by the first few years of entering school. By the middle school years, girls have even fewer science experiences and feel additionally insecure, which has been shown to impact science participation (Simpkins, Davis-Kean, & Eccles, 2006). Strenta, Elliot, Adair, Matier, and Scott (1994) observed low science self-confidence among high ability female students in higher education. Female students may also have negative moments, in regard to science participation, which could affect their science self-concept and ultimately deter learning potential (Bleeker & Jacobs, 2004).

Science self-concept appears to be an important determinant of science attitude (George, 2000) and ultimately, science participation (Simpson & Oliver, 1990). Research has shown that science attitude has the potential to predict the choice of science careers for both female and male college students and verifies that its strongest predictor is science self-concept (George, 2000). When asked about science, females rate themselves lower in achievement, maintain a lower self-confidence, and display a lower positive attitude toward the discipline relative to male students.

While science self-concept appears to be a significant predictor of science attitude, science attitude appears to be a predictor of science interest (George, 2000). A study on science attitude established that a negative attitude for a particular subject could result in declined interest (Trumper, 2006). Simpson and Oliver (1990) reported that maintaining a positive science attitude “leads to a positive commitment to science that influences lifelong interest and learning in science” (Simpson & Oliver, 1990, p. 14). Literature showed that middle school to college-aged females maintain less science interest and lack motivation to take science courses or aspire to pursue a science career compared with male students (Jacobs, Finken, Griffen, & Wright, 1998; Morgan, Isaac, & Sansone, 2001; Simpson & Oliver, 1990; Taasoobshirazi & Carr, 2008). Girls, therefore, are less likely to join science extracurricular activities and further lack these necessary enriching experiences (Kahle, Matyas, & Cho, 1985). Prior involvement in a science activity, such as a related field trip including a museum outing or working/volunteering in an associated field, was seen as an important factor influencing female students’ choices to major in a science field particularly among biology majors (Strenta et al., 1994). In fact, extracurricular science activities were observed as a positive influence on attitude and generally increased perception regarding the “utility of science” (George, 2003, p. 446), which is of significant concern to women especially if having a social and caring impact (Chiu, 2010; Chiu & Klassen, 2010; George, 2000; McDade, 1988; Morgan et al., 2001; Sax, 1994; Sax & Harper, 2007; Seymour, 1995; Strenta et al., 1994; VanLeuvan, 2004; Ware et al., 1985). Also of significance is the finding that female expressed interest in science was reported in one study, involving science-oriented females in a rural high school setting, as a more important predictor of science major choice than prior science exposure or parental influence (Jacobs et al., 1998). Without specific interest it seems unlikely that, when given the choice to choose a major, females will choose science.

Moreover, studies focusing on stereotype, such as how a scientist is portrayed in the media as unfeminine, have had a negative influence on a female’s motivation even if science interest is expressed (Stage & Maple, 1996; Taasoobshirazi & Carr, 2008). Female perception that science is a nontraditional career choice, which is often thought of as boring with minimal social engagement, seems to also discourage women from choosing science as a career interest (Stage & Maple, 1996; VanLeuvan, 2004; Taasoobshirazi & Carr, 2008). In fact, both male and female students often perceive a career in science as one that requires less interpersonal interaction while often being more financially lucrative and of higher status. A study by Morgan et al. (2001) emphasized that females rather than males reported a preference of interpersonal goals in regard to career choice and characteristics of high pay and status less. Ware and Lee (1988) likewise reported that socioeconomic status had a positive effect on science college major choice for males but not women (p. 606). Females identified orientations and attitudes towards learning science as a social responsibility as important factors in their consideration to major in science (Chiu, 2010; Sax & Harper, 2007; Seymour, 1995; Strenta et al., 1994; Taasoobshirazi & Carr, 2008). One study concerned with expression of science interest prior to college and attrition from a science program while in college reinforced a female student's interest in social issues. Strenta et al. (1994) found that when compared to men, female students, particularly biology majors, reported that a reason to choose science as a major involved affairs related to the general public, such as "national health problems like AIDS and cancer" (Strenta et al., 1994, p. 538). Sax and Harper (2007) conducted a significant research project to explain gender differences in college students using data collected from UCLA's Higher Education Research Institute. They confirmed "women's stronger orientation towards social activism", including helping others, social values and working in the community, and "men's higher status orientation" (Sax & Harper, 2007, p. 680). Ware and Lee (1988) using High School and Beyond (HS&B) data found that college "women in nonscientific fields place the greatest importance on future family and personal life" (p. 600). Potential female science majors may therefore have science interest, but due to the effect of potential future family responsibilities or related conflict, may not be choosing the field (Seymour & Hewitt, 1997; Stage & Maple, 1996; Ware & Lee, 1988).

Due to low science-self concept, negative science attitude, and lack of science experiences, it seems that low self-efficacy or belief in ability (Bandura, 1997) in regards to science and less science interest may predict science anxiety and a career choice other than science (Udo, Ramsey, & Mallow, 2004). It was assumed that the students exhibiting science anxiety would normally do well due to their science ability and work ethic; however, when present, science anxiety, particularly evident in females, serves as a "career filter" (Xie, 2005, p. 167; Udo et al., 2004, p. 435) preventing students from entering respective fields of study and certainly contributes to this underrepresentation (Udo et al., 2004). It is important to note that science anxiety presents itself early. Chiarelott and Czerniak (1987) conducted a study to measure science anxiety in Grades 4 through 9 and found science anxiety in females at age 9 was twice as much or higher than same-age males. Moreover, science participation choice and science anxiety interact negatively and that ultimately science anxiety drives "science avoidance" (Mallow, 1994, p. 234; Udo et al., 2004, p. 436).

External Factors

External factors inclusive of parent. Research has shown that one of the most important mediating factors determining whether a female student will pursue science as a career involves her parents (Jacobs et al., 1998; Rayman & Brett, 1995; Strenta et al., 1994). One critical component of parent influence in regard to science major intention involved sex-role gender-stereotypical beliefs. Jacobs and Eccles (1992), explained "*stereotypic beliefs* and *stereotypes*" refer to "category-based beliefs that are commonly shared by the population that are linked specifically to easily identifiable social groups such as males and females" (p. 932). A general role observation includes the statement that some occupations are considered masculine and others feminine and, for example, doctors are typically males and teachers females. Other generalizations have purported that men are typically assertive and females passive (Tindall & Hamil, 2004, p. 283). Such distinctions start early in a child's life and "exert large influences on male and female behavior" (Halpern, 2012, p. 260). From the moment of birth, gender reinforcement begins. When a baby girl is born, ballet, pink colors, and gentleness are envisioned, while the birth of a baby boy is associated with sports, blue colors, and toughness (Halpern, 2012). In fact, at the onset, girls appear to be discouraged from developing an interest in science. Boys, when young, are encouraged to play actively and are often given toys including cars, model kits, and building sets (Tindall & Hamil, 2004). All of these objects enforce principles of science as well as provide opportunities to develop problem-solving skills inherent to success in science (Tindall & Hamil, 2004). Girls frequently, however, lack these experiences, while being steered to other more quiet activities such as painting, writing, and playing with dolls (Jacobs & Eccles, 1992; Tindall & Hamil, 2004). In fact, a report verified a female's passivity by stating, "Young females are twice as likely to be inactive as young males" (AAUW, 1998, p. 6).

At a very young age, girls and boys already form a view of what comprises men's work and women's work. According to a study performed in the United Kingdom, girls tended to like science less and be discouraged from entering the profession due to "the social construction of science as masculine" (Breakwell, Vignoles, & Robertson, 2003, p. 437). Girls adhered to the generalization that science and related occupations, such as a scientist, are therefore masculine (Besecke & Reilly, 2006; Breakwell et al., 2003). Several studies employing a Draw a Scientist

Test (DAST), involving students kindergarten through Grade 12, supported the perception of science as a masculine subject (Chambers, 1983; Fort & Varney, 1989; Huber & Burton, 1995; Taasoobshirazi & Carr, 2008). Chambers (1983) concluded that the science stereotypic perceptions seemed to increase as students progressed from primary to secondary school (p. 264). Another such test by Fort and Varney (1989) found that only 135 of the 1600 students, Grades 2 through 12, drew a female scientist, and of the 135 female scientists drawings, “only 6 were drawn by males” (p. 9). Moreover, gender stereotype was prevalent in television, movies, computer programs, books, and fashion. Women scientists in the media are usually depicted uncharacteristically as “unsociable” and almost always as nerd-like (Brownlow et al., 2002 p. 141; Rayman & Brett, 1995).

It appears that an early female’s environment may not include the childhood science experiences that males have and supports numerous stereotypic influences. At a young age, parents play a critical part in developing a female’s gender role and her behavioral expectations, which have long-term implications. Parents’ choices and attitudes about toys, clothing, and activities can shape a female’s sense about herself. The influences of parental treatment, colors, toy selection, fashion, hair styles, and viewing science as a task that males did and art or writing as something females did, all reinforce and categorize the concept of gender role, which poses a real challenge to a female’s psychological development (Tindall & Hamil, 2004).

In addition to a parent’s sex-role gender-stereotypical belief, Bleeker and Jacobs (2004) found that parents’ confidence in a child’s ability is critical to a female having a science interest or career aspiration. Parents’ expectations in regard to their child’s ability can affect participation (Bleeker & Jacobs, 2004; Eccles, 1994) as well as general involvement (George & Kaplan, 1998). Jacobs et al. (1998) found, in a study of science oriented high school female students, "positive parent support" was important when considering a career in science (p. 699). Some parents, however, believe that science is different, and perhaps more difficult for daughters or "more important" for sons (Burkam et al., 1997, p. 302). This conceived notion influences their subsequent interaction with their child, which may lead to less related activities and therefore, less science exposure (Burkam et al., 1997). An interesting study completed by Seymour and Hewitt (1997) found that males decided to major in physics or engineering because of their high achievement in these courses. Women, on the other hand, noted that their choice to major in these disciplines was the result of parental support. A parent's belief that science is important and potentially leads to a stable career plays a significant part in influencing a daughter's choice to major in a science discipline (Seymour & Hewitt, 1997). Parent educational level (Ware et al., 1985; George & Kaplan, 1998) and whether employed in a science or technology career also positively affected a daughter's science career selection (Norby, 1997). Besecke and Reilly (2006) found that women with careers in science said that their parents did not necessarily support or not support their nontraditional career choice. Their families were instead overall supportive of their goals and exhibited a low degree of gender stereotyping, which appeared instrumental in their choice to major in a science discipline (Besecke & Reilly, 2006).

External factors inclusive of peer. Bordering a female's self-constructs, particularly self-concept, attitude, and interest can be various peer factors. In fact, a child becomes more aware of peers, and as a result, influenced as he or she ages (Eccles, 1999). In one study of group dynamics related to gender and science education, peer pressure and acceptance also played a role. A girl was, in a sense, perceived as "less feminine" if she liked science (Breakwell et al., 2003, p. 449; Kelly, 1985). In a group that did not have an interest in science, the girl who liked science may feel excluded (Breakwell et al., 2003, p. 450). Some feel peers are an important factor affecting science participation and likewise, these influences may contribute to girls feeling more insecure about expressing an interest in science (Barnett & Rivers, 2004; George, 2000; Jacobs et al., 1998; Lee, 2002; Sax & Harper, 2007). A student's science attitude is associated with peer science attitude (Simpson & Oliver, 1990). As a result, students can actually be deterred from being interested in science or even considering science as an area of study or career because of their peer group (Jacobs et al., 1998; van Langen & Dekkers, 2005). In fact, "attitudes held by peers toward science" may influence a female's science attitude more than parent or teacher (George, 2000, p. 251).

External factors inclusive of school. Schools have a critical role in ensuring that all students achieve their full potential. Studies acknowledged that the teacher is a strong influence in regard to student attitude (George, 2000, 2003; George & Kaplan, 1998; Strenta et al., 1994; Ware & Lee, 1988). George and Kaplan (1998) found that teacher influence was significant in fostering a positive science attitude. Ware and Lee (1988), analyzing the High School and Beyond (HS&B) database, found high school teachers were a significant influence to females in making plans to choose science as a major and can in fact affect female science persistence once in college (pp. 592–600, p. 605). A field study involving women and men working in a science profession noted that women, but not men, credited their teachers and college professors as reasons why they maintained an interest in science and aspired to study science (Besecke & Reilly, 2006). Moreover, in a study conducted to ascertain women's views on classroom participation, it was found that the teacher is essential in fostering the necessary environment that facilitates learning (Salter, 2003; Salter & Persaud, 2003). Other studies confirmed the critical role that teachers play in providing the needed attention and vital support, which could negatively or positively affect a female's decision to participate in science (Strenta et al., 1994). Teachers were often cited as role models who provided the necessary support to pursue a goal in science even when potential barriers were noted, such as family discouragement, gender stereotypes, or concerns in regard to peer acceptance (Besecke & Reilly, 2006).

Simpson and Oliver (1990) reported that the classroom, specifically, was an important predictor of female science participation. Therefore, even with increases in female science achievement observed among specific standardized tests (OECD, 2007, 2012; TIMMS; Martin et al., 2012), the condition or environment of a female student's learning experience must be considered (Salter & Persaud, 2003). In regard to participation in class, one study highlighted the notion of female students having a "perceived fit" in the classroom, which may or may not prompt class contribution (Salter, 2003, p. 113; Salter & Persaud, 2003, p. 833). Using the Myers Briggs Type Indicator (MBTI), the learner's classroom perception ("thinking or feeling") was related to gender differences, which may dictate the extent of female participation in the classroom (p. 832). In prior work, Persaud (1999) found that a female student valued "feeling-oriented classrooms" where the instructor was described as personable compared with "thinking classrooms" where competition and apprehension were observed (as cited in Salter, 2003, p. 113). Salter and Persaud (2003) concluded that classrooms that were adapted to thinking rather than feeling failed to facilitate female participation (p. 836). Female science undergraduate majors preferred teachers who were "approachable" and "friendly" (Seymour, 1995, p. 465) as well as "supportive" (Lee, 2002, p. 366). Several studies found that teacher-led instruction negates female student learning (Eccles, 1994; Strenta et al., 1994). In a case study reviewing adolescent female leadership, surveyed teachers reinforced the female learning preference to work cooperatively in groups (Frawley, 2005, p. 225). Female students often feel a sense of community when immersed in a collaborative learning environment. In fact, female students reported that a collaborative learning environment is nonthreatening and easier to get involved or "assume leadership roles", which promotes self-confidence (Frawley, 2005, p. 225; Guzzetti & Williams, 1996; VanLeuvan, 2004).

Hands-on activities appeared to be critical to female science learning in both middle and high school and can even make up for less science exposure outside of school (Burkam et al., 1997; Kahle & Rennie, 1993). Several studies have reported that males are more likely than females to be actively involved in performing lab work (Burkam et al., 1997; Guzzetti & Williams, 1996; Jones & Wheatley, 1990; Mallow, 1994). In fact, male students were more likely to be completing the experiment while female students would quietly proceed in another role perhaps involving note taking or drawing. This, unfortunately, is not beneficial to female engagement in science. Burkam et al. (1997) also reported that "active involvement in lab work is more critical than the quantity of lab work" (p. 322). According to Seymour and Hewitt (1997), females are less confident in performing lab activities than males. It may even be beneficial, therefore, to occasionally implement single-sex grouping for some activities, especially with laboratory experimentation and activities (AAUW, 1992; Guzzetti & Williams, 1996). Females may participate more and would be least likely to defer actions to their male counterparts requiring laboratory equipment, such as having the male in the group perform the anatomy dissection or work to focus the microscope while the female looks on or records respective data (Guzzetti & Williams, 1996, p. 42; Jones & Howe, 2000; Tindall & Hamil, 2004). This group dynamic would counteract the hierarchical socialization pattern often exhibited when male students are paired with female students in small groups and instead facilitate collaboration (Guzzetti & Williams, 1996). Having females engaged in lab tasks would also increase their science exposure and respective self-confidence (Guzzetti & Williams, 1996; Seymour, 1995). The differences in male-female learning styles should be a consideration of classroom teachers to recognize certain learning preferences and maximize instruction (Guzzetti & Williams, 1996; Salter & Persaud, 2003; Tindall & Hamil, 2004).

Teachers' habits affect classroom environments and must take into account female self-esteem (Tindall & Hamil, 2004). Research has shown that teachers give more attention to male students than females at both the elementary and high school level (Sadker & Sadker, 1986, 1994). Specifically, teachers call on male students more often to answer class questions (AAUW, 1992; Frawley, 2005; Jones & Wheatley, 1990; Mallow, 1994). In addition, male students have been observed to quickly provide answers without being called on as well as volunteer assistance and therefore, often govern class discussion (Frawley, 2005). Female students, on the other hand, talk less frequently in the classroom and are potentially acknowledged less often by teachers with attention and praise (Frawley, 2005; Sadker & Sadker, 1994). While a female student sits quietly waiting to be called upon, a teacher may then select a male student more regularly, which could potentially lower female self-confidence and discourage subsequent participation (Frawley, 2005; Sadker & Sadker, 1994).

Factors Concerning Country Influences

OECD elaborated further acknowledging for all students that science attitudinal influences, in addition to peers, include the "culture of the school, their home and family culture and more generally their national culture" (OECD, 2007, p. 125). Literature and studies recognizing culture as a factor influencing female science participation or another STEM field appeared limited. Studies acknowledged both the importance and rarity of cross-cultural research associated with self-constructs, a predictor of female intention to study science postsecondary (Chiu & Klassen, 2010; Lee, 2009). It was suggested that self-constructs form through reflection, which may develop from different perspectives across cultures (Klassen, 2004; Schaubroeck, Lam, & Xie, 2000). Respective views could result in different career goals, which are associated with intention to participate in a certain major (Lent, 2005). Chiu and Klassen (2010) evaluated if culture influenced achievement and if math self-concept was related. Findings from 34 countries did not show that math performance was associated with culture, but instead a country's economic status. For example, students with high math self-concept had high math achievement and were predominately from countries with higher socioeconomic status (Chiu & Klassen, 2010, p. 9). In a similar study involving math self-beliefs from 41 countries, differences were noted among Asian and Western European countries (Lee, 2009). Specifically, self-beliefs (math self-concept and efficacy) were low but math anxiety high in Asian countries demonstrating high math achievement, and in Western countries high math achievement was countered by low self-beliefs and anxiety (Lee, 2009, p. 364).

Moreover, Hofstede (1980) completed extensive research involving cultural groups and their varying characteristics, which led to his identification of "dimensions" or categories particular of a certain country (as cited in Robertson & Hoffman, 2000, p. 34). Two of the dimensions Hofstede described include the individualistic and collectivist cultural orientations from the Western or Eastern region, respectively (as cited in Robertson & Hoffman, 2000; Schaubroeck et al., 2000). Specifically, high self-efficacy can be associated with an individualistic or Western culture and low self-efficacy with a collectivistic or Eastern culture (Klassen, 2004). The idea is that different countries may have different values, which could translate into future studies and career aspirations. For example, individuals from a collectivistic culture may feel a strong obligation to their family and or a specific group, which could result in a stronger external influence subsequent to career choice rather than one's own intrinsic interest (Fouad et al., 2008; Lee, 2009). Another study concerning how personal, contextual, and cultural variables affect career choices of Asians Americans found that culture in addition to family background and self-efficacy are strongly considered when occupational choices require contemplation (Tang, Fouad, & Smith, 1999).

Although there appeared to be few studies regarding culture's impact on female science participation, culture was recognized as an influencing factor due to globalization, and as a result, it was difficult to discount its reach when determining those factors considered influential by a female in regard to science intention. Culture, however, is multidimensional, and further studies may need to narrow the scope to effectively categorize its impact. For example, self-belief constructs, such as self-efficacy and concept, are characterized as "academic-motivational constructs", which are not only influenced by society but also by the "educational environment of countries" (Lee, 2009, p. 363). As a result, the self-beliefs constructs as well as other predictors of female intention to study science postsecondary may be interpreted differently across cultures due to their inherent education systems (van Langen & Dekkers, 2005), which according to OECD (1999), vary from one country to another.

Factors Concerning Biological Influences

The gender disparities in science participation, in terms of intention to major in science, have been explained in literature by environmental stimuli and at times, biological influences particularly when performance is discussed. Biological differences, specifically those brain-based according to the literature, have been discussed in regard to processing (Geiger & Litwiller, 2005; Gurian & Stevens, 2004; Halpern et al., 2007). Moreover, the human brain exhibits sexual dimorphism (Giedd, 2005; Norden, 2007, p. 117).

In essence, there are inherent differences in the male and female brain, which may underscore male and female learning (Norden, 2007; Halpern et al., 2007). It has been suggested that males, having a larger spatial memory, could process more of a diagram's information and therefore make additional inferences in regard to accompanying text (Geiger & Litwiller, 2005). Jensen's work in 1998 (as cited in Halpern, 2004) involving a review of cognitive-achievement tests seemed to validate this finding. Jensen (1998) observed more males demonstrate visuospatial skills, while females showed more verbal and long-term memory ability (as cited in Halpern, 2004). Other studies have likewise shown that spatial ability is a skill more often seen in males (Brownlow, McPheron, & Acks, 2003).

Although biological differences in regard to the brain exist, they did not appear to correspond to a predisposition leading to an advantage intellectually, which may ultimately influence science participation (Halpern, 2004; Spelke, 2005). After studying numerous cognitive-achievement tests, Jensen (1998) concluded that there are "no overall sex differences in intelligence" (as cited in Halpern, 2004, p. 136). A Harvard University study on sex differences related to math and science also reported, "Men and women have equal aptitude for mathematics and science" (Spelke, 2005, p. 956). Moreover, further evidence that biological differences do not appear to be the direct cause of female science underrepresentation can be seen in highly reviewed international standardized tests, such as the Trends in International Mathematics and Science Study (TIMSS) and the Programme for International Student Assessment (PISA). Both show that females are improving their achievement scores in respective assessments, and gaps have significantly narrowed (OECD, 2007; TIMSS; Martin et al., 2012). The 2006 PISA science performance measures were nearly equal for most OECD countries (OECD, 2007). According to OECD (2007), "only the United Kingdom, Luxembourg, Denmark, the Netherlands, Mexico, and Switzerland" showed a slight increase for males, and "Turkey and Greece", a slight increase for females (p. 61). The 2009 PISA reported no gender difference in science performance (OECD, 2012). The 2006 PISA results involving the "future-oriented science motivation variable" (OECD, 2007, p. 113) also confirmed that strong science performance results alone do not ensure participation in science. In fact, for all OECD countries, "nearly twice as many males as females in OECD countries are graduating with science degrees" (OECD, 2007, p. 61).

The Influence of the Environment on Biological Factors

Since science performance is fairly equal among genders in highly reviewed international assessments and female underrepresentation persists, other factors when considering a female's intention to major in science, must be considered more critically (Bleeker & Jacobs, 2004; Brownlow et al., 2002, p. 136). Factors such as those involving a female's environment are likely significant (Bleeker & Jacobs, 2004; Tindall & Hamil, 2004). Biological differences specific to the brain cannot, however, be completely discounted. Genova (as cited in Sax & Harper, 2007) suggested, "nurture" influences "nature" (p. 670). Halpern et al. (2007) stated, "nature and nurture are integrally and reciprocally linked and cannot be separated" (p. 21). It appeared that it is not so much the innate differences that may be causing the underrepresentation in science, but that the underrepresentation created by environmental experiences (Tindall & Hamil, 2004) can be explained through these biological structures and how they function, particularly in the brain. In fact, the brain matures at different rates (Giedd, 2005) and throughout life, is shaped by the environment (McEwen, 2005). Halpern et al. (2007) concurs that the "human brain development is altered by life experiences" (p. 3).

The brain, specifically influenced by experience, demonstrates how learning, and subsequently intention to major in science, can possibly be affected. Females can report a lack of self-confidence in the area of science, which develops through their adolescence with alienation, at times, beginning fairly early in a female's life. Factors such as childhood environment, family support and perceptions, science extracurricular activities, and classroom experiences can profoundly influence a female's science self-perception and respective participation. Researchers have found that stereotypic views could affect science attitude as well as achievement. In one study, when a science test was administered and females maintained the opinion that they were not as good as males in science, they performed more poorly than males. This was in contrast to when female students were told that the test was gender equitable, which resulted in equal achievement (Schmader, 2005). Another example of the effect of environmental influences on the brain involved learning in the classroom. If a student feels an emotion toward the lesson, thinking and synthesis can be adversely affected if the emotion is negative. For example, if a female student feels that she cannot learn the material being instructed, she may actually deter learning (Gurian, Henley, & Trueman, 2001, p. 19; Norden, 2007). These negative moments are processed by a specific area in the brain responsible for emotion and may, in fact, be interpreted negatively and even as "fear" (Gurian et al., 2001; Norden, 2007, p.111). It has been found that positive emotions help with recalling situations and learning, while negative emotions may inhibit memory and therefore, learning from happening (Norden, 2007).

The brain was described as a "plastic" (Halpern, 2012, p. 375; McEwen, 2005; Norden, 2007, p. 139) structure, capable of changing, which "underlies learning and memory" (Halpern et al., 2007; McEwen, 2005; Norden, 2007, p. 104;). This concept was evident in a study by cab drivers whose profession requires visuospatial skills. Maguire et al. (as cited in Halpern, 2005) showed that cab drivers had a larger area of the brain, when compared to a control group of individuals not employed as cab drivers (Halpern, 2005, p. 116). In fact, this study showed a positive relationship with the size of the brain area responsible for this skill and the years worked as a cab driver (Halpern, 2005, p. 116). This study seemed consistent with the findings that the male brain, which is already pronounced in the brain region responsible for spatial reasoning, can be further developed through specific experiences. Another study, supporting the brain's characteristic plasticity in regard to spatial ability, involved college science background and highlighted the existence of innate skills, which have the capacity to develop when practiced (Brownlow et al., 2003). Research showed that males, with minimal science background outperformed females on mental rotation tasks likely demonstrating their inherent ability. However, males and females with equal science training, specifically involving a chemistry background, performed similarly (Brownlow et al., 2003). In fact, Kass, Ahlers, and Dugger (1998) observed that through training and practice, spatial ability could be enhanced. The concept of brain plasticity (Halpern, 2012; McEwen, 2005; Norden, 2007) along with task exposure or practice could also, in part, explain why the gap in science achievement among females has narrowed (Halpern et al., 2007; OECD, 2007, 2012). Likewise, perhaps students with a lack of science exposure and therefore, lack of skill development may contribute to a female's negative reported self-concept and infrequent choice of participation (Brownlow et al., 2003; Simpson & Oliver, 1990). In fact, Seymour (1995) reported that female students have fewer hands on experiences, which resulted in "fears about incompetence" (p. 451).

Incorporation of Frameworks

Halpern's biopsychosocial model. The difference in science achievement and participation has been explained throughout the years by both biological accounts and environmental influences, which in part appear to surmise the nature vs. nurture hypotheses. As a result, this premise of gender differences, in regard to intention to major in science, appeared to be related to the biopsychosocial model postulated by Diane Halpern (2000). This framework suggested that differences among genders are likely the result of biological and environmental factors that continuously influence one another (Halpern, 2000, 2004, 2005). According to Halpern (2004), "Nature and nurture alter each other in sequentially interacting ways" (p. 138).

Getzels-Guba model. Another model, which appears in part to explain the premise of gender differences in science, specifically a high school female's intention to major in a science, is the Getzels-Guba model put forth by Jacob Getzels and Egon Guba, which is representative of social systems theory. Their work involved a social system model inclusive of the nomothetic and idiographic dimensions (Fiore, 2004). In Bess and Dee (2008), the nomothetic dimension is said to include "forces that constitute the environment for the individual" (p. 111) and the idiographic dimension the individual and related "personality, individual beliefs, and need disposition" (p. 112).

Revised model females' intentions to major in science. From literature, specific factors emerge as influential in a female's intention to choose science as a major in college and appear best understood by connecting attributes of Halpern's biopsychosocial model with Getzels-Guba social system model. It appeared that a female's intention to major in science is the result of several direct factors, suggestive of the idiographic dimension, that are shaped by indirect factors, suggestive of the nomothetic dimension, involving parent, teacher, and peer influence. The direct factors concerned the individual herself inclusive of her science self-concept, science attitude, and science interest. As per the literature, science self-concept can be a strong predictor of science attitude, which in turn can greatly influence science interest and participation (George, 2000). It is also likely that the direct and indirect factors interact with one another. Ultimately, a female's intention to major in a science field appears to be the outcome of a multitude of experiences, from birth up to and including 12th grade, that form a female's sense of self, comprising her "conceptions, predispositions, and expectations" (Turner & Bowen, 1999; Ware et al., 1985, p. 82). Moreover, critical events in a female's adolescence determine the ultimate behavior, which in this case is intention to major in science.

As a result, a female's intention to major in science seems best explained by a combination of frameworks. The conceptual model directing this analysis is based on Halpern's biopsychosocial model highlighting biological and environmental factors that continuously influence one another (Halpern, 2000, 2004, 2005), and the Getzels and Guba model, which stresses the individual and the influences of the external environment and how both ultimately determine the observed behavior (Bess and Dee, 2008), which in this case is the intention to study science postsecondary. Halpern's biopsychosocial model was incorporated within the vision of the Getzels and Guba model to produce an adaptation and new postulation of the factors influencing a female's intention to major in science. Figure 1 depicts the hypothesized model, which serves as a guide for this analysis.

In this model, the system includes the female high school student's self-directed factors, inclusive of her science self-belief, attitude, and interest, along with the indirect factors or "forces" considered to be external to her, comprising her environment, which encompasses her parents, school, and peers as identified by the literature (Bess & Dee, 2008, p. 111). All components of the system, both internal (i.e., female student) and external (e.g., parent, school, peer), were identified through literature as having an influence on a female's intention to major in science. Components of the system may be interconnected and ultimately affect the observed behavior of the female high school student, which is intention to major or not to major in science (Fiore, 2004).

In this adapted model, a timeline was incorporated representing the contributing experiences, along the female's science educational pipeline, that influence her decision to intend to major in science. It was apparent from the literature that the factors affecting a female's intention to major in science and their manifestation begin early and predate college entrance

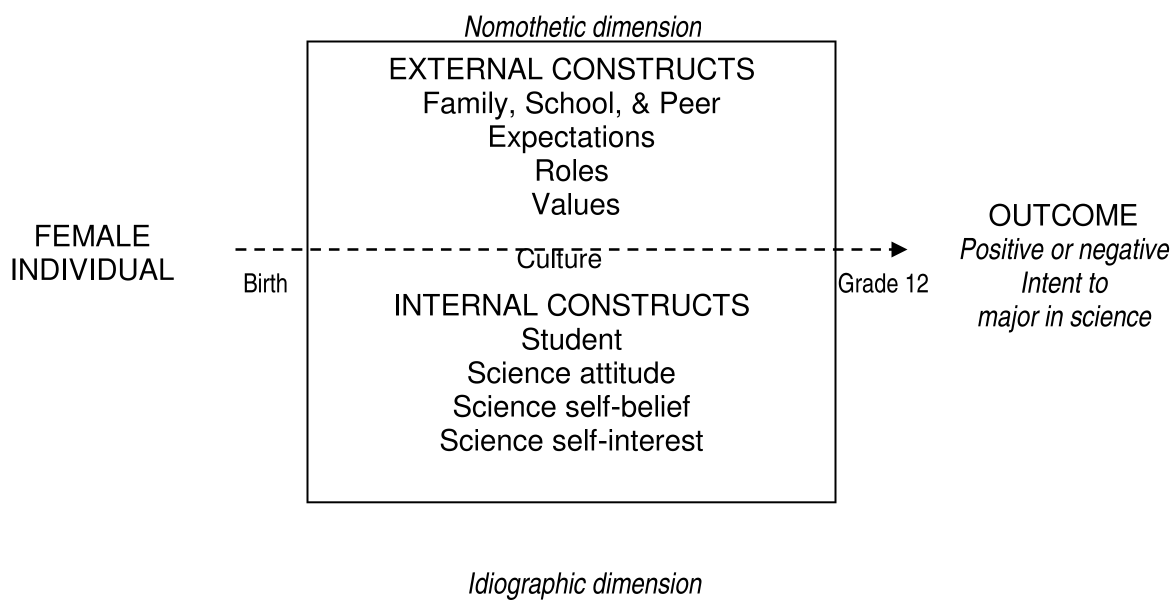

Figure 1. Hypothesized conceptual model. This hypothesized conceptual model describing the factors that influence a female's intent to major in science was formulated from reviewed literature and constructed based on Getzels and Guba social system model presented in Bess and Dee (2008 p. 112) and Halpern's biopsychosocial model. It also takes into account work by Getzels and Thelen involving the influence of culture (Fiore, 2004, p. 119). The adapted model depicts how females may process an experience due to events from birth up to and including 12th grade. These specific events, in turn, determine the response, which is intention to major in science.

(Muller et al., 2001; Sax & Harper, 2007). There appeared to be critical events in a female's adolescence inclusive of initiating events, which form a female's beliefs that later lead to the observed outcome, which in this case is the female student's behavior intending to study or not study science postsecondary. These consequences can stem, for example, from a negative science attitude resulting from having had fewer science experiences, which is evident in the middle school years. This lack of exposure can then fuel a female's decreasing confidence in science. Also, accumulating negative memories in science can provoke emotional responses. This emotion is likely integrated by the brain, which will then affect a future response to a similar experience. Norden (2007) describes this as "emotional memory" (p. 111). When a female student has low science self-concept, negative science attitude, and lack of science interest, as a result of the quality of experiences that she has incurred, it is unlikely that she will intend to major in a science field (Simpson & Oliver, 1990). How a female processes an experience due to key events is suggested to repeat during a female's science educational pipeline leading to the decision precollege to intend to major in science. In a sense, human experiences, as a result of brain interaction, "influence and guide future behavior" (Norden, 2007, p. 108).

Getzel also subsequently worked with Herbert Thelen and together suggested the idea of culture and its possible influence on a system (Fiore, 2004). In the revised model, this idea can be further extended in the contemplation of a student's country or culture's influence and individual's behavior. More specifically, a female's country of origin and therefore culture may "mediate the nomothetic and idiographic dimensions" and therefore in this case, affect an individual's observed behavior, which involves the choice to intend or not intend to major in science (Fiore, 2004, p. 119). As a result, the factor of culture is placed on the dotted line in the conceptual model and not within a nomothetic or idiographic dimension per se, which highlights the suggestion that it could integrate both dimensions to facilitate a female's intention to choose science as a major. Another suggestion, based on culture, includes the idea that for a particular culture, the nomothetic (external or indirect influences) or idiographic (individual's self or direct influences) dimension could be emphasized and more strongly influence a female's intention to choose science as a major.

Chapter 3

Methodology

Knowing the factors that influence females to intend to major in science is critical given the fact that fewer females than males: work as scientists, earn first university degrees in science, and study science in higher education, yet problems that require science to solve them appear to be the most pressing today. According to President Obama's February 2013 State of the Union address, "Now is the time to reach a level of research and development not seen since the height of the Space Race" (Obama, 2013). To have access to this career opportunity and fill the necessary jobs to support this call, women need to seek science education and training. In addition to the United States (PCAST, 2010), the European Union has set educational policy to increase the number of college graduates in mathematics, science, and technology (MST) and specifically to advance the number of participating females ("Researchers' Labour Market," 2006; van Langen & Dekkers, 2005, p. 330). According to data, however, there have been negligible increases overall (European Union, 2009; NSF, 2013).

Literature has identified various explanatory factors as possible influences to a high school female's intention to choose science as a major postsecondary. At one point, science performance was viewed as an influence; however, now that gender differences in science achievement are nearly equal as shown in the PISA 2006 assessment (OECD, 2007), or non-existent as in the PISA 2009 assessment (OECD, 2012), and disparities among female participation continue to persist, other reasons must be examined more critically. According to OECD, research suggests that science attitude may be involved in the reduced number of students studying science postsecondary (OECD, 2007). As recognized by OECD in the PISA 2006, a student's science viewpoint includes one's science "beliefs, motivational orientations, self-efficacy and values" (OECD, 2007, p. 39). Such observations were also present in literature and attributed to science participation (Besecke & Reilly, 2006; Brownlow et al., 2002; George, 2000, 2003; Taasoobshirazi & Carr, 2008; VanLeuvan, 2004; Ware et al., 1985). Moreover, a student's family, school, peers, and national culture further shape science disposition (Besecke & Reilly, 2006; George, 2000; Jacobs et al., 1998; OECD, 2007; Rayman & Brett, 1995; Simpson & Oliver, 1990; Strenta et al., 1994; Ware & Lee, 1988; van Langen & Dekkers, 2005; VanLeuvan, 2004). International surveys of primary-school-age children have shown relatively higher levels of science interest and more positive science attitudes than females in middle or high school (OECD, 2007, p. 122; TIMSS; Martin et al., 2012). Now more than ever it is important to uncover what could possibly explain the decline in interest, which could be impacting females' intentions to major in science so that policy makers concerned with the shortage of science professionals can develop strategies to alleviate this disparity and encourage females in science as they progress through their science educational pipeline (OECD, 2007, p. 122).

Many of the previous studies focused on a limited number of factors that could shape a female's future science interest, and few involved intention to major. Looking at a female's educational science pipeline, there are two critical junctures of science choice (van Langen & Dekkers, 2005, p. 330). One is intention of science major when in high school, and the other is commitment to science major while in college (van Langen & Dekkers, 2005, p. 330). Given the fact that the majority of pre-college females do not intend to major in a science related field (Hilton & Lee, 1988), it is essential to understand collectively what exactly influences this decision upstream from the decision to major in science when in college. Also, since women in science are underrepresented globally, it is important to include an international perspective. To help fill a gap in research, this study explored a comprehensive list of explanatory factors identified in literature as influential to a high school female's intention to choose science as a major utilizing a large international database.

Data

To understand why women are not choosing science as an intended major, the PISA 2006, with an emphasis on the science domain, was chosen as the source of analysis for this study. The focus of this study concerned why females are not choosing to intend to major in science. Factors involving the student, parent, school, and peer were identified from literature as important. National culture was also found to be a potential source of influence. Since the 2006 PISA concentrated on the science domain and collected attitudinal data related to science from students, parents, and schools in a wide range of countries, the PISA 2006 data set was used exclusively for this analysis. TIMSS is another large-scale international assessment; however, PISA collects information from students who are 15-years-old and close to the conclusion of their required education (OECD, 2007), while TIMSS primarily concentrates on 4th and 8th grade students (TIMSS; Martin et al., 2012). Also, while both collect data in regard to student attitude and school characteristics, only PISA includes parent information, which literature deemed as a potential influence to a female's subsequent study in science.

PISA is a comprehensive international assessment administered by the Organization for Economic Co-operation and Development (OECD, 2007). Its goal is to assess student general preparedness postsecondary (OECD, 2007, p. 3). Data were collected from the student, family, and schools (OECD, 2007). OECD member countries as well as many PISA partner countries were included. The assessment is given every 3 years. To date, five assessments have taken place in years 2000, 2003, 2006, 2009, and most recently in 2012. In addition to the standard questioning including reading, mathematics, and science performance, the PISA surveys have featured a concentration in one specific domain: reading in years 2000 and 2009, mathematics in years 2003 and 2012, and science in 2006.

The 2006 PISA, in addition to assessing student performance in reading, mathematics, and science, collected data in regard to student attitudes and motivations towards science (OECD, 2007). According to OECD, "PISA 2006 is the first international survey to consider science competency, student interests and attitudes towards science and school contexts jointly in an international context" (OECD, 2007, p. 32). The PISA 2006 assessment specifically collected attitudinal data to better understand a student's overall appreciation for science. Specific attitudinal areas evaluated included "support for scientific enquiry, self-belief as science learners, interest in science and responsibility towards resources and environments" (OECD, 2007, p. 40). The respective variables chosen by OECD for the PISA 2006 assessment were based on prior attitudinal research (OECD, 2007, p. 125). The PISA 2006 was administered to approximately 400,000 students at random in 57 countries (OECD, 2007, p. 19). The PISA 2006 assessment included students who completed "6 years of formal schooling" and were between the ages of "15 years and 3 months and 16 years and 2 months" (OECD, 2007, p. 22). A variety of institutions, both public and private, were involved in the assessment. Students provided data on their science attitude. School principals provided data on the school's make up, science instruction, and activities in addition to information reflecting student science attitude (OECD, 2007, p. 26). Parents gave their views on science issues and careers (OECD, 2007, p. 26). The parent questionnaire was optional, and only 16 countries chose to participate (OECD, 2009a, p. 448). As a result, the current investigation made comparisons collectively for all included countries and individually by country inclusive of Denmark (DNK), Germany (DEU), Iceland

(ISL), Italy (ITA), Luxembourg (LUX), New Zealand (NZL), Portugal (PRT), Korea (KOR), Turkey (TUR), Bulgaria (BGR), Colombia (COL), Croatia, (HRV), Hong Kong-China (HKG), Macao-China (MAC), and Qatar (QAT) (OECD, 2007, p. 28). Parent data were available from Poland (POL); however, due to insufficient results for several variables specific to this analysis, it was not included.

Student, parent, and principal attitudinal responses were primarily based on the Likert scale (OECD, 2009b, p. 36). For example, respective responses reported a *high interest*, *medium interest*, *low interest* or *no interest* or chose to *strongly agree*, *agree*, *disagree* or *strongly disagree* (OECD, 2007, p. 123). Indices created from individual questions were continuous (OECD, 2007, p. 332). Other variables involved a dichotomous response of yes or no or tick or no tick. As stated by OECD (2007), confirmatory factor analysis of the students' attitudinal responses was performed to "confirm the theoretically expected behaviour of the scales and indices and to validate their comparability across countries" (OECD, 2007, p. 125). To evaluate science performance, plausible values (PVs) were used, which are metrics representative of test scores (OECD, 2009a, p. 103; OECD, 2009b, p. 156).

Variables

The variables characterized the constructs based on the hypothesized model, which was described in Chapter 2 and appears in Figure 1. The independent variables are organized into two main groups: internal and external constructs. The internal construct includes relevant variables specific to the individual female student, and the external construct includes variables related to the female student's parent, school, and peer. The variables used in this analysis comprise an index of items when available or an individual item and appear as questions in the PISA 2006 student, parent, or school questionnaires (OECD, 2009a) or from the PISA 2006 science performance assessment. The PISA derived indices represent compiled responses to a group of questions from the student, parent, and school questionnaires, which were scaled and then standardized with a mean of 0 and a standard deviation of 1 (OECD, 2009b, p. 314). The student science performance values were also scaled with a mean of 500 and a standard deviation of 100 (OECD, 2009b, p. 158). Variables considered in this analysis are listed in Table 2.

Dependent variable. The dependent or response variable was an individual item indicating future oriented motivation to learn science. Specifically, it measures whether a 15-year-old female student is interested in studying science after secondary school. In other words, this variable measured whether students "intended to continue their interest in science" by choosing to study science in higher education (OECD, 2007, p. 148). Student responses were collected from the student questionnaire and included a 4-point scale reported as *strongly agree*, *agree*, *disagree*, and *strongly disagree*. In this study, this variable was collapsed coded dichotomously as *strongly agree or agree* (1) and *strongly disagree or disagree* (0). In the PISA data set, this variable is identified as ST29Q02 (OECD, 2009a, p. 456).

Independent variables inclusive of internal and external factors. ***Internal factors.*** *Student construct: Science attitude*. To assess a student's science attitude, the PISA 2006 evaluated student general appreciation of science and student personal opinion of the importance of science (OECD, 2007, p. 127). A component of the attitude category included students' value beliefs in regard to science. General value of science included how much 15-year-old students "value the contribution of science and technology for understanding the natural and constructed world and for the improvement of natural, technological and social conditions of life" (OECD, 2007, p. 127). Students' responses were collected from the student questionnaire and included a 4-point scale reported as *strongly agree*, *agree*, *disagree*, *strongly disagree*. The codes established by PISA included the following: *strongly agree* (1), *agree* (2), *disagree* (3), and *strongly disagree* (4). These codes, however, were inverted (reverse coded) in the construction of an OECD index for the general value of science (GENSCIE). The general value of science index was derived from the five items listed below, each followed by their respective PISA identification (OECD, 2009a, p. 457).

- Advances in <broad science and technology> usually improve people's living conditions. (ST18Q01)
- <Broad science> is important for helping us to understand the natural world. (ST18Q02)
- Advances in <broad science and technology> usually help to improve the economy. (ST18Q04)
- <Broad science> is valuable to society. (ST18Q06)
- Advances in <broad science and technology> usually bring social benefits. (ST18Q09)

Personal value of science includes the perception that science is individually important as per student opinion. Students' responses were collected from the student questionnaire and included a 4-point scale reported as *strongly agree*, *agree*, *disagree*, *strongly disagree*. The code established by PISA included the following: *strongly agree* (1), *agree* (2), *disagree* (3), and *strongly disagree* (4). These codes, however, were inverted (reverse coded) in the construction of an OECD index OECD for the personal value of science (PERSCIE). The personal value of science index was derived from the five items listed below, each followed by their respective PISA identification (OECD, 2009a, p. 457).

- Some concepts in <broad science> help me see how I relate to other people. (ST18Q03)
- I will use <broad science> in many ways when I am an adult. (ST18Q05)
- <Broad science> is very relevant to me. (STQ1807)

- I find that <broad science> helps me to understand things around me. (ST18Q08)
- When I leave school there will be many opportunities for me to use <broad science>. (ST18Q10)

This study also included a single variable self-do well in science (ST36Q01) measure, which further characterized a female's personal attitude towards science. PISA survey responses were recorded according to a 4-point scale reported as *very important*, *important*, *of little importance*, and *not important at all*. Codes established by PISA were recoded for purposes of this study and included *very important* (4), *important* (3), *of little importance* (2), and *not important at all* (1). The single item is listed below followed by its PISA respective identification (OECD, 2009a, p. 378).

- Self - Do well in science (ST36Q01)

Science self-belief. To assess student self-belief, PISA (2006) evaluated student science self-efficacy and science self-concept. A student's belief in his or her confidence (self-efficacy) or academic ability (self-concept) often renders a student's performance and future career goals (OECD, 2007, p. 133). Science self-efficacy includes the degree of confidence that students maintain that they can succeed in science due to "their own ability to handle tasks effectively and overcome difficulties" (OECD, 2007, p. 133). According to Bussey and Bandura (1999), self-efficacy is critical to taking on challenges, persevering, and sustaining the "motivation needed to succeed" (p. 687). Students were asked to evaluate how easily they could complete a particular science task (OECD, 2007, p. 134). Student responses were collected from the student questionnaire and included a 4-point scale reported as: *I could do this easily*, *I could do this with a bit of effort*, *I would struggle to do this on my own*, *I couldn't do this*. The codes established by PISA included the following: *I could do this easily* (1), *I could do this with a bit of effort* (2), *I* *would struggle to do this on my own* (3), and *I couldn't do this* (4). These codes, however, were inverted (reverse coded) in the construction of an OECD index of self-efficacy (SCIEEFF), which was derived from the eight items listed below, each followed by their respective PISA identification (OECD, 2009b, p. 322).

- Recognize the science question that underlies a newspaper report on a health issue. (ST17Q01)
- Explain why earthquakes occur more frequently in some areas than in others. (ST17Q02)
- Describe the role of antibiotic in the treatment of disease. (ST17Q03)
- Identify the science question associated with the disposal of garbage. (ST17Q04)
- Predict how changes to an environment will affect the survival of certain species. (ST17Q05)
- Interpret the scientific information provided on the labeling of food items. (ST17Q06)
- Discuss how new evidence can lead you to change your understanding about the possibility of life on Mars. (ST17Q07)
- Identify the better of two explanations for the formation of acid rain. (ST17Q08)

Science self-concept includes the degree to which students believe that they can succeed in science due to "beliefs in their own academic abilities in science" (OECD, 2007, p. 133). According to Bleeker and Jacobs (2004), self-perceptions play an important role in career aspirations. Students reported how easily they could complete a particular science task. Student responses were collected from the student questionnaire and included a 4-point scale reported as *strongly agree*, *agree*, *disagree*, *strongly disagree*. The codes established by PISA included the following: *strongly agree* (1), *agree* (2), *disagree* (3), and *strongly disagree* (4). These codes, however, were inverted (reverse coded) in the construction of an OECD index of self-concept

(SCSCIE). The index of self-concept was derived from the six items listed below, each followed by their respective PISA identification (OECD, 2009b, p. 323).

- Learning advanced <school science> topics would be easy for me. (ST37Q01)
- I can usually give good answers to <test questions> on <school science> topics. (ST37Q02)
- I learn <school science> topics quickly. (ST37Q03)
- <School science> topics are easy for me. (ST37Q04)
- When I am being taught in <school science>, I can understand the concepts very well. (ST37Q05)
- I can easily understand new ideas in <school science>. (ST37Q06)

Science interest and motivation. This variable included the degree to which students express an interest in and motivation towards science. According to OECD (2007), "Research has shown that an early interest in science is a strong predictor of lifelong science learning and/or a career in a science or technology field" (p. 139). Moreover, "Interest in a subject can influence the intensity and continuity of student engagement in learning" (OECD, 2007, p. 140). To discern student science interest questions related to general science interest, science enjoyment, interest in learning science topics, and instrumental motivation were considered. An additional component to science interest involved students' participation in science-related activities. To demonstrate general science interest, students reported on their interest in various areas of science. Student responses were collected from the student questionnaire and included a 4-point scale reported as *high interest*, *medium interest*, *low interest*, and *no interest*. The codes established by PISA included the following: *high interest* (1), *medium interest* (2), *low interest* (3), and *no interest* (4). These codes, however, were inverted (reverse coded) in the construction of an index of general interest in learning science (INTSCIE). The index of general interest in learning science was derived from the eight items listed below, each followed by their respective PISA identification (OECD, 2009a, p. 455).

- Topics in physics (ST21Q01)
- Topics in chemistry (ST21Q02)
- The biology of plants (ST21Q03)
- Human biology (ST21Q04)
- Topics in astronomy (ST21Q05)
- Topics in geology (ST21Q07)
- Ways scientists design experiments (ST21Q07)
- What is required for scientific explanations (ST21Q08)

Science enjoyment is another characteristic measuring interest. According to research, science enjoyment is a predictor to science major (Ware et al., 1985) and science career choice (VanLeuvan, 2004). Student responses were collected from the student questionnaire and included a 4-point scale reported as *strongly agree*, *agree*, *disagree*, and *strongly disagree*. The codes established by PISA included the following: *strongly agree* (1), *agree* (2), *disagree* (3), and *strongly disagree* (4). These codes, however, were inverted (reverse coded) in the construction of an OECD index of science enjoyment (JOYSCIE). The index of science enjoyment was derived from the five items listed below, each followed by their respective PISA identification (OECD, 2009a, p. 456).

- I generally have fun when I am learning <broad science> topics. (ST16Q01)
- I like reading about <broad science>. (ST16Q02)
- I am happy doing <broad science> problems. (ST16Q03)

- I enjoy acquiring new knowledge in <broad science>. (ST16Q04)
- I am interested in learning about <broad science>. (ST16Q05)

Participation in related science activities was surveyed. Student responses were collected from the student questionnaire and included a 4-point scale reported as *very often*, *regularly*, *sometimes*, *never or hardly ever*. The codes established by PISA included the following: *very often* (1), *regularly* (2), *sometimes* (3), and *never or hardly ever* (4). These codes, however, were inverted (reverse coded) in the construction of an OECD index of science related activities (SCIEACT). The index of science related activities was derived from the six items listed below, each followed by their respective PISA identification (OECD, 2009a, p. 457).

- Watch TV programs about <broad science>. (ST19Q01)
- Borrow or buy books on <broad science> topics. (ST19Q02)
- Visit web sites about <broad science> topics. (ST19Q03)
- Listen to radio programs about advances in <broad science>. (ST19Q04)
- Read <broad science> magazines or science articles in newspapers. (ST19Q05)
- Attend a <broad science> club. (ST19Q06)

Student motivation in science was also included in this analysis. Student responses were collected from the student questionnaire and included a 4-point scale reported as *strongly agree*, *agree*, *disagree*, *strongly disagree*. The codes established by PISA included the following: *strongly agree* (1), *agree* (2), *disagree* (3), and *strongly disagree* (4). These codes, however, were inverted (reverse coded) in the construction of an OECD index for instrumental motivation to learn science (INSTSCIE). The index for instrumental motivation to learn science was derived from the five items listed below, each followed by their respective PISA identification (OECD, 2009a, p. 456).

- Making an effort in my <school science> subjects is worth it because this will help me in the work I want to do later on. (ST35Q01)
- What I learn in my <school science> subjects is important to me because I need this for what I want to study later. (ST35Q02)
- I study <school science> because it is useful to me. (ST35Q03)
- Studying my <school science> subjects is worthwhile for me because what I learn will improve my career prospects. (ST35Q04)
- I will learn many things in my <school science> subjects that will help me get a job. (ST35Q05)

External factors. *Parent construct.* There was an optional parent questionnaire. This study includes parent data specific to OECD member countries Demark, Germany, Iceland, Italy, Korea, Luxembourg, New Zealand, Portugal, Turkey and partner countries Bulgaria, Colombia, Croatia, Hong Kong-China, Macao-China, and Qatar. Parents provided information on a variety of science topics. One involved their responses to their child's past science activities when 10 years of age, which included a 4-point scale reported as *very often*, *regularly*, *sometimes*, and *never*. The codes established by PISA included the following: *very often* (1), *regularly* (2), *sometimes* (3), and *never* (4). These codes, however, were inverted (reverse coded) in the construction of an OECD an index of students' past science activities at age 10 (PQSCIACT). The index of students' past science activities at age 10 was derived from the five items listed below, each followed by their respective PISA identification (OECD, 2009a, p. 462).

- Watched TV programs about science. (PA02Q01)
- Read books on scientific discoveries. (PA02Q02)
- Watched, read or listened to science fiction. (PA02Q03)

- Visited web sites about science topics. (PA02Q04)
- Attended a science club. (PA02Q05)

Parents also provided information on their views on the importance of science learning, which included a 4-point scale reported as *strongly agree*, *agree*, *disagree*, and *strongly disagree*. The codes established by PISA included the following: *strongly agree* (1), *agree* (2), *disagree* (3), and *strongly disagree* (4). These codes, however, were inverted (reverse coded) in the construction of an OECD index of parent view on the importance of science learning (PQSCIMP). The index of parent view on the importance of science learning was derived from the four items listed below, each followed by their respective PISA identification (OECD, 2009a, p. 463).

- It is important to have good scientific knowledge and skills in order to get any good job in today's world. (PA04Q01)
- Employers generally appreciate strong scientific knowledge and skills among their employees. (PA04Q02)
- Most jobs today require some scientific knowledge and skills. (PA04Q03)
- It is an advantage in the job market to have good scientific knowledge and skills. (PA04Q04)

Parents provided information on their views on science career motivation. Parents responded yes or no. The codes established by PISA included the following: *yes* (1) and *no* (2). These codes, however, were inverted (reverse coded) in the construction of an OECD index of parent view on science career motivation (PQSCCAR). The index of parent view on science career motivation was derived from the four items listed below, each followed by their respective PISA identification (OECD, 2009a, p. 463).

- The child shows an interest to work in a <science related career>. (PA05Q02)
- They expect their child will go into a <science related career>. (PA05Q03)
- Their child has shown interest in studying science after completing <secondary school>. (PA05Q04)
- They expect their child will study science after completing <secondary school>. (PA05Q05)

Parents provided information on their general value of science, which included a 4-point scale reported as *strongly agree*, *agree*, *disagree*, and *strongly disagree*. The codes established by PISA included the following: *strongly agree* (1), *agree* (2), *disagree* (3), and *strongly disagree* (4). These codes, however, were inverted (reverse coded) in the construction of an OECD index of parent general value of science (PQGENSCI). The index of parent general value of science was derived from the five items listed below, each followed by their respective PISA identification (OECD, 2009a, p. 463).

- Advances in <broad science and technology> usually improve people's living conditions. (PA06Q01)
- <Broad science> is important for helping us to understand the natural world. (PA06Q02)
- Advances in <broad science and technology> usually help improve the economy. (PA06Q04)
- <Broad science> is valuable to society. (PA06Q06)
- Advances in <broad science and technology>usually bring social benefits. (PA06Q09)

Parents provided information on their personal value of science, which included a 4-point scale reported as *strongly agree*, *agree*, *disagree*, and *strongly disagree*. The codes established by PISA included the following: *strongly agree* (1), *agree* (2), *disagree* (3), and *strongly* *disagree* (4). These codes, however, were inverted (reverse coded) in the construction of an OECD index of parent personal value of science (PQPERSCI). The index of parent personal value of science was derived from the four items listed below, each followed by their respective PISA identification (OECD, 2009a, p. 463).

- Some concepts in <broad science> help me to see how I relate to other people. (PA06Q03)
- There are many opportunities for me to use <broad science> in my everyday life. (PA06Q05)
- <Broad science>is very relevant to me. (PA06Q07)
- I find that <broad science>helps me to understand the things around me. (PA06Q08)

Other questions and indices important to the parent construct include parent education level, socioeconomic status (SES), and parent occupation. Ware et al. (1985) found in their survey of college freshman that higher levels of parent education positively predicted female science major choice (p. 77). Contradictions were noted in regard to SES and female major choice. Using a large sample from the High School and Beyond (HS&B) data set, Ware and Lee (1988) found that socioeconomic status had a positive effect for male science major choice, but not for female (p. 606). Using data from the National Education Longitudinal Study (NELS:88), Trusty, Robinson, Plata, and Ng (2000) reported SES was a positive predictor in regard to female science and mathematics college major choice. However, Trusty (2002), also using NELS:88 data, found that SES had minimal effect on female science and mathematics major choice. Burkam et al. (1997) reported that socioeconomic status predicted science learning. Moreover, having a parent employed in a science-related career was observed to be a positive factor in female science choice (Norby, 1997). The 2006 PISA questionnaires included respective variables. Parent occupation information responses were compared to ISCO occupations designated as science oriented to create the variable representing either parent maintained a science-related career (OECD, 2009a, p. 451). The index of economic, cultural, and social status (ESCS) was constructed based on data concerning home possessions, higher parental occupation, and the higher parental education expressed as years of schooling (OECD, 2009b, p. 346). Respective variables, each followed by their PISA identification, are listed.

- Either parent science-related career as reported by student (SRC_E)
- Index of economic, social, and cultural status (ESCS)

Individual items involving source of learning specific to family were included as explanatory variables. OECD coding was maintained in this study and included selected or *tick* (1) or not selected or *no tick* (2). For the purposes of this analysis, the responses for no tick were recoded as (0). The items, followed by their PISA identification, are listed below (OECD, 2009a, p. 336).

- Sci info – photosynthesis (ST20QA5)
- Sci info – formation of continents (ST20QB5)
- Sci info – genes and chromosomes (ST20QC5)
- Sci info – climate change (ST20QE5)
- Sci info – evolution (ST20QF5)
- Sci info – nuclear energy (ST20QG5)
- Sci info – health (ST20QH5)

Peer construct. A student's peers were found influential in literature (George, 2000; Jacobs et al., 1998; Simpson & Oliver, 1990; van Langen & Dekkers, 2005). In PISA 2006, (OECD, 2007) the peer response translated into a peer's interest. Students provided a response concerning whether they learned a particular science content from their peers. OECD coding was maintained in this study and included selected or *tick* (1) or not selected or *no tick* (2). For the purposes of this analysis, the responses for no tick were recoded as (0). The peer variables, each followed by their PISA identification, are listed below (OECD, 2009a, p. 336).

- Sci info – photosynthesis (ST20QA4)
- Sci info – continents (ST20QB4)
- Sci info – genes (ST20QC4)
- Sci info – climate change (ST20QE4)
- Sci info – evolution (ST20QF4)
- Sci info – nuclear energy (ST20QG4)
- Sci info – health (ST20QH4)

School construct. Both students and principals provided information specific to schools and learning. School preparation for science-related careers was self-reported by students and included a 4-point scale reported as *strongly agree*, *agree*, *disagree*, and *strongly disagree*. The codes established by PISA included the following: *strongly agree* (1), *agree* (2), *disagree* (3), and *strongly disagree* (4). These codes, however, were inverted (reverse coded) in the construction of an OECD index of school preparation for science-related careers (CARPREP). The index of school preparation for science-related careers was derived from four items listed below, each followed by their respective PISA identification (OECD, 2009a, p. 459).

- The subjects available at my school provide students with the basic skills and knowledge for a <science-related> career. (STQ27Q01)
- The <school science> subjects at my school provide students with the basic skills and knowledge for many different careers. (STQ2702)

- The subjects I study provide me with the basic skills and knowledge for a <science-related career>. (ST27Q03)
- My teachers equip me with the basic skills and knowledge I need for a <science related career>. (STQ2704)

Student information on interaction in science teaching and learning was self-reported by students and included a 4-point scale reported as *in all lessons*, *in most lessons*, *in some lessons*, and *never or hardly ever*. The codes included the following: *in all lessons* (1), *in most lessons* (2), *in some lessons* (3), and *never or hardly ever* (4). These codes, however, were inverted (reverse coded) in the construction of an OECD index science teaching and learning with a focus on interaction (SCINTACT). The index of science teaching and learning with a focus on interaction was derived from the four items listed below, each followed by their respective PISA identification (OECD, 2009b, p. 333).

- Students are given opportunities to explain their ideas. (ST34Q01)
- The lessons involve students' opinions about the topics. (ST34Q05)
- There is a class debate or discuss. (ST34Q09)
- The students have discussions about topics. (ST34Q13)

Student information on hands-on activities in science teaching and learning was self-reported by students and included a 4-point scale reported as *in all lessons*, *in most lessons*, *in some lessons*, and *never or hardly ever*. The codes established by PISA included the following: *in all lessons* (1), *in most lessons* (2), *in some lessons* (3), and *never or hardly ever* (4). These codes, however, were inverted (reverse coded) in the construction of an OECD index of interaction in science teaching and learning with a focus on hands-on activities (SCHANDS). The index of science teaching and learning with a focus on hands-on activities was derived from the four items listed below, each followed by their PISA identification (OECD, 2009b, p. 333).

- Students spend time in the laboratory doing practical experiments. (ST34Q02)
- Students are required to design how a <school science> questions could be investigated in the laboratory. (ST34Q03)
- Students are asked to draw conclusions from an experiment they have conducted. (ST34Q06)
- Students do experiments following the instructions of the teacher. (ST34Q14)

Student information on student investigations in science teaching and learning was provided by students and included a 4-point scale reported as *in all lessons*, *in most lessons*, *in some lessons*, and *never or hardly ever*. The codes established by PISA included the following: *in all lessons* (1), *in most lessons* (2), *in some lessons* (3), and *never or hardly ever* (4). These codes, however, were inverted (reverse coded) in the construction of an OECD index of student investigations in science teaching and learning (SCINVEST). The index of science teaching and learning with a focus on investigations was derived from the three items listed below, each followed by their respective PISA identification (OECD, 2009a, p. 459).

- Students are allowed to design their own experiments. (ST34Q08)
- Students are given the chance to choose their own investigations. (ST34Q11)
- Students are asked to do an investigation to test out their own ideas. (ST34Q16)

Student information on model or applications in science teaching and learning was provided by students and included a 4-point scale reported as *in all lessons*, *in most lessons*, *in some lessons*, and *never or hardly ever*. The codes established by PISA included the following: *in all lessons* (1), *in most lessons* (2), *in some lessons* (3), and *never or hardly ever* (4). These codes, however, were inverted (reverse coded) in the construction of an OECD index of model or applications in science teaching and learning (SCAPPLY). The index of science teaching and learning with a focus on applications was derived from the four items listed below, each followed by their respective PISA identification (OECD, 2009a, p. 459).

- The teacher explains how a <school science> idea can be applied to a number of different phenomena. (ST34Q07)
- The teacher uses science to help students understand the world outside school. (ST34Q12)
- The teacher clearly explains the relevance of <broad science> concepts to our lives. (ST34Q15)
- The teacher uses examples of technological application to show how <school science> is relevant to society. (ST34Q17)

Students provided a response as to whether they learned a particular science content area from their schools (vs. peers and parents). OECD coding was maintained in this study with selected or *tick* (1) or not selected or *no tick* (2). For the purposes of this study, no tick was recoded as (0). The school variables, each followed by their respective PISA identification, are listed below (OECD, 2009a, p. 336)

- Photosynthesis (ST20QA2)
- Continents (ST20QB2)
- Genes (ST20QC2)
- Climate change (ST20QE2)
- Evolution (ST20QF2)
- Nuclear energy (ST20QG2)
- Health (ST20QH2)

School principals provided information on school activities that promote science learning. As stated in PISA 2006 (OECD, 2007), "Activities external to the classroom can enhance students' learning in science, as they can provide a motivation for students and help to place science in a real-life context" (p. 259). School principals responded to the question, "Is your school involved in any of the following activities to promote engagement with science among students in <national modal grade for 15 year-olds>?" (OECD, 2009a, p. 348). Responses included a *yes* or *no* response. OECD coding was maintained in this study with *yes* (1) or not selected or *no* (2). These codes, however, were inverted (reverse coded) in the construction of an OECD index of school activities that promote science learning (SCIPROM). The index of school activities that promote science learning was derived from the five items listed below, each followed by their respective PISA identification (OECD, 2009a, p. 461).

- Science clubs (SC20Q01)
- Science fairs (SC20Q02)
- Science competitions (SC20Q03)
- Extracurricular science projects including science research (SC20Q04)
- Excursions and field trips (SC20Q05)

Additional individual items and indices important to the school construct included activities students have the opportunity to participate in, such as job fairs and industry lectures or visits. Reported by the school principal, responses included *never*, *once a year*, and *more than once a year*. PISA codes were maintained in this study and included *never* (1), once *a year* (2), and *more than once a year* (3). The items followed by their PISA identification are listed below (OECD, 2009a, p. 440).

- Participate in business/industry lectures (SC23Q02)
- Participate business/industry visits (SC23Q03)

From the literature, the proportion of girls at school based on enrollment appeared important to explore. This index, followed by its PISA identification, was derived from school enrollment data (OECD, 2009a, p. 452).

- Proportion of girls based on enrollment (PCGIRLS)

Academic ability in science was measured by science performance data reported in the PISA 2006 assessment as plausible values in science. The variables as per the PISA 2006 data set are listed below (OECD, 2009a, pp. 43-47; OECD, 2009b, pp. 156-160).

- PV1SCIE
- PV2SCIE
- PV3SCIE
- PV4SCIE
- PV5SCIE

Table 2

Independent and Dependent Variables From the PISA 2006 Data Set by Construct

Variable	Coding scheme
Dependent variable	
Measures if a female student intends to study science after secondary school	1 *strongly agree* (SA), *agree* (A) and 0 *strongly disagree* (SD), *disagree* (D)
Independent variables	
Student	
General value of science	PISA index[a]
Personal value of science	PISA index[a]
Self - Do well science	4 *very important*, 3 *important*, 2 *of little importance*, 1 *not important at all*[1]
Science self-efficacy	PISA index[a]
Science self-concept	PISA index[a]

Table 2 (continued)

Independent and Dependent Variables From the PISA 2006 Data Set by Construct

Variable	Coding scheme
General interest in learning science	PISA index[a]
Enjoyment of science	PISA index[a]
Science activities	PISA index[a]
Instrumental motivation in science	PISA index[a]
Parent	
Science activities at age 10	PISA index[a]
Parent view - importance of science	PISA index[a]
Parent reports on science career motivation	PISA index[a]
Parent general value of science	PISA index[a]
Parent personal value of science	PISA index[a]
Either parent science-related career	1 yes and 0 no/undetermined[2]
Index of economic, social and cultural status	PISA index[a]
Sci info - Photosynthesis - family	1 tick (selected), 0 no tick (not selected)
Sci info - Continents - family	1 tick (selected), 0 no tick (not selected)
Sci info - Genes - family	1 tick (selected), 0 no tick (not selected)
Sci info - Climate change - family	1 tick (selected), 0 no tick (not selected)
Sci info - Evolution - family	1 tick (selected), 0 no tick (not selected)
Sci info - Nuclear energy – family	1 tick (selected), 0 no tick (not selected)
Sci info - Health – family	1 tick (selected), 0 no tick (not selected)
Peer	
Sci info - Photosynthesis - friends	1 tick (selected), 0 no tick (not selected)
Sci info - Continents - friends	1 tick (selected), 0 no tick (not selected)
Sci info - Genes – friends	1 tick (selected), 0 no tick (not selected)
Sci info - Climate change - friends	1 tick (selected), 0 no tick (not selected)
Sci info - Evolution - friends	1 tick (selected), 0 no tick (not selected)
Sci info - Nuclear energy - friends	1 tick (selected), 0 no tick (not selected)
Sci info - Health - friends	1 tick (selected), 0 no tick (not selected)
School	
School preparation for science-related careers	PISA index[a]
Science Teaching - Interaction	PISA index[a]
Science Teaching - Hands-on activities	PISA index[a]
Science Teaching - Student investigations	PISA index[a]
Science Teaching - Focus on applications or models	PISA index[a]
Sci info - Photosynthesis - school	1 tick (selected), 0 no tick (not selected)
Sci info - Continents - school	1 tick (selected), 0 no tick (not selected)
Sci info - Genes - school	1 tick (selected), 0 no tick (not selected)
Sci info - Climate change - school	1 tick (selected), 0 no tick (not selected)
Sci info - Evolution - school	1 tick (selected), 0 no tick (not selected)

Table 2 (continued)

Independent and Dependent Variables From the PISA 2006 Data Set by Construct

Variable	Coding scheme
Sci info - Nuclear energy - school	1 tick (selected), 0 no tick (not selected)
Sci info - Health - school	1 tick (selected), 0 no tick (not selected)
Participate business/industry lectures	3 more than once a year, 2 once a year, 1 never
Participate business/industry visits	3 more than once a year, 2 once a year, 1 never
Proportion of girls at school	Continuous value (decimal)[4]
School activities to promote the learning of science	Pisa index[a]
Science performance	
Plausible value in science	Continuous value (decimal)[5]
Plausible value in science	Continuous value (decimal)[5]
Plausible value in science	Continuous value (decimal)[5]
Plausible value in science	Continuous value (decimal)[5]
Plausible value in science	Continuous value (decimal)[5]

Note. [a]All are continuous values (decimal). The item responses to create all PISA indices were inverted (reverse coded), scaled to have a mean of 0 and standard deviation of 1.

1. ST36Q01 student responses were inverted.
2. Derived from student responses to parent occupation, which were then coded according to ISCO (International Standard Classification of Occupations) and coded as per science or not science field (OECD, 2009b, p. 307).
3. Index derived from three variables including the index of home possessions, the index of highest occupational status of parents and the index of highest educational level of parents in terms of years of schooling (OECD, 2009b, p. 346).
4. Information provided by school principal determined by the number of girls enrolled at school divided by total number of boys and girls.
5. Science performance values were scaled to have a mean of 500 and standard deviation of 100.

Analytical Plan

The goal of this study was to perform a comprehensive analysis inclusive of numerous independent variables to identify the “most parsimonious” set of predictors that are effective in forecasting a female’s intention to study science postsecondary (Hosmer, Lemeshow, & Sturdivant, 2013, p. 1). This analysis specifically determined which constructs, if any, influence a female student’s intention to study science postsecondary, which is indicative of interest to study science when pursing higher education and possible career choice. This objective fills a significant gap in prior research, which included studies where only a few of the potential factors were examined. According to Tatsuoka (1973), studies that looked at each variable individually neglected to provide valued information on how variables contribute in relation to each other (p.

9). Another gap addressed by this study included a cross-country comparison.

To analyze the PISA 2006 data and identify variables of potential influence, logistic regression was used. General logistic regression equations are identified in (1) and (2) where p is the outcome or dependent variable (intention to major in science postsecondary), α is the Y intercept, βs slope parameters and Xs are the predictors or independent variables (Allison, 2012; Peng, So et al., 2002). This statistical procedure facilitated the analysis of binary dependent variables with either quantitative or categorical independent variables (Allison, 2012; Peng, Lee, & Ingersoll, 2002). The specific method used was logit logistics regression, which "predicts the logit of an event outcome from a set of predictors" (Peng, Lee, & Ingersoll, 2002, p. 6). It determined the odds that an event will happen, which in this study, was the likelihood that a female student will intend to study science postsecondary based on a single item or multiple indices characteristic of factors observed in literature as consequential and appearing in the PISA 2006 assessment or questionnaire. Given the purpose of the study, which provided insight into which distinct factor(s) matter to female intention to study science postsecondary, this analysis identified the respective predictors and was exclusively at the individual level and nonhierarchical. Even the information specific to schools and learning or school preparation for science-related careers was considered at the student level (OECD, 2009a). Therefore, hierarchical modeling or multilevel modeling, designed for levels of grouped data or when "clustered samples" are of interest, was not a consideration and therefore not an appropriate strategy (Li, Oranje, & Jiang, 2009, p. 435; Steenbergen & Jones, 2002).

Data from the PISA 2006 and accompanying student, school, and parent science questionnaires was included in the analysis. The parent questionnaire was optional, and this analysis, therefore, only involved data from countries that participated in the parent questionnaire providing there was sufficient data for all variables considered in this analysis. The countries included in this analysis were Bulgaria, Colombia, Croatia, Denmark, Germany, Hong Kong-China, Iceland, Italy, Korea, Luxembourg, Macao-China, New Zealand, Portugal, Qatar, and Turkey. Using an extensive review of literature as a guide, a subset of independent variables was selected from the PISA 2006 dataset, which were categorized, according to the postulated model, as having an internal or external dimension. This study initially evaluated nearly 300 explanatory or independent variables. These variables were subsequently further scrutinized as important due to their recognition in prior studies or to include due to suspect of contribution, but lacking prior evidence. The dependent variable, female intention to study science postsecondary, was treated as a dichotomous response variable distinguishing female students who agreed or did not agree with this intention. For invalid or missing cases, this study used listwise deletion to exclude them from analyses. Missing cases in the PISA data set occurred for several reasons, such as no response was provided, more than one response for the same question was provided, the question may have been subsequently deleted due to an error denoted by OECD, or if OECD felt that the question was not answered because the person completing questionnaire did not get to it and did not "reach" it (OECD, 2009a, p. 331). OECD-provided weights were used to calculate statistics to facilitate more precise population estimates (OECD, 2009a, pp. 36-37).

$$\text{Log}\left[\frac{\text{pi}}{1-\text{pi}}\right] = \alpha + \beta 1\text{Xi}1 + \beta 2\text{Xi}2 + \ldots + \beta \text{kXik} \quad (1)$$

$$\text{p}_\text{i} = \frac{\exp^{(\alpha+\beta 1\text{xi}1+\ \beta 2\text{xi}2+\ldots\beta\text{kxik})}}{1+\exp^{(\alpha+\beta 1\text{xi}1+\ \beta 2\text{xi}2+\ldots\beta\text{kxik})}} \quad (2)$$

To assess the logistic regression model, statistical analyses were conducted in several major steps that included overall model evaluation, statistical tests of the predictor variables, goodness of fit statistics and model validation (Peng, Lee, & Ingersoll, 2002). First, using SAS, descriptive analyses were initially done to understand the characteristics of the sample, mean, and frequency distributions. To determine and evaluate model fit, data were split into a training set for model fitting purposes and a test set for model validation (Austin & Tu, 2004; Hayes, Price, & York, 2013; Nicholls, Wolfe, Besterfield-Sacre, & Shuman, 2010, p. 209; Tatsuoka, 1973; Thall, Russell, & Simon, 1997). Second, to evaluate possible high correlations interaction effect between predictors and ensure the full rank assumption of logistic regression is satisfied, multicollinearity was assessed using the variance inflation factor (VIF) test. Values greater than 10 were removed. According to Thall et al. (1997), if the variable (X_i) is a “true predictor” (p. 417) and the βs or slope parameters are “sufficiently large relative to the standard deviation” (p. 417) of the outcome event and is not interacting or collinear with other predictors in the model, then the predictor variable (X_i) should be included. The fitted model from the training set was validated on the test data set (Thall et al., 1997). Third, to understand the factors that determine females’ intentions to study science postsecondary, logistic regression analysis was conducted. Due to the exploratory nature of the study and the large number of predictors in the model, a sensible approach was taken as follows. To make sure the most basic and important factors were controlled for, this model included a group of student, parent, and school factors that have been consistently found significant in the literature. To explore some new predictors and establish the “most parsimonious” (Hosmer et al., 2013, p. 1) model, backward elimination was performed to identify potential variables that are independent predictors of the outcome (Austin & Tu, 2004). Variable meanings and coefficient estimates (e.g., predictor influence to the model) were examined followed by the removal of negligible variables. Based off of the Wald chi-square test statistic, individual regression coefficients with a *p*-value greater than 0.05 were eliminated (Thall et al., 1997; Thall, Simon, & Grier, 1992). Variables, however, that were identified in the literature as important, but reported to have a *p*-value greater than 0.05, remained in the model. The backward elimination procedure was re-run with the data subset to re-identify and explore some new items that are potentially significant. Logistic regression was then run on the test data set to measure model performance, evaluated through the concordance statistic (c statistic), which represents the lift curve area under the "Receiver Operating Characteristic (ROC) curve" (Hosmer et al., 2013, p. 173). Confidence intervals and *p*-values were analyzed to perform quality assurance testing. This procedure was first done to achieve a model for the whole sample inclusive of the 15 countries. A subgroup analysis for each individual country was then performed.

Limitations of this Study

Limitations of this study are noted. First, this study focused on intention to study science postsecondary. Although one can infer that intention to study science postsecondary is indicative of a student's likelihood of studying science in higher education and subsequent career choice, it does not, however, capture student commitment to a college science major. The use of intent as a dependent variable therefore limited the conclusion about influences of factors on actual science major enrollment. With that being said, it was imperative to evaluate science study intention precollege because research acknowledges that experiences during a female's education from as early as birth up to and including secondary schooling are influential to a female's intention to study science postsecondary (Muller et al., 2001; Sax & Harper, 2007; Ware & Lee, 1988). Moreover, given the two critical moments of science choice (p. 330), which include intention to major in science when in high school and commitment to major in science when in college (van Langen & Dekkers, 2005), the majority of precollege females do not intend to study science postsecondary (Hilton & Lee, 1988). It was crucial, therefore, to study the possible explanatory factors prior to or during secondary studies, which is upstream from commitment to major in the science educational pipeline. Such factors were identified in the PISA 2006 data set.

Although analyzing a secondary data set was advantageous due to its size, and the PISA dataset is extremely beneficial because of its international reach, there are limitations relating to study design because the study is inherently secondary and may not always address a variable specifically. For example, one of the factors that have been cited as a contributing predictor to a female's intention to study science involves peers. A peer variable was included in the PISA 2006 data set, but the respective information was not inclusive of all specific peer-group influences discussed in literature, such as respective influences on science attitude (George, 2000; Simpson & Oliver, 1990) and various group dynamics (Breakwell et al., 2003). Future studies should include focus groups or interviews with specific questions in regard to stereotypes and group dynamics.

Lastly, this analysis identified an accurate model with predictive utility. It included a large international data sample with possible explanatory factors to make collective generalizations for all 15-year-old females. Because parent information concerning science was critical to analyzing the predictors of female intention to study science postsecondary, the PISA 2006 assessment was ideal; however, only certain countries completed the optional survey, which limited cross-country comparisons. Since underrepresentation in female science participation is recognized worldwide, future parent surveys should include a broader scope inclusive of more countries. This is an important consideration for OECD, which may want to discuss with additional countries in hope of expanding the optional parent questionnaire country reach. In addition, if country variation is noted, future studies may also want to include an in-depth qualitative analysis inclusive of focus groups and individual interviews in one or more countries as determined by this study. Likewise, distinctions among countries may be due to inherent differences within national education systems (van Langen & Dekkers, 2005), and as a result should be examined more critically.

Despite these noted theoretical, data specific, and analytical limitations, the PISA 2006 data set is a comprehensive and extensive international data set, which evaluated all of the recognized influential constructs (i.e., student, parent, school, and peer) and facilitated a cross-country comparison. Analyzing this data set enabled the identification of a model with predictive utility and assisted in expanding the research regarding women in science more broadly and inclusive of a global context. In addition, PISA is an ongoing assessment with the science domain planned again for 2015, which will provide yet an additional opportunity to analyze data and make comparisons to results of this study.

In conclusion, it remains critical to understand the factors that impact a female's intention to study science postsecondary to heighten awareness and implement strategies to change and potentially, increase the number of females intending to major in science and therefore, potentially, increase the number of female scientists.

Chapter 4

Results

Due to the goal of this analysis, which was to attain “the best fitting and most parsimonious” model useful in predicting the intended dichotomous outcome, an effective approach involved logistic regression (Hosmer et al., 2013, p. 1). This technique facilitated the identification of a “set of significant predictor variables” and excluded variables that do not contribute to explaining differences in the outcome (Nicholls et al., 2010, p. 209); in other words, factors that do not influence a high school female’s intention to study science postsecondary. Because of the large data set used in this analysis and incorporation of a comprehensive array of numerous variables, backward elimination was employed to create models for all countries collectively and individually (Berk, 1978, p. 2).

The results from the analysis are presented in this chapter and appear collectively for all countries in a pooled sample as well as by individual country. The results section for both the pooled sample as well as each individual country begin with descriptive statistics followed by a discussion of the regression results reflecting important predictors of a female’s intention to study science postsecondary, which is indicative of female science study when in higher education and science career choice. Following a presentation of the results, each research question is revisited with a discussion of the trends observed across all countries as well as comparisons by regions. This information is useful in determining if the variables that influence female intention to study science are common and “applicable” across several countries from a variety of regions or if they are distinct (Hagger et al., 2010, p. 307). Goodness of fit metrics pertaining to all models affirming model performance are included in the appendix.

Findings Based on all 15 Countries (Pooled Sample)

Descriptive statistics results. The pooled all-countries sample includes the following countries: Denmark, Germany, Iceland, Italy, Luxembourg, New Zealand, Portugal, Korea, Turkey, Bulgaria, Colombia, Croatia, Hong Kong-China, Qatar and Macao-China. Table 3 shows the variables considered in this analysis and lists the independent variables by construct (student, parent, peer, and school). The descriptive statistics reflect the total sample inclusive of all variables from which the model depicted in Table 4 was built. The model ultimately selected a series of variables that were the most important in predicting female intention to major in science postsecondary. The total sample listed in Table 3 is the number of times that specific variable was represented for all 15 countries pooled. The mean and standard deviation for each respective variable is also stated. As described in Chapter 3, many variables are indices, which were scaled and then standardized with a mean of 0 and a standard deviation of 1 (OECD, 2009b, p. 314). Positive index values are therefore associated with a more positive response in the case of student, parent, and school questionnaire scaled indices or higher level of rank in the case of the PISA index concerning economic, social, and cultural status (OECD, 2007; OECD, 2009a). All of the student indices for the pooled all-countries sample, with the exception of science self-efficacy, reported a mean value greater than 0. According to OECD (2007), a value less than 0 on such an attitudinal index indicates that females in this pooled all-countries sample reported less positively than the average student from OECD countries. The mean value below 0 for the school construct index science teaching: hands-on activities indicated lower rates of this type of science instruction for all countries included in this analysis. The PISA index of economic, social, and cultural status was less than 0 and below the OECD average (OECD, 2009b). Science performance was also below the OECD average. In regard to derived science content (coded 1 for tick or selected and 0 for no tick or not selected), females in this sample reported that most is learned from school with means closer to 1.

Table 3

Descriptive Statistics for Pooled All-Countries Sample by Construct

Variable	*N*	Mean	Std. Deviation
Student			
General value of science index	93702	.16	1.02
Personal value of science index	93636	.20	.98
Self - Do well science	85244	2.04	.82
Science self-efficacy index	93686	-.028	.97
Science self-concept index	85698	.11	.98
General interest in learning science index	93825	.14	.99
Enjoyment of science index	94045	.14	.98
Science activities index	93983	.28	.98
Instrumental motivation in science index	85614	.15	.97
Parent			
Science activities at age 10 index	75523	.12	.99
Parents view - importance of science index	75246	.12	.97
Parents reports on science career motivation index	75341	.05	.99
Parent general value of science index	75441	.09	1.00
Parent personal value of science index	75269	.19	.99
Either parent science-related career	91765	.14	.35
Economic, social and cultural status index	93915	-.18	1.08
Sci info - Photosynthesis - family	94259	.06	.23
Sci info - Continents - family	94259	.08	.27
Sci info - Genes - family	94259	.08	.27
Sci info - Climate change - family	94259	.12	.32
Sci info - Evolution - family	94259	.11	.31
Sci info - Nuclear energy – family	94259	.09	.29
Sci info - Health – family	94259	.49	.50
Peer			
Sci info - Photosynthesis - friends	94259	.03	.17
Sci info - Continents - friends	94259	.03	.17
Sci info - Genes - friends	94258	.03	.17
Sci info - Climate change - friends	94259	.04	.20
Sci info - Evolution - friends	94259	.05	.22
Sci info - Nuclear energy - friends	94259	.04	.20
Sci info - Health - friends	94259	.16	.36
School			
School preparation for science-related careers index	93380	.01	1.01

Table 3 (continued)

Descriptive Statistics for Pooled All-Countries Sample by Construct

Variable	*N*	Mean	Std. Deviation
Science Teaching - Interaction index	86260	.11	1.02
Science Teaching - Hands-on activities index	86167	-.064	1.06
Science Teaching - Student investigations index	85969	.15	1.04
Science Teaching - Focus on applications or models index	85979	.05	1.01
Sci info - Photosynthesis - school	94259	.87	.34
Sci info - Continents - school	94259	.80	.40
Sci info - Genes - school	94259	.79	.41
Sci info - Climate change - school	94259	.75	.43
Sci info - Evolution - school	94259	.70	.46
Sci info - Nuclear energy - school	94258	.67	.47
Sci info - Health - school	94258	.63	.48
Participate business/industry lectures	85697	1.88	.79
Participate business/industry visits	85631	2.00	.79
Proportion of girls at school	87748	.49	.22
School activities to promote the learning of science index	92090	.20	.96
Science performance			
Plausible value in science	95008	479.18	104.39
Plausible value in science	95008	479.37	104.39
Plausible value in science	95008	479.20	104.40
Plausible value in science	95008	479.28	104.45
Plausible value in science	95008	479.17	104.35

Regression analysis results. For the pooled all-countries model the school, student, and parent constructs positively matter to a female's intention to study science postsecondary. Most important was the instrumental motivation in science index (odds ratio = 2.52, $p < .001$). With all other variables held equal, this was a 152% increase in the odds of female intention to study science postsecondary. This is followed by the enjoyment of science index. Results indicated that, compared with female students who did not enjoy science, those who had interest in science specific to science enjoyment had 82% higher odds of their intention to study science postsecondary (odds ratio = 1.82, $p < .001$), with all other variables held equal. Two of the three student science attitude variables were seen as positive factors. They include the personal value of science index (odds ratio = 1.34, $p < .001$) and the student attitude variable self-do well in science (odds ratio = 1.26, $p < .001$). The third science attitude variable, general value of science index, in contrast to a student's personal value of science, reported a negative relationship (odds ratio = 0.84, $p < .001$). The PISA 2006 student science interest variable concerning science activities also positively mattered (odds ratio = 1.24, $p < .001$). Of the science self-belief variables, science self-concept index reported a positive relationship (odds ratio = 1.19, $p < .001$), while science self-efficacy index was negative (odds ratio = 0.94, $p < .001$).

Of the parent variables, the PISA 2006 index concerning parents' view on science career motivation positively mattered (odds ratio = 1.82, $p < .001$). Results indicated that parents' report on science career motivation accounts for an 82% increase in the odds of female intention to study science postsecondary, with all other variables in the model held equal. Other parent variables that were seen to positively influence a female's intention to study science postsecondary include whether either parent maintained an occupation in science (odds ratio = 1.18, $p < .001$) and the parents' views on the importance of learning science index (odds ratio = 1.15, $p < .001$).

Of the school variables pertaining to science teaching and learning, science investigations positively mattered (odds ratio = 1.06, $p < .001$). Science investigations included student opportunities to conduct experiments and investigate or test their own scientific assumptions.

Lastly, in regard to overall derived science content and with all other variables in the model held equal for each, schools and parents were positive factors for high school females in regard to intention to study science postsecondary. This was observed by collectively examining the point estimates for each item within the respective category and the exponentiation of their sum to obtain the odds ratio.

When considering the pooled-country model inclusive of 15 countries, it appears that it is very important for female students to be motivated to learn science that is taught in school, have opportunities to design and carry out their own experiments in school, enjoy and personally value science, as well as have parents who have expectations that their child will subsequently study, major, and/or have a career in science and work in a science-related occupation themselves.

Table 4

Pooled All-Countries Model by Construct

Variable	Odds ratio	Std. error	Significance
Student			
General value of science index	0.84	0.01	***
Personal value of science index	1.34	0.01	***
Self - Do well science	1.26	0.01	***
Science self-efficacy index	0.94	0.00	***
Science self-concept index	1.19	0.01	***
Enjoyment of science index	1.82	0.01	***
Science activities index	1.24	0.01	***
Instrumental motivation in science index	2.52	0.01	***
Parent			
Parent view - importance of science index	1.15	0.01	***
Parent report on science career motivation index	1.82	0.01	***
Parent general value of science index	0.91	0.01	***
Parent personal value of science index	0.85	0.00	***
Either parent science-related career	1.18	0.01	***
Economic, social and cultural status index	0.85	0.01	***
Sci info – Continents – family	1.12	0.03	***
Sci info - Genes - family	1.20	0.02	***
Sci info - Climate change - family	0.89	0.02	***
Sci info - Evolution - family	0.91	0.01	***
Sci info - Health – family	1.03	0.00	***
Peer			
Sci info - Continents - friends	0.73	0.03	***
Sci info - Genes - friends	0.61	0.02	***
Sci info - Climate change - friends	0.91	0.01	***
Sci info - Evolution - friends	1.22	0.02	***
Sci info - Health - friends	1.16	0.01	***

Table 4 (continued)

Pooled All-Countries Model by Construct

Variable	Odds ratio	Std. error	Significance
School			
School preparation for science-related careers index	0.97	0.01	**
Science Teaching - Interaction index	0.98	0.00	***
Science Teaching - Hands-on activities index	0.98	0.01	**
Science Teaching - Student investigations index	1.06	0.01	***
Science Teaching - Focus on applications or models index	0.83	0.01	***
Sci info - Photosynthesis - school	1.15	0.01	***
Sci info - Climate change - school	0.98	0.01	**
Sci info - Evolution - school	1.10	0.01	***
Sci info - Nuclear energy - school	1.09	0.02	***
Sci info - Health - school	1.05	0.02	**
Participate business/industry lectures	0.89	0.01	***
Participate business/industry visits	0.98	0.01	*
Proportion of girls at school	0.68	0.02	***
School activities to promote the learning of science index	0.97	0.00	***

Note. $N = 52{,}565$.
* $p < 0.05$ ** $p < 0.01$ *** $p < .001$.

Findings Based on Individual Countries (Subcountry Analysis)

Bulgaria. ***Descriptive statistics results.*** Table 5 shows the variables included in the Bulgaria country analysis and lists the independent variables by construct (student, parent, peer, and school). The descriptive statistics reflect the total sample inclusive of all variables from which the Bulgaria model depicted in Table 6 was built. The model ultimately selected a series of variables that were the most important in predicting, among females in Bulgaria, their intention to major in science postsecondary. The total sample listed in Table 5 is the number of times that specific variable was represented in the Bulgaria sample. The mean and standard deviation for each respective variable is also stated. All the student indices for the Bulgaria sample, with the exception of science self-efficacy, reported a mean value greater than 0. According to OECD (2007), a value less than 0 on such an attitudinal index indicates that females in this pooled all country sample reported less positively than the average student from

OECD countries. All school construct teaching specific indices were above the OECD average of 0. The PISA index of economic, social, and cultural status was less than 0 and below the OECD average (OECD, 2009b). Science performance was also below the OECD average. In regard to derived science content (coded 1 for tick or selected and 0 for no tick or not selected), females in this sample reported that most is learned from school with means closer to 1.

Table 5

Descriptive Statistics for Bulgaria Sample by Construct

Variable	*N*	Mean	Std. Deviation
Student			
General value of science index	4287	.26	1.00
Personal value of science index	4280	.37	.91
Self - Do well science	4180	2.13	.74
Science self-efficacy index	4280	-.02	1.04
Science self-concept index	4229	.36	.84
General interest in learning science index	4359	.18	.99
Enjoyment of science index	4380	.38	.82
Science activities index	4370	.77	.82
Instrumental motivation in science index	4225	.35	.83
Parent			
Science activities at age 10 index	4180	.44	.90
Parent view - importance of science index	4179	.42	.86
Parent reports on science career motivation index	4176	.06	.98
Parent general value of science index	4176	.49	.92
Parent personal value of science index	4163	.62	.89
Either parent science-related career	4268	.19	.39
Economic, social and cultural status index	4396	-.15	.98
Sci info - Photosynthesis - family	4420	.13	.34
Sci info - Continents - family	4420	.15	.36
Sci info - Genes - family	4420	.14	.35
Sci info - Climate change - family	4420	.16	.37
Sci info - Evolution - family	4420	.17	.38
Sci info - Nuclear energy – family	4420	.16	.36
Sci info - Health – family	4420	.53	.50
Peer			
Sci info - Photosynthesis - friends	4420	.10	.31
Sci info - Continents - friends	4420	.10	.31

Table 5 (continued)

Descriptive Statistics for Bulgaria Sample by Construct

Variable	*N*	Mean	Std. Deviation
Sci info - Genes – friends	4420	.11	.31
Sci info - Climate change - friends	4420	.12	.32
Sci info - Evolution - friends	4420	.13	.33
Sci info - Nuclear energy - friends	4420	.12	.32
Sci info - Health - friends	4420	.21	.41
School			
School preparation for science-related careers index	4308	.39	.96
Science Teaching - Interaction index	4267	.33	.91
Science Teaching - Hands-on activities index	4261	.06	1.09
Science Teaching - Student investigations index	4246	.54	.98
Science Teaching - Focus on applications or models index	4243	.45	.98
Sci info - Photosynthesis - school	4420	.83	.38
Sci info - Continents - school	4420	.78	.42
Sci info - Genes - school	4420	.75	.43
Sci info - Climate change - school	4420	.69	.46
Sci info - Evolution - school	4420	.65	.48
Sci info - Nuclear energy - school	4420	.58	.49
Sci info - Health - school	4420	.49	.50
Participate business/industry lectures	4309	1.83	.76
Participate business/industry visits	4241	2.05	.87
Proportion of girls at school	4350	.46	.21
School activities to promote the learning of science index	4352	.04	.83
Science performance			
Plausible value in science	4498	439.44	104.56
Plausible value in science	4498	439.47	104.82
Plausible value in science	4498	438.67	103.93
Plausible value in science	4498	438.46	103.91
Plausible value in science	4498	439.24	104.34

Regression analysis results. Factors that positively mattered for female secondary school students in Bulgaria in regards to intention to study science postsecondary included the student, parent, and school. Most important was a PISA 2006 student index, which includes the female students' instrumental motivation to learn science (odds ratio value = 2.31, $p < .001$). Results indicated that, compared with students who were not instrumentally motivated in science, those who were had 131% higher odds of their intention to study science postsecondary, with all other variables in the model held equal. There were also several other student-related variables observed to have a positive relationship, indicative of being important predictors to female intention to study science postsecondary. They included the science related activities index (odds ratio = 1.47, $p < .001$), the personal value of science index (odds ratio = 1.44, $p < .001$), enjoyment of science index (odds ratio = 1.40, $p < .001$), and science self-efficacy index (odds ratio = 1.11, $p < .001$). In contrast to the personal value of science index odds ratio result, general value of science index reported a negative relationship (odds ratio = 0.78, $p < .001$). Of the science self-belief variables, Bulgaria was one of only two countries in this analysis to report that science self-efficacy index positively mattered and not science self-concept index. The student variable self-do well in science also reported a positive relationship (odds ratio value = 1.39, $p < .001$).

Parent and school variables also mattered to female students in Bulgaria. Of the parent variables, the PISA 2006 index, which included the parents' report on science career motivation and their related expectations positively mattered (odds ratio = 1.70, $p < .001$). This result indicates a 70% increase in female intention to study science postsecondary with all other variables in the model held constant. Whether either parent had a science field occupation had a slight positive relationship (odds ratio = 1.02, $p < .001$). The school variable that positively mattered included school preparation for a science career (odds ratio = 1.11, $p < .001$).

Lastly, with all variables in the model held equal for each, science content obtained by a female high school student from school and parents appear to be positive factors in regard to intention to study science postsecondary. This was observed by collectively examining the point estimates for each item within the respective category and the exponentiation of their sum to obtain the odds ratio.

When considering the model for Bulgaria, it is very important for female students to be motivated to learn science that is taught in school, enjoy and personally value science, engage in science activities, have school instruction that prepares them potentially for a science career, as well as have parents who have expectations that their child will subsequently study, major, and/or have a career in science.

Table 6

Bulgaria Model by Construct

Variable	Odds ratio	Std. error	Significance
Student			
General value of science index	0.78	0.02	***
Personal value of science index	1.44	0.02	***
Self - Do well science	1.39	0.03	***
Science self-efficacy index	1.11	0.01	***
Enjoyment of science index	1.40	0.02	***
Science activities index	1.47	0.01	***
Instrumental motivation in science index	2.31	0.02	***
Parent			
Parent report on science career motivation index	1.70	0.02	***
Either parent science-related career index	1.02	0.05	***
Index of economic, social and cultural status index	0.85	0.01	***
Sci info – Photosynthesis – family	1.25	0.03	***
Sci info – Evolution- family	1.19	0.04	***
Sci info – Health - family	0.86	0.02	***
Peer			
Sci info - Photosynthesis - friends	0.70	0.13	**
Sci info - Continents - friends	0.50	0.05	***
Sci info – Genes - friends	1.27	0.05	***
Sci info - Climate change - friends	1.30	0.08	***
Sci info – Nuclear energy - friends	1.39	0.03	***
Sci info - Health - friends	1.14	0.04	***
School			
School preparation for science-related careers index	1.11	0.01	***
Science Teaching - Focus on applications or models index	0.89	0.02	***
Participate business/industry visits	0.86	0.01	***
Sci info - Genes - school	1.16	0.03	***
Sci info – Climate change- school	1.18	0.03	***

Table 6 (continued)

Bulgaria Model by Construct

Variable	Odds ratio	Std. error	Significance
Sci info - Nuclear energy - school	0.88	0.03	***

Note. $N = 2988$.

* $p < 0.05$ ** $p < 0.01$ *** $p < .001$.

Colombia. ***Descriptive statistics results***. Table 7 shows the variables included in the Colombia country analysis and lists the independent variables by construct (student, parent, peer, and school). The descriptive statistics reflect the total sample inclusive of all variables from which the Colombia model depicted in Table 8 was built. The model ultimately selected a series of variables that were the most important in predicting, among females in Colombia, their intention to major in science postsecondary. The total sample listed in Table 7 is the number of times that specific variable was represented in the Colombia sample. The mean and standard deviation for each respective variable is also stated. All the student indices for the Colombia sample reported a mean value greater than 0. All school teaching specific indices were above the OECD average of 0. The PISA index of economic, social, and cultural status was less than 0 and below the OECD average (OECD, 2009b). Science performance was also below the OECD average. In regard to derived science content (coded 1 for tick or selected and 0 for no tick or not selected), females in this sample reported that most is learned from school with means closer to 1.

Table 7

Descriptive Statistics for Colombia Sample by Construct

Variable	*N*	Mean	Std. Deviation
Student			
General value of science index	4448	.47	.91
Personal value of science index	4437	.88	.84
Self - Do well science	4269	2.41	.68
Science self-efficacy index	4450	.01	.92
Science self-concept index	4299	.75	.77

Table 7 (continued)

Descriptive Statistics for Colombia Sample by Construct

Variable	*N*	Mean	Std. Deviation
General interest in learning science index	4448	1.12	.94
Enjoyment of science index	4453	.80	.78
Science activities index	4448	.99	.78
Instrumental motivation in science index	4307	.62	.82
Parent			
Science activities at age 10 index	4160	.39	1.08
Parent view - importance of science index	4152	.38	.87
Parent reports on science career motivation index	4150	.64	.86
Parent general value of science index	4171	.50	.95
Parent personal value of science index	4152	.90	.91
Either parent science-related career	4417	.09	.28
Economic, social and cultural status index	4453	-.93	1.24
Sci info - Photosynthesis - family	4460	.06	.24
Sci info - Continents - family	4460	.07	.26
Sci info - Genes - family	4460	.08	.27
Sci info - Climate change - family	4460	.12	.33
Sci info - Evolution - family	4460	.11	.31
Sci info - Nuclear energy – family	4460	.04	.20
Sci info - Health – family	4460	.47	.50
Peer			
Sci info - Photosynthesis - friends	4460	.04	.19
Sci info - Continents - friends	4460	.04	.20
Sci info - Genes – friends	4460	.04	.20
Sci info - Climate change - friends	4460	.06	.23
Sci info - Evolution - friends	4460	.06	.24
Sci info - Nuclear energy - friends	4460	.03	.18
Sci info - Health - friends	4460	.12	.32
School			
School preparation for science-related careers index	4433	.48	.96
Science Teaching - Interaction index	4387	.38	.83
Science Teaching - Hands-on activities index	4367	.30	.91
Science Teaching - Student investigations index	4350	.67	.94
Science Teaching - Focus on applications or models index	4357	.59	.98
Sci info - Photosynthesis - school	4460	.82	.38
Sci info - Continents - school	4460	.73	.45
Sci info - Genes - school	4460	.81	.39
Sci info - Climate change - school	4460	.66	.48
Sci info - Evolution - school	4460	.74	.44

Table 7 (continued)

Descriptive Statistics for Colombia Sample by Construct

Variable	*N*	Mean	Std. Deviation
Sci info - Nuclear energy - school	4460	.60	.49
Sci info - Health - school	4460	.53	.50
Participate business/industry lectures	4397	1.84	.78
Participate business/industry visits	4406	1.92	.77
Proportion of girls at school	4142	.52	.14
School activities to promote the learning of science index	4457	.85	.78
Science performance			
Plausible value in science	4478	391.53	85.14
Plausible value in science	4478	392.20	85.11
Plausible value in science	4478	391.77	84.93
Plausible value in science	4478	392.16	85.69
Plausible value in science	4478	391.64	84.90

Regression analysis results. Factors that positively mattered for female secondary school students in Colombia in regards to intention to study science postsecondary included the student, parent, and peer. Most important was a student variable instrumental motivation to learn science (odds ratio = 3.34, $p < .001$). This result indicated that, compared with students who were not instrumentally motivated in science, those that were had 234% higher odds of female intention to study science postsecondary with all other variables in the model are held constant.

Other student variables reporting a positive relationship, indicative of being important predictors to female intention to study science postsecondary, included the self-do well in science variable (odds ratio = 1.77, $p < .001$), enjoyment of science index (odds ratio = 1.63, $p < .001$), science related activities index (odds ratio = 1.58, $p < .001$), and personal value of science index (odds ratio = 1.20, $p < .001$). In contrast to the personal value of science variable result, general value of science reported a negative relationship.

An important parent variable is the PISA 2006 index, which includes the parents' report on science career motivation and their related expectations (odds ratio = 1.51, $p < .001$). This corresponded to a 51% increase in female intention to study science postsecondary with all other variables in the model held constant.

Science content obtained by a female high school student from peers was a positive factor in regard to intention to study science postsecondary with all other variables in the model held equal. This was observed by collectively examining the point estimates for each item within the respective category and the exponentiation of their sum to obtain the odds ratio.

When considering the model for Colombia, it was very important for female students to be motivated to learn science that is taught in school, enjoy and personally value science, engage in science activities, and have parents who have expectations that their child will subsequently study, major, and/or have a career in science. Peers also positively mattered.

Table 8

Colombia Model by Construct

Variable	Odds ratio	Std. error	Significance
Student			
General value of science index	0.77	0.02	***
Personal value of science index	1.20	0.05	**
Self - Do well science	1.77	0.03	***
Enjoyment of science index	1.63	0.02	***
Science activities index	1.58	0.03	***
Instrumental motivation in science index	3.34	0.02	***
Parent			
Parent report on science career motivation index	1.51	0.03	***
Either parent science-related career	0.84	0.01	***
Economic, social and cultural status index	0.76	0.02	***
Sci info - Photosynthesis – family	0.77	0.08	***
Sci info – Continents – family	1.38	0.06	***
Sci info – Genes – family	0.64	0.08	***
Sci info – Evolution- family	1.59	0.01	***
Sci info – Nuclear energy – family	0.48	0.11	***
Peer			
Sci info – Genes - friends	1.97	0.09	***
Sci info - Climate change - friends	1.15	0.05	**

Table 8 (continued)

Colombia Model by Construct

Variable	Odds ratio	Std. error	Significance
Sci info – Nuclear energy - friends	1.58	0.11	***
Sci info - Health - friends	0.66	0.09	***
School			
Science Teaching - Focus on applications or models index	0.80	0.01	***
Proportion of girls at school	0.45	0.12	***
Sci info - Photosynthesis – school	0.58	0.05	***
Sci info - Continents – school	1.24	0.04	***
Sci info - Genes - school	0.85	0.03	***
Sci info – Evolution - school	0.88	0.03	***
Sci info - Health - school	1.12	0.04	**

Note. $N = 2936$.

* $p < 0.05$ ** $p < 0.01$ *** $p < .001$.

Germany. ***Descriptive statistics results.*** Table 9 shows the variables included in the Germany country analysis and lists the independent variables by construct (student, parent, peer, and school). The descriptive statistics reflect the total sample inclusive of all variables from which the Germany model depicted in Table 10 was built. The model ultimately selected a series of variables that were the most important in predicting, among females in Germany, their intention to major in science postsecondary. The total sample listed in Table 9 is the number of times that specific variable was represented in the Germany sample. The mean and standard deviation for each respective variable is also stated. There were several student attitudinal indices for the Germany sample that reported a mean value below 0, which included the following: general value of science, personal value of science, enjoyment of science, and instrumental motivation in science. Several school teaching specific indices are below the OECD average of 0, which included the following: student investigations, focus on applications or models, and school activities to promote science learning. Parent indices below the OECD average included science activities at age 10 and parent report on science career motivation. The PISA index of economic, social, and cultural status was above the OECD average (OECD, 2009b). Science performance was also above the OECD average. In regard to derived science content (coded 1 for tick or selected and 0 for no tick or not selected), females in this sample reported that most is consistently earned from school with means closer to 1.

Table 9

Descriptive Statistics for Germany Sample by Construct

Variable	*N*	Mean	Std. Deviation
Student			
General value of science index	4580	-.09	1.06
Personal value of science index	4575	-.23	1.07
Self - Do well science	4488	2.00	.77
Science self-efficacy index	4577	.07	.98
Science self-concept index	4540	.26	.99
General interest in learning science index	4714	.19	.89
Enjoyment of science index	4721	-.08	1.09
Science activities index	4722	.12	.93
Instrumental motivation in science index	4529	-.08	1.04
Parent			
Science activities at age 10 index	3930	-.12	.89
Parent view - importance of science index	3902	.00	1.05
Parent reports on science career motivation index	3920	-.31	.79
Parent general value of science index	3907	.06	1.06
Parent personal value of science index	3902	.05	1.11
Either parent science-related career	4541	.20	.40
Economic, social and cultural status index	4686	.30	.93
Sci info - Photosynthesis - family	4598	.91	.28
Sci info - Continents - family	4598	.16	.36
Sci info - Genes - family	4598	.10	.30
Sci info - Climate change - family	4598	.16	.36
Sci info - Evolution - family	4598	.14	.35
Sci info - Nuclear energy – family	4598	.15	.36
Sci info - Health – family	4598	.61	.49
Peer			
Sci info - Photosynthesis - friends	4598	.03	.16
Sci info - Continents - friends	4598	.03	.16
Sci info - Genes – friends	4598	.02	.15
Sci info - Climate change - friends	4598	.04	.19
Sci info - Evolution - friends	4598	.04	.19
Sci info - Nuclear energy - friends	4598	.04	.20
Sci info - Health - friends	4598	.19	.39

Table 9 (continued)

Descriptive Statistics for Germany Sample by Construct

Variable	*N*	Mean	Std. Deviation
School			
School preparation for science-related careers index	4557	.11	1.09
Science Teaching - Interaction index	4555	.10	.92
Science Teaching - Hands-on activities index	4547	.16	.86
Science Teaching - Student investigations index	4545	-.07	.96
Science Teaching - Focus on applications or models index	4539	-.08	.89
Sci info - Photosynthesis - school	4598	.81	.39
Sci info - Continents - school	4598	.73	.44
Sci info - Genes - school	4598	.74	.44
Sci info - Climate change - school	4598	.80	.40
Sci info - Evolution - school	4598	.67	.47
Sci info - Nuclear energy - school	4598	.69	.46
Sci info - Health - school	4598	.64	.48
Participate business/industry lectures	4644	2.21	.75
Participate business/industry visits	4667	2.59	.58
Proportion of girls at school	4664	.49	.10
School activities to promote the learning of science index	4688	-.09	.94
Science performance			
Plausible value in science	4891	515.95	100.02
Plausible value in science	4891	516.11	100.16
Plausible value in science	4891	516.04	99.93
Plausible value in science	4891	516.70	99.61
Plausible value in science	4891	516.23	99.76

Regression analysis results. Factors that positively mattered for female secondary school students in Germany in regards to intention to study science postsecondary included the school, parent, student, and peer. Most important was a student index, which included the female students' instrumental motivation to learn science (odds ratio = 2.43, $p < .001$). Results indicated that, compared with students who were not instrumentally motivated in science, those who were had 143% higher odds of their intention to study science postsecondary with all other variables in the model held constant. Three other student variables are viewed as important predictors. They included enjoyment of science index (odds ratio = 1.45, $p < .001$), personal value of science index (odds ratio = 1.44, $p < .001$) and science self-concept index (odds ratio = 1.40, $p < .001$). It is of interest to note that in contrast to the positive relationship for the personal value of science index, the general value of science index is negative (odds ratio = 0.87, $p < .001$). Also of the science self-belief factors, the science self-concept index reported a positive relationship, and science self-efficacy was not found to matter for female secondary students in Germany in regard to intention to study science postsecondary.

Of the school variables, school activities to promote science learning was found to positively matter (odds ratio = 1.33, $p < .001$). This index included student responses involving if their school had activities that promoted science learning, such as science clubs, fairs, competitions or projects, and field trips. This result indicated that, compared with schools that did not have activities to promote science learning, those schools with respective activities had 33% higher odds of female intention to study science postsecondary, with all other variables in the model held constant. This index was found to positively matter in only one other country in this analysis. Germany was one of seven countries to report a positive odds ratio and one of two countries greater than or equal to 2.00 for the proportion of female students at school variable. An odds ratio value of 2.00 ($p < .001$) indicated that, compared with schools that did not have a high proportion of female students at school, those that did had 100% higher odds of female intention to study science postsecondary with all other variables in the model held constant.

An important parent variable was the PISA 2006 index, which includes the parents' report on science career motivation and their related expectations (odds ratio = 2.05, $p < .001$). This equates to a 105% increase in female intention to study science postsecondary when all other variables in the model were held constant. Moreover, Germany was one of only two countries to report a positive odds ratio value for the PISA 2006 derived index indicative of socioeconomics (odds ratio = 1.22, $p < .001$). This result indicated a 22% increase in female intention to study science postsecondary with all other variables in the model held constant.

Science content obtained by a female high school student from peers was a positive factor in regard intention to study science postsecondary when all other variables in the model are held equal. This was observed by collectively examining the point estimates for each item within the respective category and the exponentiation of their sum to obtain the odds ratio.

In regard to the Germany model as a whole, female students were motivated to learn school science, enjoy and personally value science, and have confidence in their related ability. Other influencing factors included school offerings to promote science learning, parent view of science career motivation, and socioeconomic background. Peers also were important.

Table 10

Germany Model by Construct

Variable	Odds ratio	Std. error	Significance
Student			
General value of science index	0.87	0.02	***
Personal value of science index	1.44	0.02	***
Science self-concept index	1.40	0.02	***
Enjoyment of science index	1.45	0.02	***
Instrumental motivation in science index	2.43	0.03	***
Parent			
Parent report on science career motivation index	2.05	0.03	***
Parent personal value of science index	0.85	0.02	***
Economic, social and cultural status index	1.22	0.02	***
Sci info - Photosynthesis – family	1.32	0.05	***
Sci info – Continents – family	0.77	0.04	***
Sci info – Genes – family	0.75	0.02	***
Sci info – Climate change- family	1.26	0.02	***
Sci info – Evolution – family	1.29	0.04	***
Sci info – Health – family	0.80	0.03	***
Peer			
Sci info – Continents - friends	1.70	0.11	***
Sci info - Genes - friends	2.36	0.07	***
Sci info – Evolution – friends	0.70	0.05	***

Table 10 (continued)

Germany Model by Construct

Variable	Odds ratio	Std. error	Significance
Sci info – Nuclear energy - friends	0.84	0.06	**
Sci info - Health - friends	0.74	0.01	***
School			
Participate business/industry lectures	0.82	0.01	***
Proportion of girls at school	2.00	0.13	***
School activities to promote the learning of science index	1.33	0.02	***
Sci info - Continents – school	0.90	0.03	***
Sci info – Nuclear energy - school	0.86	0.02	***
Sci info - Health - school	0.82	0.03	***

Note. $N = 2794$.

* $p < 0.05$ ** $p < 0.01$ *** $p < .001$.

Denmark. ***Descriptive statistics results.*** Table 11 shows the variables included in the Denmark country analysis and lists the independent variables by construct (student, parent, peer, and school). The descriptive statistics reflect the total sample inclusive of all variables from which the Denmark model depicted in Table 12 was built. The model ultimately selected a series of variables that were the most important in predicting, among females in Denmark, their intention to major in science postsecondary. The total sample listed in Table 11 is the number of times that specific variable was represented in the Denmark sample. The mean and standard deviation for each respective variable is also stated. Several of the student indices for the Denmark sample reported a mean value below 0. They included the following: general value of science, personal value of science, science self-efficacy, science self-concept, general interest in learning science, science activities, enjoyment of science and science activities. School teaching specific indices below 0 included the following: preparation for a science related career, interaction, investigation and school activities to promote science learning. Parent indices below the average included the following: parent importance of science, parent general value of science, and parent personal value of science. The PISA index of economic, social, and cultural status was above the OECD average (OECD, 2009b). Science performance was slightly below the OECD average. In regard to derived science content (coded 1 for tick or selected and 0 for no tick or not selected), females in this sample reported that most is learned from school with means closer to 1.

Table 11

Descriptive Statistics for Denmark Sample by Construct

Variable	*N*	Mean	Std. Deviation
Student			
General value of science index	4492	-.28	.84
Personal value of science index	4488	-.18	1.00
Self - Do well science	4218	1.89	.79
Science self-efficacy index	4482	-.09	1.02
Science self-concept index	4243	-.09	1.00
General interest in learning science index	4478	-.17	1.05
Enjoyment of science index	4493	-.08	.97
Science activities index	4501	-.15	.97
Instrumental motivation in science index	4216	.03	.96
Parent			
Science activities at age 10 index	2781	.01	.94
Parent view - importance of science index	2723	-.49	.89
Parent reports on science career motivation index	2748	.04	1.04
Parent general value of science index	2766	-.23	.99
Parent personal value of science index	2758	-.01	1.00
Either parent science-related career	4334	.20	.40
Economic, social and cultural status index	4496	.30	.89
Sci info - Photosynthesis - family	4526	.08	.27
Sci info - Continents - family	4526	.10	.30
Sci info - Genes - family	4526	.10	.30
Sci info - Climate change - family	4526	.13	.34
Sci info - Evolution - family	4526	.11	.31
Sci info - Nuclear energy – family	4526	.16	.36
Sci info - Health – family	4526	.55	.50
Peer			
Sci info - Photosynthesis - friends	4526	.02	.15
Sci info - Continents - friends	4526	.02	.12
Sci info - Genes – friends	4526	.02	.15
Sci info - Climate change - friends	4526	.03	.18
Sci info - Evolution - friends	4526	.04	.19

Table 11 (continued)

Descriptive Statistics for Denmark Sample by Construct

Variable	*N*	Mean	Std. Deviation
Sci info - Nuclear energy - friends	4526	.05	.22
Sci info - Health - friends	4526	.20	.40
School			
School preparation for science-related careers	4461	-.05	.90
Science Teaching - Interaction	4246	-.01	.92
Science Teaching - Hands-on activities	4246	.66	.77
Science Teaching - Student investigations	4228	-.11	.91
Science Teaching - Focus on applications or models	4229	.19	.80
Sci info - Photosynthesis - school	4526	.91	.28
Sci info - Continents - school	4526	.69	.46
Sci info - Genes - school	4526	.89	.31
Sci info - Climate change - school	4526	.85	.35
Sci info - Evolution - school	4526	.75	.43
Sci info - Nuclear energy - school	4526	.86	.35
Sci info - Health - school	4526	.79	.40
Participate business/industry lectures	3782	2.15	.66
Participate business/industry visits	3765	2.42	.62
Proportion of girls at school	3549	.50	.04
School activities to promote the learning of science index	3759	-.84	.73
Science performance			
Plausible value in science	4532	495.12	92.46
Plausible value in science	4532	495.01	92.49
Plausible value in science	4532	494.78	93.24
Plausible value in science	4532	494.11	92.62
Plausible value in science	4532	494.56	92.96

Regression analysis results. Factors that positively mattered for female secondary school students in Denmark in regards to intention to study science postsecondary included the student and parent. Most important was the student index instrumental motivation to learn science (odds ratio = 4.14, $p < .001$). Results indicated that, compared with students who were not instrumentally motivated to learn science, those that were had 314% higher odds of intention to study science postsecondary with all other variables in the model held constant. Three additional student variables were important predictors. They included enjoyment of science index (odds ratio = 2.30, $p < .001$), personal value of science index (odds ratio = 1.62, $p < .001$), science-related activities index (odds ratio = 1.42, $p < .001$), and science self-concept index (odds ratio = 1.19, $p < .01$). Of science values, personal value positively mattered and general value negatively.

This is followed by important parent variables in regard to female intention to study science postsecondary. The PISA 2006 index parents' report on science career motivation and their related expectations reported a positive relationship (odds ratio = 1.93, $p < .001$). Results indicated that compared to students whose parents did not have expectations for their child in regard to science, those who did had 93% higher odds of female intention to study science postsecondary with all other variables held constant. Denmark was the only country in this analysis that reported a positive odds ratio value for the index concerning parents' view on the general value of science (odds ratio = 1.27, $p < .001$). Having either parent work in a science occupation also had a positive relationship in regard to female intention to study science postsecondary.

With all variables in the model held equal, science content obtained by a female high school student from each category, parents, school, and/or peer did not contribute positively. This was observed by collectively examining the point estimates for each item within the respective category and the exponentiation of their sum to obtain the odds ratio.

In regard to the Denmark model, female students must be motivated to learn school science, enjoy and personally value science, and have confidence in their related ability. Other influencing factors included parent view of science career motivation and whether the parents themselves maintain an occupation in a science field.

Table 12

Denmark Model by Construct

Variable	Odds ratio	Std. error	Significance
Student			
General value of science index	0.65	0.04	***
Personal value of science index	1.62	0.05	***
Science self-concept index	1.19	0.06	**
Science activities index	1.42	0.03	***
Enjoyment of science index	2.30	0.04	***
Instrumental motivation in science index	4.14	0.04	***
Parent			
Parents report on science career motivation index	1.93	0.03	***
Parent general value of science index	1.27	0.01	***
Parent personal value of science index	0.82	0.03	***
Either parent science-related career	1.03	0.17	***
Sci info - Photosynthesis – family	2.10	0.06	***
Sci info – Continents – family	0.78	0.03	***
Sci info – Genes – family	0.81	0.08	**
Sci info – Climate change- family	1.22	0.07	**
Sci info – Nuclear energy – family	0.60	0.06	***
Sci info – Health – family	0.67	0.05	***
Peer			
Sci info - Photosynthesis - friends	0.56	0.21	**
Sci info - Continents - friends	0.53	0.16	***
Sci info - Genes - friends	2.37	0.08	***
Sci info - Evolution – friends	1.40	0.02	***
School			
Science Teaching - Focus on applications or models index	0.80	0.03	**
Science Teaching – Hands on activities index	0.89	0.04	***
Participate business/industry lectures	0.84	0.01	***
Participate business/industry visits	0.83	0.02	***
Proportion of girls at school	0.23	0.72	*
Sci info - Photosynthesis – school	0.64	0.01	***
Sci info - Continents – school	0.66	0.09	***
Sci info - Genes – school	0.70	0.06	***
Sci info – Climate change – school	0.76	0.11	*
Sci info - Evolution – school	0.52	0.11	***
Sci info - Nuclear energy - school	1.46	0.12	**
Sci info - Health - school	1.56	0.06	***

Note. $N = 1455$.

* $p < 0.05$ ** $p < 0.01$ *** $p < .001$.

Hong Kong-China. ***Descriptive statistics results.*** Table 13 shows the variables included in the Hong Kong-China country analysis and lists the independent variables by construct (student, parent, peer, and school). The descriptive statistics reflect the total sample inclusive of all variables from which the Hong Kong-China model depicted in Table 14 was built. The model ultimately selected a series of variables that were the most important in predicting, among females in Hong Kong-China, their intention to major in science postsecondary. The total sample listed in Table 13 is the number of times that specific variable was represented in the Hong Kong-China sample. The mean and standard deviation for each respective variable is also stated. All the student indices for the Hong Kong-China sample reported a mean value greater than 0 with the exception of science self-concept. All school teaching specific indices were above the OECD average of 0 with the exception of school preparation for science related career and interaction. The PISA index of economic, social and cultural status was below the OECD average (OECD, 2009b). Science performance was above the OECD average. In regard to derived science content (coded 1 for tick or selected and 0 for no tick or not selected), females in this sample reported that most is learned from school with means closer to 1.

Table 13

Descriptive Statistics for Hong Kong-China Sample by Construct

Variable	*N*	Mean	Std. Deviation
Student			
General value of science index	4629	.54	1.01
Personal value of science index	4629	.52	.89
Self - Do well science	3721	1.97	.96
Science self-efficacy index	4629	.07	.95
Science self-concept index	3713	-.26	.96
General interest in learning science index	4626	.20	.97
Enjoyment of science index	4628	.38	.89
Science activities index	4629	.26	.99
Instrumental motivation in science index	3716	.16	.94

Table 13 (continued)

Descriptive Statistics for Hong Kong-China Sample by Construct

Variable	*N*	Mean	Std. Deviation
Parent			
Science activities at age 10 index	4523	.13	1.01
Parent view - importance of science index	4532	.15	.95
Parent reports on science career motivation index	4532	.04	.85
Parent general value of science index	4534	.07	.94
Parent personal value of science index	4534	.27	.86
Either parent science-related career	4542	.06	.23
Economic, social and cultural status index	4614	-.67	.93
Sci info - Photosynthesis - family	4630	.07	.26
Sci info - Continents - family	4630	.06	.23
Sci info - Genes - family	4630	.06	.24
Sci info - Climate change - family	4630	.11	.31
Sci info - Evolution - family	4630	.06	.24
Sci info - Nuclear energy – family	4630	.05	.22
Sci info - Health – family	4630	.47	.50
Peer			
Sci info - Photosynthesis - friends	4630	.04	.20
Sci info - Continents - friends	4630	.02	.15
Sci info - Genes – friends	4630	.03	.16
Sci info - Climate change - friends	4630	.04	.19
Sci info - Evolution - friends	4630	.06	.19
Sci info - Nuclear energy - friends	4630	.03	.18
Sci info - Health - friends	4630	.20	.40
School			
School preparation for science-related careers index	4623	-.13	.89
Science Teaching - Interaction index	3728	-.29	.84
Science Teaching - Hands-on activities index	3728	.29	.86
Science Teaching - Student investigations index	3721	.22	.85
Science Teaching - Focus on applications or models index	3721	.00	.95
Sci info - Photosynthesis - school	4630	.96	.20
Sci info - Continents - school	4630	.78	.41
Sci info - Genes - school	4630	.59	.49
Sci info - Climate change - school	4630	.83	.38
Sci info - Evolution - school	4630	.40	.49
Sci info - Nuclear energy - school	4630	.77	.42
Sci info - Health - school	4630	.80	.40
Participate business/industry lectures	4611	2.18	.75

Table 13 (continued)

Descriptive Statistics for Hong Kong-China Sample by Construct

Variable	*N*	Mean	Std. Deviation
Participate business/industry visits	4611	2.12	.74
Proportion of girls at school	4645	.51	.21
School activities to promote the learning of science index	4645	.94	.64
Science performance			
Plausible value in science	4645	546.09	90.77
Plausible value in science	4645	545.65	90.36
Plausible value in science	4645	546.16	91.06
Plausible value in science	4645	546.28	90.48
Plausible value in science	4645	546.26	90.34

Regression analysis results. Factors that positively mattered for female secondary school students in Hong Kong-China in regards to intention to study science postsecondary included the student and parent. Most important was a student variable and PISA 2006 index instrumental motivation to learn science (odds ratio = 2.83, $p < .001$). Results indicated that, compared with students who were not instrumentally motivated to learn science, those who were had 183% higher odds of their intention to study science postsecondary with all other variables held constant in the model.

Several other student variables were important predictors. They included the enjoyment of science index (odds ratio = 2.29, $p < .001$), science self-concept index (odds ratio = 1.48, $p < .001$), science activities index (odds ratio = 1.31, $p < .001$), and the general interest in learning science index (odds ratio = 1.29, $p < .001$). Hong Kong female students also reported a strong positive relationship for self-do well in science (odds ratio = 1.92, $p < .001$). Results indicated that, compared with students who did not feel it was important to do well in science, those that did had 92% higher odds of their intention to study science postsecondary with all other variables in the model held equal. Hong Kong female students were one of three countries included in this analysis to report that general interest in learning science positively mattered (odds ratio = 1.29, $p < .001$) and the only country in this analysis to report the PISA 2006 attitude index personal value of science was not significant to the model.

Other important predictors of female intention to study science postsecondary were two parent variables. First, the PISA 2006 index parents' report on science career motivation and their related expectations had a positive relationship (odds ratio = 1.81, $p < .001$). It was also important to note that Hong Kong-China female secondary students reported the highest odds ratio (1.46, $p < .001$) for having either parent working in a science occupation. Results indicated that, compared to students who did not have either parent working in a science field, those that did had 46% higher odds of their intention to study science postsecondary when all other variables in the model were held constant.

Science content obtained by a female high school student from parents was a positive factor in regard intention to study science postsecondary with all other variables in the model held equal. This was observed by collectively examining the point estimates for each item within the respective category and the exponentiation of their sum to obtain the odds ratio. Hong Kong-China female secondary students reporting that derived content from parents was important supported or coincided with the finding that Hong Kong female secondary students reported that having either parent work in a science occupation in addition to parent view on science career motivation were important, as previously mentioned.

In regard to the Hong Kong-China model, female students must be motivated to learn school science, enjoy science, be engaged in science activities, and have confidence in their related ability. Other influencing factors included parent view of science career motivation and whether the parents themselves maintain an occupation in a science field.

Table 14

Hong Kong-China Model by Construct

Variable	Odds ratio	Std. error	Significance
Student			
General value of science index	0.82	0.02	***
Science self-concept index	1.48	0.03	***
General interest in learning science index	1.29	0.01	***
Science activities index	1.31	0.02	***
Enjoyment of science index	2.29	0.01	***
Instrumental motivation in science index	2.83	0.04	***
Self - Do well science	1.92	0.02	***
Parent			
Parent report on science career motivation index	1.81	0.01	***
Parent view - importance of science index	0.85	0.01	***
Economic, social and cultural status index	0.80	0.01	***
Either parent science-related career	1.46	0.05	***
Sci info - Photosynthesis – family	1.39	0.06	***
Sci info – Continents – family	0.83	0.04	***
Sci info – Genes – family	0.70	0.02	***
Sci info – Climate change- family	1.34	0.04	***
Sci info – Evolution – family	0.83	0.04	***
Sci info – Nuclear energy – family	1.37	0.06	***
Sci info – Health – family	1.12	0.04	**
Peer			
Sci info - Continents - friends	1.82	0.06	***
Sci info - Genes - friends	0.69	0.04	***
Sci info - Climate change – friends	0.63	0.05	***
Sci info - Nuclear energy – friends	1.19	0.03	***
School			
Science Teaching – Interaction index	0.80	0.03	***
Sci info - Continents – school	0.79	0.04	***
Sci info - Genes – school	1.18	0.03	***
Sci info – Climate change – school	0.89	0.03	***
Sci info - Nuclear energy - school	0.75	0.03	***

Note. $N = 3221$.

* $p < 0.05$ ** $p < 0.01$ *** $p < .001$.

Croatia. ***Descriptive statistics results.*** Table 15 shows the variables included in the Croatia country analysis and lists the independent variables by construct (student, parent, peer, and school). The descriptive statistics reflect the total sample inclusive of all variables from which the Croatia model depicted in Table 16 was built. The model ultimately selected a series of variables that were the most important in predicting, among females in Croatia, their intention to major in science postsecondary. The total sample listed in Table 15 is the number of times that specific variable was represented in the Croatia sample. The mean and standard deviation for each respective variable is also stated. All the student indices for the Croatia sample reported a mean value greater than 0, with the exception of science self-concept. All school teaching specific indices were above the OECD average of 0, with the exception of hands-on activities. Parent attitudinal indices were above the OECD average with the exception of parent view on the importance of science and parents reports on science career motivation. The PISA index of economic, social, and cultural status was less than 0 and below the OECD average (OECD, 2009b). Science performance was slightly below the OECD average. In regard to derived science content (coded 1 for tick or selected and 0 for no tick or not selected), females in this sample reported that most is learned from school with means closer to 1.

Table 15

Descriptive Statistics for Croatia Sample by Construct

Variable	*N*	Mean	Std. Deviation
Student			
General value of science index	5196	.15	.90
Personal value of science index	5191	.19	.87
Self - Do well science	4479	1.76	.83
Science self-efficacy index	5194	.14	.90
Science self-concept index	4545	-.03	.86
General interest in learning science index	5185	.17	.87
Enjoyment of science index	5202	.10	.90
Science activities index	5163	.36	.85
Instrumental motivation in science index	4461	.05	.93
Parent			
Science activities at age 10 index	4962	.19	.88
Parents view - importance of science index	4978	-.28	.96
Parents reports on science career motivation index	4981	-.08	.96

Table 15 (continued)

Descriptive Statistics for Croatia Sample by Construct

Variable	*N*	Mean	Std. Deviation
Parent general value of science index	4981	.11	.96
Parent personal value of science index	4974	.18	.93
Either parent science-related career	5134	.18	.39
Economic, social and cultural status index	5205	-.11	.87
Sci info - Photosynthesis - family	5207	.07	.26
Sci info - Continents - family	5207	.13	.34
Sci info - Genes - family	5207	.12	.33
Sci info - Climate change - family	5207	.13	.34
Sci info - Evolution - family	5207	.12	.32
Sci info - Nuclear energy – family	5207	.13	.33
Sci info - Health – family	5207	.62	.49
Peer			
Sci info - Photosynthesis - friends	5207	.03	.18
Sci info - Continents - friends	5207	.04	.19
Sci info - Genes – friends	5207	.02	.15
Sci info - Climate change - friends	5207	.04	.19
Sci info - Evolution - friends	5207	.04	.19
Sci info - Nuclear energy - friends	5207	.04	.21
Sci info - Health - friends	5207	.19	.40
School			
School preparation for science-related careers index	5177	.19	.95
Science Teaching - Interaction index	4553	.28	.97
Science Teaching - Hands-on activities index	4547	-.35	1.04
Science Teaching - Student investigations index	4529	.24	.97
Science Teaching - Focus on applications or models index	4529	.11	1.02
Sci info - Photosynthesis - school	5207	.96	.19
Sci info - Continents - school	5207	.86	.35
Sci info - Genes - school	5207	.94	.23
Sci info - Climate change - school	5207	.85	.35
Sci info - Evolution - school	5207	.88	.32
Sci info - Nuclear energy - school	5207	.69	.46
Sci info - Health - school	5207	.66	.47
Participate business/industry lectures	4946	1.57	.70
Participate business/industry visits	5082	2.19	.79
Proportion of girls at school	5127	.50	.26
School activities to promote the learning of science index	5213	.14	1.03

Table 15 (continued)

Descriptive Statistics for Croatia Sample by Construct

Variable	*N*	Mean	Std. Deviation
Science Performance			
Plausible value in science	5213	493.50	85.27
Plausible value in science	5213	494.19	85.13
Plausible value in science	5213	493.58	85.64
Plausible value in science	5213	493.69	85.11
Plausible value in science	5213	493.50	85.27

Regression analysis results. Factors that positively mattered for female secondary school students in Croatia in regards to female intention to study science postsecondary included the school, student, parent, and peer.

The two highest reporting odds ratio values included the parent and student constructs. For the student, the science attitude index personal value of science was important (odds ratio = 1.77, $p < .001$). This result indicated that, compared with students who did not personally value science, those who did had 77% higher odds of their intention to study science postsecondary with all other variables in the model held equal. This was followed by several student variables with positive relationships in regard to female intention to study science postsecondary and included the following: instrumental motivation to learn science index (odds ratio = 1.73, $p < .001$), enjoyment of science index (odds ratio = 1.72, $p < .001$), science activities (odds ratio = 1.40, $p < .001$), and science self-concept index (odds ratio = 1.12, $p < .001$). Similar to several other countries, the student personal value of science was a positive factor (odds ratio = 1.77, $p < .001$) and general value of science negative (odds ratio = 0.75, $p < .001$). Similar to other countries, science self-concept positively mattered (odds ratio = 1.12, $p < .001$), but science self-efficacy was not significant to female intention to study science postsecondary. The attitude variable self-do well in science was a positive factor (odds ratio = 1.26, $p < .001$).

The PISA 2006 index parents' view on science career motivation and their related expectations was very important to female intention to study science postsecondary (odds ratio = 1.77, $p < .001$). Another parent variable reporting a positive relationship was whether either parent has an occupation in science (odds ratio = 1.15, $p < .001$).

In regard to the school variables, Croatia was one of three countries to report that science teaching related to hands-on activities (odds ratio = 1.11, $p < .001$), and student investigations (odds ratio = 1.27, $p < .001$) positively mattered. Croatia was one of seven countries that reported that the proportion of female enrollment positively mattered (odds ratio = 1.20, $p < .001$).

Science content obtained by a female high school student from peers was a positive factor in regard intention to study science postsecondary with all other variables in the model held equal. This was observed by collectively examining the point estimates for each item within the respective category and the exponentiation of their sum to obtain the odds ratio.

Considering the Croatia model, female students must be motivated to learn school science, enjoy and personally value science, partake in science-related activities, and have confidence in their related ability. Other influencing factors included parents' view of science career motivation and whether the parents themselves maintain an occupation in a science field. The school was also an important factor particularly the experiments that a school encourages a student to conduct and how the teacher explains science relevance. Peers were another influencing factor.

Table 16

Croatia Model by Construct

Variable	Odds ratio	Std. error	Significance
Student			
General value of science index	0.75	0.01	***
Personal value of science index	1.77	0.01	***
Science self-concept index	1.12	0.02	***
Science activities index	1.40	0.02	***
Enjoyment of science index	1.72	0.01	***
Instrumental motivation in science index	1.73	0.01	***
Self - Do well science	1.26	0.01	***
Parent			
Parent report on science career motivation index	1.77	0.01	***
Science activities at age 10 index	0.89	0.02	***
Either parent science-related career	1.15	0.02	***
Sci info – Continents – family	0.78	0.03	***
Sci info – Genes – family	1.16	0.04	***
Sci info – Health – family	0.86	0.02	***
Peer			
Sci info - Photosynthesis - friends	1.15	0.06	*
Sci info - Continents - friends	0.71	0.05	***
Sci info - Genes - friends	1.26	0.07	**
Sci info - Evolution – friends	1.15	0.04	**
Sci info - Health – friends	0.88	0.04	**
School			
Participate business/industry visits	0.86	0.02	***
Science Teaching – Interaction index	0.82	0.02	***
Science Teaching - Hands-on activities index	1.11	0.01	***
Science Teaching - Student investigations index	1.27	0.02	***
Science Teaching - Focus on applications or models index	0.87	0.01	***
Proportion of girls at school	1.20	0.05	***
Sci info - Continents – school	0.67	0.02	***
Sci info - Genes – school	1.13	0.04	**

Note. $N = 3387$.

* $p < 0.05$ ** $p < 0.01$ *** $p < .001$.

Iceland. ***Descriptive statistics results***. Table 17 shows the variables included in the Iceland country analysis and lists the independent variables by construct (student, parent, peer, and school). The descriptive statistics reflect the total sample inclusive of all variables from which the Iceland model depicted in Table 18 was built. The model ultimately selected a series of variables that were the most important in predicting, among females in Iceland, their intention to major in science postsecondary. The total sample listed in Table 17 is the number of times that specific variable was represented in the Iceland sample. The mean and standard deviation for each respective variable is also stated. There were several student attitudinal indices reporting values below the OECD mean, which included the following: general value of science, personal value of science, general interest in learning science, enjoyment of science, and science activities. Several school teaching specific indices were below the OECD average of 0, which included the following concentrations: interaction, hands-on activities, investigations, applications or models, and school activities to promote science learning. Parent attitudinal indices reporting values below the OECD mean included science activities at age 10, parent view on the importance of science, parent general value of science, and personal value of science. The PISA index of economic, social, and cultural status was above the OECD average (OECD, 2009b). Science performance was below the OECD average. In regard to derived science content (coded 1 for tick or selected and 0 for no tick or not selected), females in this sample reported that most is learned from school with means closer to 1.

Table 17

Descriptive Statistics for Iceland Sample by Construct

Variable	*N*	Mean	Std. deviation
Student			
General value of science index	3729	-.19	1.05
Personal value of science index	3728	-.15	1.15
Self - Do well science	3548	1.97	.94
Science self-efficacy index	3747	.13	1.16
Science self-concept index	3559	.10	1.10
General interest in learning science index	3740	-.15	1.18
Enjoyment of science index	3752	-.032	1.14
Science activities index	3740	-.22	1.05

Table 17 (continued)

Descriptive Statistics for Iceland Sample by Construct

Variable	*N*	Mean	Std. deviation
Instrumental motivation in science index	3549	.09	1.12
Parent			
Science activities at age 10 index	2426	-.40	1.09
Parent view - importance of science index	2404	-.49	.91
Parent reports on science career motivation index	2412	.13	1.14
Parent general value of science index	2413	-.14	1.02
Parent personal value of science index	2399	-.17	1.03
Either parent science-related career	3696	.25	.43
Economic, social and cultural status index	3745	.77	.88
Sci info - Photosynthesis - family	3757	.06	.23
Sci info - Continents - family	3757	.09	.23
Sci info - Genes - family	3757	.08	.27
Sci info - Climate change - family	3757	.11	.31
Sci info - Evolution - family	3757	.07	.25
Sci info - Nuclear energy – family	3757	.12	.32
Sci info - Health – family	3757	.52	.50
Peer			
Sci info - Photosynthesis - friends	3757	.02	.15
Sci info - Continents - friends	3757	.02	.15
Sci info - Genes – friends	3757	.02	.14
Sci info - Climate change - friends	3757	.03	.17
Sci info - Evolution - friends	3757	.02	.16
Sci info - Nuclear energy - friends	3757	.06	.24
Sci info - Health - friends	3757	.24	.43
School			
School preparation for science-related careers index	3725	.05	1.01
Science Teaching - Interaction index	3551	-.19	.87
Science Teaching - Hands-on activities index	3549	-.63	.97
Science Teaching - Student investigations index	3547	-.43	.87
Science Teaching - Focus on applications or models index	3548	-.014	.99
Sci info - Photosynthesis - school	3757	.93	.25
Sci info - Continents - school	3757	.84	.37
Sci info - Genes - school	3757	.95	.23
Sci info - Climate change - school	3757	.85	.35
Sci info - Evolution - school	3757	.89	.31
Sci info - Nuclear energy - school	3757	.77	.42
Sci info - Health - school	3757	.62	.48

Table 17 (continued)

Descriptive Statistics for Iceland Sample by Construct

Variable	*N*	Mean	Std. deviation
Participate business/industry lectures	3631	1.86	.73
Participate business/industry visits	3494	2.00	.71
Proportion of girls at school	3654	.49	.04
School activities to promote the learning of science index	3633	-.72	.67
Science performance			
Plausible value in science	3789	490.80	96.54
Plausible value in science	3789	491.11	96.58
Plausible value in science	3789	490.17	96.47
Plausible value in science	3789	491.50	97.00
Plausible value in science	3789	491.19	96.60

Regression analysis results. Factors that positively mattered for female secondary school students in Iceland in regards to intention to study science postsecondary included the student, parent, and school. The most important was a student variable and PISA 2006 index instrumental motivation to learn science (odds ratio = 2.97, $p < .001$). Results indicated that, compared with students who were not instrumentally motivated to learn science, those who were had 197% higher odds of their intention to student science postsecondary with all other variables in the model held constant.

Several other student variables were important factors. The following reported positive relationships: enjoyment of science index (odds ratio = 1.81, $p < .001$), personal value of science index (odds ratio = 1.58, $p < .001$), science activities index (odds ratio = 1.46, $p < .001$), and science self-concept index (odds ratio = 1.28, $p < .001$). Like several other countries in this analysis, the personal value of science index was a positive factor (odds ratio = 1.58, $p < .001$) and general value of science index negative (odds ratio = 0.90, $p < .01$). Also, the science self-concept index positively mattered; however, science self-efficacy was not found to be significant for the Iceland model. The attitude variable self-do well in science was also seen as a positive factor (odds ratio = 1.31, $p < .001$).

Several parent factors were positively important in the Iceland model. First, an important predictor of female intention to study science postsecondary was parents' reports on science career motivation and their related expectations (odds ratio = 1.47, $p < .001$). Results indicated that, compared with students whose parents did not have expectations in regard to their child's future studies in science, those that did had 47% higher odds of female intention to study science postsecondary. Iceland also reported the second highest odds ratio value for either parent working in a science occupation (odds ratio = 1.31, $p < .001$). The parents' personal value of science index was also a positive factor (odds ratio = 1.16, $p < .001$). Iceland was the only country in this analysis to report this variable positively mattered.

Of the school variables, only one positively mattered. The one school variable with a positive odds ratio (1.13, $p < .001$) concerned whether the school offered opportunities to participate in science industry lectures.

Science content obtained by a female high school student from parents was a positive factor in regard to intention to study science postsecondary and schools and peers negatively. This was observed by collectively examining the point estimates for each item within the respective category and the exponentiation of their sum to obtain the odds ratio. Iceland female secondary students reporting that derived content from parents was important supported or coincided with the finding that Iceland female secondary students report that having either parent work in a science occupation is important, as previously mentioned. Both are findings similar to only Hong Kong-China.

When considering the model for Iceland, it is very important for female students to be motivated to learn science that is taught in school, enjoy and personally value science, engage in science activities, as well as have parents who have expectations that their child will subsequently study, major, and/or have a career in science and parents who themselves personally value science. Having a parent work in a science field is also viewed as an influencing factor.

Table 18

Iceland Model by Construct

Variable	Odds ratio	Std. error	Significance
Student			
General value of science index	0.90	0.04	**
Personal value of science index	1.58	0.04	***
Science self-concept index	1.28	0.03	***
Science activities index	1.46	0.02	***
Enjoyment of science index	1.81	0.04	***
Instrumental motivation in science index	2.97	0.02	***
Self - Do well science	1.31	0.02	***
Parent			
Parent report on science career motivation index	1.47	0.02	***
Parent general value of science index	0.82	0.02	***
Parent personal value of science index	1.16	0.01	***
Either parent science-related career	1.31	0.04	***
Economic, social and cultural status index	0.82	0.03	***
Sci info – Photosynthesis – family	1.48	0.11	***
Sci info – Continents – family	0.76	0.07	***
Sci info – Genes – family	0.67	0.04	***
Sci info – Climate change – family	1.41	0.07	***
Sci info – Evolution – family	1.40	0.06	***
Sci info – Nuclear energy – family	1.11	0.04	*
Sci info – Health – family	0.77	0.06	***
Peer			
Sci info - Photosynthesis - friends	1.34	0.09	**
Sci info - Continents - friends	0.59	0.13	***
Sci info - Genes - friends	0.32	0.10	***
Sci info - Climate change – friends	2.45	0.08	***
Sci info - Health – friends	1.35	0.03	***

Table 18 (continued)

Iceland Model by Construct

Variable	Odds ratio	Std. error	Significance
School			
Participate business/industry lectures	1.13	0.02	***
Proportion of girls at school	0.14	0.53	***
Sci info - Continents – school	0.78	0.06	***
Sci info - Genes – school	0.41	0.07	***
Sci info – Climate change – school	1.29	0.03	***
Sci info - Evolution – school	1.17	0.05	**
Sci info – Nuclear energy – school	0.78	0.06	***

Note. $N = 1741$.

* $p < 0.05$ ** $p < 0.01$ *** $p < .001$.

Italy. ***Descriptive statistics results***. Table 19 shows the variables included in the Italy country analysis and lists the independent variables by construct (student, parent, peer, and school). The descriptive statistics reflect the total sample inclusive of all variables from which the Italy model depicted in Table 20 was built. The model ultimately selected a series of variables that were the most important in predicting, among females in Italy, their intention to major in science postsecondary. The total sample listed in Table 19 is the number of times that specific variable was represented in the Italy sample. The mean and standard deviation for each respective variable is also stated. All the student indices for the Italy sample reported a mean value greater than 0 with the exception of general value of science and science self-efficacy. Several school teaching specific indices were below the OECD average of 0, which included the following: school preparation for science-related career, hands-on activities, student investigations, focus on applications or models and school activities to promote science learning. Parent report on science career motivation was below the OECD average. The PISA index of economic, social, and cultural status was less than 0 and below the OECD average (OECD, 2009b). Science performance was also below the OECD average. In regard to derived science content (coded 1 for tick or selected and 0 for no tick or not selected), females in this sample reported that most is learned from school with means closer to 1.

Table 19

Descriptive Statistics for Italy Sample by Construct

Variable	*N*	Mean	Std. Deviation
Student			
General value of science index	21659	-.04	.92
Personal value of science index	21650	.10	.85
Self - Do well science	19538	2.02	.75
Science self-efficacy index	21630	-.21	.79
Science self-concept index	19614	.12	.89
General interest in learning science index	21614	.13	.86
Enjoyment of science index	21657	.07	.88
Science activities index	21677	.21	.90
Instrumental motivation in science index	19613	.04	.87
Parent			
Science activities at age 10 index	18830	.17	.91
Parent view - importance of science index	18687	.09	.93
Parent reports on science career motivation index	18699	-.13	.99
Parent general value of science index	18774	.04	.98
Parent personal value of science index	18747	.20	.92
Either parent science-related career	21585	.14	.35
Economic, social and cultural status index	21683	-.08	.96
Sci info - Photosynthesis - family	21760	.04	.21
Sci info - Continents - family	21760	.06	.24
Sci info - Genes - family	21760	.08	.26
Sci info - Climate change - family	21760	.12	.33
Sci info - Evolution - family	21760	.11	.31
Sci info - Nuclear energy – family	21760	.09	.29
Sci info - Health – family	21760	.53	.50
Peer			
Sci info - Photosynthesis - friends	21760	.01	.10
Sci info - Continents - friends	21760	.01	.11
Sci info - Genes – friends	21760	.02	.13
Sci info - Climate change - friends	21760	.03	.16
Sci info - Evolution - friends	21760	.03	.17
Sci info - Nuclear energy - friends	21760	.02	.15
Sci info - Health - friends	21760	.11	.31
School			
School preparation for science-related careers index	21559	-.17	.99

Table 19 (continued)

Descriptive Statistics for Italy Sample by Construct

Variable	*N*	Mean	Std. Deviation
Science Teaching - Interaction index	19770	.32	.98
Science Teaching - Hands-on activities index	19747	-.41	1.13
Science Teaching - Student investigations index	19715	-.09	1.02
Science Teaching - Focus on applications or models index	19712	-.15	.98
Sci info - Photosynthesis - school	21760	.91	.28
Sci info - Continents - school	21760	.86	.35
Sci info - Genes - school	21760	.85	.35
Sci info - Climate change - school	21760	.69	.46
Sci info - Evolution - school	21760	.80	.40
Sci info - Nuclear energy - school	21760	.68	.47
Sci info - Health - school	21760	.57	.50
Participate business/industry lectures	20918	1.96	.82
Participate business/industry visits	21071	2.01	.81
Proportion of girls at school	20810	.50	.25
School activities to promote the learning of science index	21166	-.10	.83
Science performance			
Plausible value in science	21773	487.50	96.07
Plausible value in science	21773	487.30	96.00
Plausible value in science	21773	487.05	96.34
Plausible value in science	21773	486.77	95.82
Plausible value in science	21773	487.50	96.07

Regression analysis results. Factors that positively mattered for female secondary school students in Italy in regards to intention to study science postsecondary included the student, parent, and school. The most important was a student variable and PISA 2006 index, which included the female students' instrumental motivation to learn science (odds ratio = 2.17, $p < .001$). Results indicated that, compared with students who were not instrumentally motivated to learn science, those that were had 117% higher odds of their intention to study science postsecondary when all other variables in the model were held constant.

Several other student variables were important factors. They included the PISA 2006 science interest index enjoyment of science (odds ratio = 1.91, $p < .001$), science activities index (odds ratio = 1.37, p < .001), science self-concept index (odds ratio = 1.25, $p < .001$), personal value of science index (odds ratio = 1.20, $p < .001$) and science self-efficacy index (odds ratio = 1.15, $p < .001$). It was important to note that Italy is the only country included in this analysis that reported both science self-belief measures, science self-concept and science self-efficacy, as positive factors. Also, like other countries, personal value of science was a positive factor and general value of science negative (odds ratio = 0.83, $p < .001$). The attitude variable self-do well in science was also a positive factor (odds ratio = 1.39, $p < .001$).

Parent and school variables positively mattered. An important predictor of female intention to study science postsecondary was PISA 2006 parent index parents' report on science career motivation and their related expectations (odds ratio = 1.70, $p < .001$). Results indicated that, compared with students whose parents did not maintain child expectations in regard to future science studies, those that did had 70% higher odds of their intention to study science postsecondary with all other variables in the model held equal. Italy was also one of seven countries that reported that the proportion of female enrollment positively mattered (odds ratio= 1.71, $p < .001$).

Similar to Denmark, science content obtained in Italy by a female high school student from parents, school, and peer did not positively matter. This was observed by collectively examining the point estimates for each item within the respective category and the exponentiation of their sum to obtain the odds ratio.

Considering the Italy model, female students must be motivated to learn school science, enjoy and personally value science, partake in science-related activities, and have belief in their confidence as well as related content ability. Other influencing factors included parents' view of science career motivation. The school was also an important factor particularly when there is a high proportion of female enrollment.

Table 20

Italy Model by Construct

Variable	Odds ratio	Std. error	Significance
Student			
General value of science index	0.83	0.02	***
Personal value of science index	1.20	0.02	***
Science self-efficacy index	1.15	0.02	***
Science self-concept index	1.25	0.01	***
Science activities index	1.37	0.01	***
Enjoyment of science index	1.91	0.02	***
Instrumental motivation in science index	2.17	0.01	***
Self - Do well science	1.39	0.01	***
Parent			
Parent report on science career motivation index	1.70	0.01	***
Parent view - importance of science index	0.88	0.01	***
Either parent science-related career	0.92	0.01	**
Sci info – Continents – family	0.64	0.04	***
Sci info – Climate change – family	0.87	0.03	***
Sci info – Evolution – family	1.28	0.02	***
Sci info – Nuclear energy – family	1.11	0.03	***
Peer			
Sci info - Photosynthesis - friends	0.69	0.05	***
Sci info - Continents - friends	1.40	0.09	***
Sci info - Genes - friends	1.33	0.05	***
Sci info - Climate change – friends	1.18	0.06	**
Sci info - Evolution – friends	1.20	0.04	***
Sci info - Nuclear energy – friends	0.77	0.04	***
Sci info - Health – friends	1.23	0.02	***
School			
Science Teaching - Focus on applications or models index	0.89	0.01	***
Proportion of girls at school	1.71	0.02	***
Sci info - Photosynthesis – school	0.73	0.03	***
Sci info - Genes – school	0.83	0.02	***
Sci info - Evolution – school	1.16	0.01	***

Note. N = 14,202.

* $p < 0.05$ ** $p < 0.01$ *** $p < .001$.

Korea. ***Descriptive statistics results.*** Table 21 shows the variables included in the Korea country analysis and lists the independent variables by construct (student, parent, peer, and school). The descriptive statistics reflect the total sample inclusive of all variables from which the Korea model depicted in Table 22 was built. The model ultimately selected a series of variables that were the most important in predicting, among females in Korea, their intention to major in science postsecondary. The total sample listed in Table 21 is the number of times that specific variable was represented in the Korea sample. The mean and standard deviation for each respective variable is also stated. Several student indices for the Korea sample reported a mean value below the OECD average, which included the following: personal value of science, science self-efficacy, science self-concept, general interest in learning science, enjoyment of science, science activities, and instrumental motivation in science. Several school teaching specific indices were below the OECD average of 0, which included the following: school preparation for a science related career, interaction, hands-on activities, investigations, and focus on applications and models. Parent attitudinal related indices that reported values below the OECD average included the following: parent report on science career motivation and personal value of science. The PISA index of economic, social, and cultural status was below the OECD average (OECD, 2009b). Science performance was above the OECD average. In regard to derived science content (coded 1 for tick or selected and 0 for no tick or not selected), females in this sample reported that most is learned from school with means closer to 1.

Table 21

Descriptive Statistics for Korea Sample by Construct

Variable	*N*	Mean	Std. deviation
Student			
General value of science index	5169	.26	.97
Personal value of science index	5168	-.07	.87
Self - Do well science	5160	1.96	.76

Table 21 (continued)

Descriptive Statistics for Korea Sample by Construct

Variable	*N*	Mean	Std. deviation
Science self-efficacy index	5170	-.23	.90
Science self-concept index	5166	-.72	.95
General interest in learning science index	5157	-.25	.97
Enjoyment of science index	5172	-.18	1.00
Science activities index	5168	-.19	.98
Instrumental motivation in science index	5161	-.27	.94
Parent			
Science activities at age 10 index	5105	.08	1.06
Parent view - importance of science index	5103	.09	.83
Parent reports on science career motivation index	5102	-.071	.89
Parent general value of science index	5107	.13	1.00
Parent personal value of science index	5094	-.22	.94
Either parent science-related career	5143	.11	.31
Economic, social and cultural status index	5168	-.01	.82
Sci info - Photosynthesis - family	5159	.02	.12
Sci info - Continents - family	5159	.01	.10
Sci info - Genes - family	5159	.02	.15
Sci info - Climate change - family	5159	.04	.19
Sci info - Evolution - family	5159	.02	.15
Sci info - Nuclear energy – family	5159	.02	.14
Sci info - Health – family	5159	.21	.41
Peer			
Sci info - Photosynthesis - friends	5159	.02	.14
Sci info - Continents - friends	5159	.01	.11
Sci info - Genes – friends	5158	.01	.12
Sci info - Climate change - friends	5159	.02	.15
Sci info - Evolution - friends	5159	.02	.14
Sci info - Nuclear energy - friends	5159	.01	.10
Sci info - Health - friends	5159	.05	.22
School			
School preparation for science-related careers	5169	-.28	.91
Science Teaching - Interaction index	5158	-1.04	.95
Science Teaching - Hands-on activities index	5157	-.42	.93
Science Teaching - Student investigations index	5157	-.21	.90
Science Teaching - Focus on applications or models index	5158	-.34	.97
Sci info - Photosynthesis - school	5159	.88	.33
Sci info - Continents - school	5159	.87	.33
Sci info - Genes - school	5159	.87	.33

Table 21 (continued)

Descriptive Statistics for Korea Sample by Construct

Variable	*N*	Mean	Std. deviation
Sci info - Climate change - school	5159	.77	.42
Sci info - Evolution - school	5159	.76	.43
Sci info - Nuclear energy - school	5158	.63	.48
Sci info - Health - school	5158	.61	.49
Participate business/industry lectures	5176	1.64	.69
Participate business/industry visits	5141	1.51	.62
Proportion of girls at school	5176	.49	.38
School activities to promote the learning of science index	5176	.53	.88
Science performance			
Plausible value in science	5176	521.14	90.18
Plausible value in science	5176	521.96	89.99
Plausible value in science	5176	522.44	90.35
Plausible value in science	5176	522.36	90.61
Plausible value in science	5176	521.14	90.18

Regression analysis results. Factors that positively mattered for female students in Korea in regards to intention to study science postsecondary included the student, parent, and peer. Most important was a student variable and PISA 2006 index instrumental motivation to learn science (odds ratio = 4.19, $p < .001$). Korea reported this as the highest odds ratio value for this variable among all countries in the analysis. Results indicated that compared with students who are not instrumentally motivated to learn science, those that are have 319% higher odds of their intention to study science postsecondary when all other variables in the model were held constant.

Several other student variables were important factors. They included the following: enjoyment of science index (odds ratio = 2.41, $p < .001$), science self-concept index (odds ratio = 1.29, $p < .001$), personal value of science index (odds ratio = 1.26, $p < .001$), and science activities index (odds ratio = 1.13, $p < .001$). Like most countries included in this analysis, Korea reported that the self-belief variable science self-concept positively mattered, but the other self-belief component, science self-efficacy, was not found to be significant. Similar to other countries included in this analysis, the student attitude factor of personal value of science positively mattered, but the general value of science was found to be negative (odds ratio = 0.86, $p < .001$). The attitude variable self-do well in science was also a positive factor (odds ratio = 1.15, $p < .001$).

Another important predictor of female intention to study science postsecondary was two parent variables. One includes the parents' report on science career motivation and their related expectations (odds ratio = 1.79, $p < .001$). Whether either parent had an occupation in a science field also was a positive factor (odds ratio = 1.22, $p < .001$). In fact, either parent with a science occupation was a positive influence for every country from the Asian region included in this analysis with the exception of Macao-China.

Science content obtained by a female high school student from peers was a positive factor in regard intention to study science postsecondary and schools and parents negatively. This was observed by collectively examining the point estimates for each item within the respective category and the exponentiation of their sum to obtain the odds ratio.

Considering the Korea model, female students must be motivated to learn school science, enjoy and personally value science, partake in science-related activities, and have belief in their confidence as well as related content ability. Other influencing factors included parents' view of science career motivation and whether either parent maintains an occupation in a science field. Peers were another influencing factor.

Table 22

Korea Model by Construct

Variable	Odds ratio	Std. error	Significance
Student			
General value of science index	0.86	.02	***
Personal value of science index	1.26	.02	***

Table 22 (continued)

Korea Model by Construct

Variable	Odds ratio	Std. error	Significance
Science self-concept index	1.29	.03	***
Science activities index	1.13	.01	***
Enjoyment of science index	2.41	.02	***
Instrumental motivation in science index	4.19	.03	***
Self - Do well science	1.15	.03	***
Parent			
Parent report on science career motivation index	1.79	.01	***
Parent view - importance of science index	0.84	.02	***
Either parent science-related career	1.22	.01	***
Sci info – Photosynthesis – family	1.36	.07	***
Sci info – Climate change – family	1.42	.02	***
Sci info – Evolution – family	0.61	.09	***
Sci info – Health – family	0.86	.02	***
Peer			
Sci info - Photosynthesis - friends	0.74	.05	***
Sci info - Continents - friends	3.89	.06	***
Sci info - Genes - friends	2.51	.11	***
Sci info - Climate change – friends	0.64	.14	**
Sci info - Evolution – friends	0.67	.05	***
Sci info - Nuclear energy – friends	2.93	.13	***
Sci info - Health – friends	0.78	.05	***
School			
Science Teaching - Hands-on activities index	0.87	.02	***
Science Teaching - Focus on applications or models index	0.88	.02	***
School preparation for science-related careers index	0.82	.02	***
Proportion of girls at school	0.76	.02	***
Sci info - Photosynthesis – school	0.83	.06	**
Sci info - Genes – school	0.87	.03	***

Note. $N = 4612$.

* $p < 0.05$ ** $p < 0.01$ *** $p < .001$.

Luxembourg . ***Descriptive statistics results***. Table 23 shows the variables included in the Luxembourg country analysis and lists the independent variables by construct (student, parent, peer, and school). The descriptive statistics reflect the total sample inclusive of all variables from which the Luxembourg model depicted in Table 24 was built. The model ultimately selected a series of variables that were the most important in predicting, among females in Luxembourg, their intention to major in science postsecondary. The total sample listed in Table 23 is the number of times that specific variable was represented in the Luxembourg sample. The mean and standard deviation for each respective variable is also stated. Several student indices for the Luxembourg sample reported a mean value below 0, which included the following: general value of science, personal value of science, science self-efficacy, enjoyment of science, and instrumental motivation in science. Several school teaching specific indices were below the OECD average of 0, which included the following: preparation for a science-related career, interaction, hands-on activities, investigations and focus on applications or models. Parent science attitudinal indices with values below the OECD average included the following: parent view on the importance of science, parent report on science career motivation, and parent general value of science. The PISA index of economic, social, and cultural status was above the OECD average (OECD, 2009b). Science performance was below the OECD average. In regard to derived science content (coded 1 for tick or selected and 0 for no tick or not selected), females in this sample reported that most is learned from school with means closer to 1.

Table 23

Descriptive Statistics for Luxembourg Sample by Construct

Variable	*N*	Mean	Std. deviation
Student			
General value of science	4526	-.02	1.12
Personal value of science	4525	-.10	1.12
Self - Do well science	4405	1.85	.92
Science self-efficacy	4530	-.13	1.04
Science self-concept	4416	.24	1.06
General interest in learning science	4539	.14	1.00
Enjoyment of science	4547	-.04	1.11
Science activities	4539	.11	.98
Instrumental motivation in science	4433	-.15	1.09
Parent			
Science activities at age 10	3472	.01	.95

Table 23 (continued)

Descriptive Statistics for Luxembourg Sample by Construct

Variable	*N*	Mean	Std. deviation
Parent view - importance of science	3457	-.41	1.04
Parent reports on science career motivation	3469	-.17	.92
Parent general value of science	3470	-.07	1.05
Parent personal value of science	3460	.01	1.07
Either parent science-related career	4427	.15	.36
Index of economic, social and cultural status	4488	.09	1.10
Sci info - Photosynthesis - family	4558	.06	.24
Sci info - Continents - family	4558	.12	.33
Sci info - Genes - family	4558	.11	.31
Sci info - Climate change - family	4558	.15	.36
Sci info - Evolution - family	4558	.14	.35
Sci info - Nuclear energy – family	4558	.18	.38
Sci info - Health – family	4558	.54	.50
Peer			
Sci info - Photosynthesis - friends	4558	.02	.15
Sci info - Continents - friends	4558	.03	.16
Sci info - Genes – friends	4558	.02	.14
Sci info - Climate change - friends	4558	.05	.21
Sci info - Evolution - friends	4558	.04	.20
Sci info - Nuclear energy - friends	4558	.05	.22
Sci info - Health - friends	4558	.18	.38
School			
School preparation for science-related careers	4505	-.11	1.11
Science Teaching - Interaction	4473	-.09	1.04
Science Teaching - Hands-on activities	4468	-.23	1.04
Science Teaching - Student investigations	4454	-.14	1.03
Science Teaching - Focus on applications or models	4456	-.16	1.03
Sci info - Photosynthesis - school	4558	.78	.41
Sci info - Continents - school	4558	.77	.42
Sci info - Genes - school	4558	.55	.50
Sci info - Climate change - school	4558	.77	.42
Sci info - Evolution - school	4558	.65	.48
Sci info - Nuclear energy - school	4558	.52	.50
Sci info - Health - school	4558	.71	.45
Participate business/industry lectures	4553	1.72	.66
Participate business/industry visits	4553	2.16	.66
Proportion of girls at school	4567	.50	.18
School activities to promote the learning of science	4553	.15	1.04

Table 23 (continued)

Descriptive Statistics for Luxembourg Sample by Construct

Variable	*N*	Mean	Std. deviation
Science performance			
Plausible value in science	4567	486.97	96.90
Plausible value in science	4567	487.17	96.81
Plausible value in science	4567	486.98	96.33
Plausible value in science	4567	486.87	96.23
Plausible value in science	4567	486.25	96.36

Regression analysis results. Factors that positively mattered for female secondary school students in Luxembourg in regards to intention to study science postsecondary included the student, parent, and peer. Most important was a student variable and PISA 2006 index, which included the female students' instrumental motivation to learn science (odds ratio = 2.41, $p < .001$). Results indicated that, compared to students who were not instrumentally motivated to learn science, those that were had 141% higher odds of their intention to study science postsecondary with all other variables in the model held equal.

Several other student variables were important predictors. They included the following: enjoyment of science index (odds ratio = 1.40, $p < .001$), personal value of science index (odds ratio = 1.45, $p < .001$), science activities index (odds ratio = 1.16, $p < .001$), and the science attitude variable self-do well in science (odds ratio = 1.61, $p < .001$). Like most countries, personal value of science was a positive factor and general value of science negative (odds ratio = 0.72, $p < .001$). Luxembourg was one of three countries not to report either self-belief measure, science self-concept or science self-efficacy, as significant to the model.

Other important predictors of female intention to study science postsecondary were the parent PISA 2006 index parents' report on science career motivation and their related expectations (odds ratio = 1.65, $p < .001$). Results indicated that, compared with students whose parents did not maintain expectations in regard to their child's future science studies, those that did had 65% higher odds of their intention to study science postsecondary with all other variables in the model held constant. Whether either parent worked in a science field also positively mattered (odds ratio = 1.08, $p < .001$).

Science content obtained by a female high school student from peers was a positive factor in regard to intention when all other variables in the model were held constant. This was observed by collectively examining the point estimates for each item within the respective category and the exponentiation of their sum to obtain the odds ratio.

Considering the Luxembourg model, female students must be motivated to learn school science, enjoy and personally value science, and partake in science-related activities. Other influencing factors included parents' view of science career motivation and whether either parent maintains an occupation in a science field. Peers were another influencing factor.

Table 24

Luxembourg Model by Construct

Variable	Odds ratio	Std. error	Significance
Student			
General value of science	0.72	0.01	***
Personal value of science	1.45	0.01	***
Science activities	1.16	0.03	***
Enjoyment of science	1.40	0.01	***
Instrumental motivation in science	2.41	0.02	***
Self - Do well science	1.61	0.01	***
Parent			
Parent report on science career motivation	1.65	0.01	***
Either parent science-related career	1.08	0.04	***
Sci info – Photosynthesis – family	0.80	0.05	***
Sci info – Genes – family	0.82	0.05	***
Sci info – Evolution – family	0.67	0.05	***
Sci info – Nuclear energy – family	1.46	0.02	***
Sci info – Health – family	0.85	0.01	***
Peer			
Sci info - Continents - friends	0.82	0.04	***

Table 24 (continued)

Luxembourg Model by Construct

Variable	Odds ratio	Std. error	Significance
Sci info - Genes - friends	3.55	0.15	***
Sci info - Climate change – friends	0.85	0.04	***
Sci info - Evolution – friends	1.22	0.07	**
Sci info - Nuclear energy – friends	0.62	0.08	***
School			
Proportion of girls at school	1.23	0.06	**
Sci info - Genes – school	0.85	0.03	***
Sci info - Evolution – school	0.85	0.03	***
Sci info - Health – school	0.87	0.04	***

Note. $N = 2729$.

* $p < 0.05$ ** $p < 0.01$ *** $p < .001$.

Macao-China. ***Descriptive statistics results.*** Table 25 shows the variables included in the Macao-China country analysis and lists the independent variables by construct (student, parent, peer, and school). The descriptive statistics reflect the total sample inclusive of all variables from which the Macao-China model depicted in Table 26 was built. The model ultimately selected a series of variables that were the most important in predicting, among females in Macao-China their intention to major in science postsecondary. The total sample listed in Table 25 is the number of times that specific variable was represented in the Macao-China sample. The mean and standard deviation for each respective variable is also stated. All the student indices for the Macao-China sample reported a mean value greater than 0 with the exception of science self-efficacy and science self-concept. Several school teaching specific indices were below the OECD average of 0, which included the following: school preparation for a science related career, interaction, hands-on activities, and focus on applications or models. Parent science attitudinal indices reporting values below 0 included science activities at age 10 and parent general value of science. The PISA index of economic, social, and cultural status was less than 0 and below the OECD average (OECD, 2009b). Science performance was above the

OECD average. In regard to derived science content (coded 1 for tick or selected and 0 for no tick or not selected), females in this sample reported that most is learned from school with means closer to 1.

Table 25

Descriptive Statistics for Macao-China Sample by Construct

Variable	*N*	Mean	Std. deviation
Student			
General value of science	4752	.53	.93
Personal value of science	4752	.34	.79
Self - Do well science	2946	2.01	.75
Science self-efficacy	4749	-.12	.92
Science self-concept	2937	-.15	.91
General interest in learning science	4749	.09	.84
Enjoyment of science	4753	.39	.83
Science activities	4749	.25	.87
Instrumental motivation in science	2937	.36	.81
Parent			
Science activities at age 10	4709	-.08	1.02
Parent view - importance of science	4703	.38	.87
Parent reports on science career motivation	4700	.21	.83
Parent general value of science	4698	-.04	.91
Parent personal value of science	4684	.19	.86
Either parent science-related career	4699	.04	.19
Index of economic, social and cultural status	4746	-.91	.89
Sci info - Photosynthesis - family	4756	.05	.22
Sci info - Continents - family	4756	.04	.19
Sci info - Genes - family	4756	.04	.20
Sci info - Climate change - family	4756	.11	.32
Sci info - Evolution - family	4756	.04	.20
Sci info - Nuclear energy – family	4756	.04	.21
Sci info - Health – family	4756	.49	.50
Peer			
Sci info - Photosynthesis - friends	4756	.04	.19
Sci info - Continents - friends	4756	.03	.16
Sci info - Genes – friends	4756	.04	.19
Sci info - Climate change - friends	4756	.05	.23
Sci info - Evolution - friends	4756	.05	.22
Sci info - Nuclear energy - friends	4756	.03	.18
Sci info - Health - friends	4756	.26	.44

Table 25 (continued)

Descriptive Statistics for Macao-China Sample by Construct

Variable	*N*	Mean	Std. deviation
School			
School preparation for science-related careers	4746	-.17	.87
Science Teaching - Interaction	2994	-.41	.90
Science Teaching - Hands-on activities	2998	-.19	.86
Science Teaching - Student investigations	2982	.02	.91
Science Teaching - Focus on applications or models	2987	-.19	.92
Sci info - Photosynthesis - school	4756	.94	.24
Sci info - Continents - school	4756	.86	.35
Sci info - Genes - school	4756	.63	.48
Sci info - Climate change - school	4756	.80	.40
Sci info - Evolution - school	4756	.51	.50
Sci info - Nuclear energy - school	4756	.68	.47
Sci info - Health - school	4756	.70	.46
Participate business/industry lectures	4677	1.59	.74
Participate business/industry visits	4592	1.57	.72
Proportion of girls at school	4760	.51	.22
School activities to promote the learning of science	4760	.41	.72
Science performance			
Plausible value in science	4760	509.45	78.96
Plausible value in science	4760	509.82	78.73
Plausible value in science	4760	509.29	79.30
Plausible value in science	4760	509.45	78.78
Plausible value in science	4760	509.31	79.60

Regression analysis results. Factors that positively mattered for female secondary school students in Macao-China in regards to intention to study science postsecondary included the student, parent, school, and peer.

Several student variables were important predictors. Enjoyment of science index reported a strong and positive relationship (odds ratio = 1.84, $p < .001$). Results indicated that, compared to students who did not enjoy science, those that did had 84% higher odds of their intention to study science postsecondary with all other variables in the model held constant. Other student variables that positively mattered included the following: instrumental motivation to learn science index (odds ratio value = 1.66, $p < .001$), personal value of science index (odds ratio = 1.54, $p < .001$), science activities (odds ratio = 1.42, $p < .001$), science self-concept (odds ratio = 1.33, $p < .001$), and the student attitude variable self-do well in science (odds ratio = 1.39, $p < .001$). Like other countries, the PISA 2006 attitude index personal value in science positively mattered, but the PISA 2006 attitude index general value in science negatively mattered (odds ratio = 0.74, $p < .001$). Also like most countries in this analysis, the PISA 2006 self-belief index science self-concept positively mattered while the PISA 2006 self-belief index science self-efficacy was not found to be significant to the model.

Other important predictors of female intention to study science postsecondary involved the parent and school constructs. Concerning parents, the PISA 2006 index parents' report on science career motivation and their related expectations reported a positive relationship (odds ratio = 1.68, $p < .001$). Results indicated that, compared to students whose parents did not maintain expectations in regard to their child's future science studies, those that did had 68% higher odds of their intention to study science postsecondary with all other variables in the model held constant. School factors that positively mattered were the index of science teaching with an emphasis on hands-on activities (odds ratio = 1.12, $p < .001$) and school opportunities for the student to participate in science related industry lectures (odds ratio = 1.14, $p < .001$). Whether the school had a higher female enrollment was another influential and positive factor (odds ratio = 1.57, $p < .001$).

In regard to content obtained in Macao-China by a female high school student from parents, school, or peers and with all other variables in the model held equal, all mattered positively. This was observed by collectively examining the point estimates for each item within the respective category and the exponentiation of their sum to obtain the odds ratio.

Considering the Macao-China model, female students must be motivated to learn school science, enjoy and personally value science, in science-related activities, and maintain confidence in their science ability. Other influencing factors included parents' view of science career motivation, school emphasis on hands-on activities, and opportunities to hear science-related industry lectures in addition to high female school enrollment. Peers were another influencing factor.

Table 26

Macao-China Model by Construct

Variable	Odds ratio	Std. error	Significance
Student			
General value of science	0.74	0.01	***
Personal value of science	1.54	0.02	***
Science activities	1.42	0.02	***
Enjoyment of science	1.84	0.02	***
Science self-concept	1.33	0.04	***
Instrumental motivation in science	1.66	0.02	***
Self - Do well science	1.39	0.01	***
Parent			
Parent report on science career motivation	1.68	0.03	***
Parent view - importance of science	0.89	0.01	***
Either parent science-related career	0.87	0.07	***
Sci info – Continents – family	2.70	0.05	***
Sci info – Climate change – family	0.74	0.03	***
Sci info – Nuclear energy – family	0.72	0.10	**
Sci info – Health – family	0.74	0.03	***
Peer			
Sci info - Photosynthesis - friends	0.76	0.04	***
Sci info - Genes - friends	2.11	0.06	***
Sci info - Climate change – friends	0.86	0.05	**
Sci info - Evolution – friends	0.59	0.06	***
Sci info - Nuclear energy – friends	1.82	0.06	***
School			
Participate business/industry lectures	1.14	0.02	***
Participate business/industry visits	0.85	0.04	***
Science Teaching - Hands-on activities	1.12	0.03	***
School activities to promote the learning of science	0.68	0.03	***

Table 26 (continued)

Macao-China Model by Construct

Variable	Odds ratio	Std. error	Significance
Proportion of girls at school	1.57	0.05	***
Sci info - Photosynthesis – school	1.49	0.06	***
Sci info - Continents – school	0.88	0.05	*
Sci info - Climate – school	0.85	0.07	*

Note. $N = 2437$.

* $p < 0.05$ ** $p < 0.01$ *** $p < .001$.

New Zealand. ***Descriptive statistics results***. Table 27 shows the variables included in the New Zealand country analysis and lists the independent variables by construct (student, parent, peer, and school). The descriptive statistics reflect the total sample inclusive of all variables from which the New Zealand model depicted in Table 28 was built. The model ultimately selected a series of variables that were the most important in predicting, among females in New Zealand, their intention to major in science postsecondary. The total sample listed in Table 27 is the number of times that specific variable was represented in the New Zealand sample. The mean and standard deviation for each respective variable is also stated. Several student indices for the New Zealand sample reported a mean value below 0, which included the following: general value of science, science self-efficacy, science self-concept, general interest in learning science, enjoyment of science, and science activities. All school teaching specific indices were above the OECD average of 0. Only two of the parent science attitudinal indices were below 0, which included the parent view on importance of science and parent general value of science. The PISA index of economic, social, and cultural status was above the OECD average (OECD, 2009b). Science performance was also above the OECD average. In regard to derived science content (coded 1 for tick or selected and 0 for no tick or not selected), females in this sample reported that most is learned from school with means closer to 1.

Table 27

Descriptive Statistics for New Zealand Sample by Construct

Variable	*N*	Mean	Std. Deviation
Student			
General value of science	4771	-.13	.99
Personal value of science	4772	.04	1.04
Self - Do well science	4349	2.05	.85
Science self-efficacy	4776	-.02	1.05
Science self-concept	4354	-.06	.95
General interest in learning science	4778	-.10	1.02
Enjoyment of science	4780	-.003	.99
Science activities	4780	-.25	.97
Instrumental motivation in science	4356	.18	1.01
Parent			
Science activities at age 10	3301	.08	.89
Parent view - importance of science	3304	-.45	.92
Parent reports on science career motivation	3315	.19	1.09
Parent general value of science	3307	-.08	.98
Parent personal value of science	3304	.14	.99
Either parent science-related career	4675	.21	.41
Index of economic, social and cultural status	4727	.12	.83
Sci info - Photosynthesis - family	4788	.08	.28
Sci info - Continents - family	4788	.11	.31
Sci info - Genes - family	4788	.11	.31
Sci info - Climate change - family	4788	.13	.34
Sci info - Evolution - family	4788	.16	.37
Sci info - Nuclear energy – family	4788	.11	.32
Sci info - Health – family	4788	.47	.50
Peer			
Sci info - Photosynthesis - friends	4788	.04	.18
Sci info - Continents - friends	4788	.03	.16
Sci info - Genes – friends	4788	.03	.18
Sci info - Climate change - friends	4788	.04	.19
Sci info - Evolution - friends	4788	.07	.25
Sci info - Nuclear energy - friends	4788	.03	.18
Sci info - Health - friends	4788	.20	.40
School			
School preparation for science-related careers	4759	.21	.95
Science Teaching - Interaction	4367	.13	.94
Science Teaching - Hands-on activities	4363	.32	.74
Science Teaching - Student investigations	4361	.00	.90

Table 27 (continued)

Descriptive Statistics for New Zealand Sample by Construct

Variable	*N*	Mean	Std. Deviation
Science Teaching - Focus on applications or models	4360	.18	.97
Sci info - Photosynthesis - school	4788	.90	.31
Sci info - Continents - school	4788	.80	.40
Sci info - Genes - school	4788	.91	.29
Sci info - Climate change - school	4788	.82	.39
Sci info - Evolution - school	4788	.69	.46
Sci info - Nuclear energy - school	4788	.75	.43
Sci info - Health - school	4788	.85	.36
Participate business/industry lectures	4586	2.18	.82
Participate business/industry visits	4504	1.96	.86
Proportion of girls at school	4823	.51	.29
School activities to promote the learning of science	4604	.52	.84
Science performance			
Plausible value in science	4823	532.31	106.93
Plausible value in science	4823	532.69	106.86
Plausible value in science	4823	532.71	106.10
Plausible value in science	4823	532.82	107.10
Plausible value in science	4823	532.89	106.74

Regression analysis results. Factors that positively mattered for female secondary school students in New Zealand in regards to intention to study science postsecondary included the school, parent, student, and peer.

Most important was the student variable and PISA 2006 index female students' instrumental motivation to learn science (odds ratio = 3.70, $p < .001$). Results indicated that, compared with students who were not instrumentally motivated to learn science, those that were had 270% higher odds of their intention to study science postsecondary with all other variables in the index held equal. Several other student variables were important predictors. They included the following: personal value of science index (odds ratio = 1.88, $p < .001$), general interest in learning science (odds ratio = 1.74, $p < .001$), enjoyment of science index (odds ratio = 1.66, $p < .001$), science self-concept (odds ratio = 1.61, $p < .001$), and science activities (odds ratio = 1.14, $p < .001$). The odds ratio value for science self-concept was the highest positive value among all countries in the analysis, and like most countries the other science self-belief factor, science self-efficacy, mattered negatively (odds ratio = 0.75, $p < .001$). New Zealand was also one of three countries to state that the PISA 2006 interest index involving general science interest positively mattered, and in fact, reported the highest positive relationship (odds ratio = 1.74, $p < .001$). The student attitude variable self do-well in science also mattered positively (odds ratio = 1.32, $p < .001$).

School related PISA 2006 indices found to be important included science teaching and learning with an emphasis on investigations in the classroom (odds ratio = 1.13, $p < .001$) and school activities to promote science learning (odds ratio = 1.13, $p < .001$). Another positive factor was proportion of female enrollment at school (odds ratio = 1.17, $p < .001$).

Other important predictors of female intention to study science postsecondary were the parents' report on science career motivation and their related expectations (odds ratio = 2.31, $p < .001$). Having either parent working in a science occupation was another positive factor (odds ratio = 1.04, $p < .001$). New Zealand was also one of two countries with a positive odds ratio value for socioeconomic background (odds ratio = 1.12, $p < .001$).

Science content obtained in New Zealand by a female high school student from school and peers positively mattered when all other variables are held equal. This was observed by collectively examining the point estimates for each item within the respective category and the exponentiation of their sum to obtain the odds ratio.

In regard to the New Zealand model as a whole, it was important that female students be motivated to learn school science, enjoy and personally value science, maintain a general interest in science learning, partake in science-related activities and have confidence in their related ability. Other influencing factors included school instruction allowing students opportunities to conduct experiments, school activities that promote science learning, parent view of science career motivation, and socioeconomic background and whether either parent maintains an occupation in a science field. Peers also were important.

Table 28

New Zealand Model by Construct

Variable	Odds ratio	Std. error	Significance
Student			
General value of science	0.78	0.03	***
Personal value of science	1.88	0.03	***
Science activities	1.14	0.02	***
Enjoyment of science	1.66	0.04	***
Science self-efficacy	0.75	0.03	***
Science self-concept	1.61	0.02	***
General interest in learning science	1.74	0.04	***
Instrumental motivation in science	3.70	0.03	***
Self - Do well science	1.32	0.04	***
Parent			
Parents report on science career motivation	2.31	0.01	***
Parents view - importance of science	0.88	0.01	***
Parent personal value of science	0.75	0.01	***
Index of economic, social and cultural status	1.12	0.01	***
Either parent science-related career	1.04	0.05	***
Sci info – Continents – family	0.90	0.04	*
Sci info – Genes – family	1.16	0.07	*
Sci info – Evolution – family	1.20	0.02	***
Sci info – Nuclear energy – family	0.77	0.03	***
Sci info – Health – family	0.84	0.02	***
Peer			
Sci info - Photosynthesis - friends	3.00	0.06	***
Sci info - Continents - friends	2.13	0.13	***
Sci info - Climate change – friends	0.74	0.05	***
Sci info - Evolution – friends	1.50	0.07	***
Sci info - Nuclear energy – friends	1.89	0.12	***
School			
School preparation for science-related careers	0.90	0.02	***
Participate business/industry lectures	0.86	0.03	***
Science Teaching - Focus on applications or models	0.74	0.03	***

Table 28 (continued)

New Zealand Model by Construct

Variable	Odds ratio	Std. error	Significance
Science Teaching - Student investigations	1.13	0.02	***
School activities to promote the learning of science	1.13	0.03	***
Proportion of girls at school	1.17	0.05	***
Sci info - Photosynthesis – school	1.75	0.03	***
Sci info – Climate change – school	0.47	0.04	***
Sci info - Evolution – school	1.26	0.05	***

Note. $N = 2408$.

* $p < 0.05$ ** $p < 0.01$ *** $p < .001$.

Portugal. ***Descriptive statistic results***. Table 29 shows the variables included in the Portugal country analysis and lists the independent variables by construct (student, parent, peer, and school). The descriptive statistics reflect the total sample inclusive of all variables from which the Portugal model depicted in Table 30 was built. The model ultimately selected a series of variables that were the most important in predicting, among females in Portugal, their intention to major in science postsecondary. The total sample listed in Table 29 is the number of times that specific variable was represented in the Portugal sample. The mean and standard deviation for each respective variable is also stated. All the student indices for the Portugal sample reported a mean value greater than 0. All school teaching specific indices were above the OECD average of 0. All of the parent science attitudinal indices were greater the OECD average of 0 with the exception of science activities at age 10. The PISA index of economic, social, and cultural status was less than 0 and below the OECD average (OECD, 2009b). Science performance was also below the OECD average. In regard to derived science content (coded 1 for tick or selected and 0 for no tick or not selected), females in this sample reported that most is learned from school with means closer to 1.

Table 29

Descriptive Statistics for Portugal Sample by Construct

Variable	*N*	Mean	Std. Deviation
Student			
General value of science	5088	.37	.90
Personal value of science	5087	.47	.83
Self - Do well science	3991	2.21	.79
Science self-efficacy	5089	.21	.91
Science self-concept	4025	.31	.82
General interest in learning science	5079	.17	.87
Enjoyment of science	5095	.32	.79
Science activities	5092	.46	.89
Instrumental motivation in science	4011	.49	.95
Parent			
Science activities at age 10	4475	-.06	1.07
Parent view - importance of science	4458	.34	.88
Parent reports on science career motivation	4458	.08	1.09
Parent general value of science	4476	.10	.95
Parent personal value of science	4467	.17	.91
Either parent science-related career	5040	.10	.30
Index of economic, social and cultural status	5091	-.59	1.28
Sci info - Photosynthesis - family	5100	.06	.24
Sci info - Continents - family	5100	.08	.28
Sci info - Genes - family	5100	.09	.28
Sci info - Climate change - family	5100	.15	.36
Sci info - Evolution - family	5100	.18	.39
Sci info - Nuclear energy – family	5100	.10	.31
Sci info - Health – family	5100	.47	.50
Peer			
Sci info - Photosynthesis - friends	5100	.04	.19
Sci info - Continents - friends	5100	.04	.21
Sci info - Genes – friends	5100	.04	.20
Sci info - Climate change - friends	5100	.08	.27
Sci info - Evolution - friends	5100	.11	.31
Sci info - Nuclear energy - friends	5100	.06	.23
Sci info - Health - friends	5100	.21	.41
School			
School preparation for science-related careers	5072	.23	.90
Science Teaching - Interaction	4021	.38	.95

Table 29 (continued)

Descriptive Statistics for Portugal Sample by Construct

Variable	*N*	Mean	Std. Deviation
Science Teaching - Hands-on activities	4018	.12	.89
Science Teaching - Student investigations	4007	.44	.93
Science Teaching - Focus on applications or models	4001	.33	.97
Sci info - Photosynthesis - school	5100	.91	.28
Sci info - Continents - school	5100	.88	.33
Sci info - Genes - school	5100	.84	.36
Sci info - Climate change - school	5100	.81	.39
Sci info - Evolution - school	5100	.78	.42
Sci info - Nuclear energy - school	5100	.74	.44
Sci info - Health - school	5100	.78	.41
Participate business/industry lectures	5003	1.78	.73
Participate business/industry visits	5020	2.31	.68
Proportion of girls at school	5070	.51	.05
School activities to promote the learning of science	5109	.71	.76
Science performance			
Plausible value in science	5109	478.69	86.81
Plausible value in science	5109	479.45	87.51
Plausible value in science	5109	478.53	87.40
Plausible value in science	5109	478.59	87.04
Plausible value in science	5109	479.62	87.10

Regression analysis results. Factors that positively mattered for female secondary school students in Portugal in regards to intention to study science postsecondary included the student, school, parent, and peer.

Most important was student variable and PISA 2006 instrumental motivation to learn science (odds ratio = 2.33, $p < .001$). Results indicated that, compared to students who were not instrumentally motivated to learn science, those that were would have 133% higher odds of their intention to study science postsecondary with all other variables in the model held constant. Several other student variables that were important predictors included the following: personal value of science index (odds ratio = 1.29, $p < .001$), enjoyment of science index (odds ratio = 1.29, $p < .001$), and science activities index (odds ratio = 1.27, $p < .001$). Neither of the science self-belief indices was significant for the Portugal model. Also, like most countries, the PISA 2006 science attitude index personal value of science is a positive factor and the PISA 2006 science attitude index general value of science negative (odds ratio = 0.81, $p < .001$). Portugal also reported the highest odds ratio value for the student variable self-do well in science (odds ratio = 1.99, $p < .001$).

There were several school construct factors of importance. Whether the school enrolls a high proportion of girls was positively influential (odds ratio = 2.05, $p < .001$). Along with Germany, these two countries were the only two reporting an odds ratio value greater than or equal to 2.0 for this variable. The PISA 2006 school index for science teaching and learning with an emphasis on investigations in the classroom was also a positive factor (odds ratio = 1.13, $p < .001$).

Another important and positive predictor of female intention to study science postsecondary was the parent variable and PISA 2006 index parents' report on science career motivation and their related expectations (odds ratio = 2.13, $p < .001$).

In regard to content obtained in Portugal by a female high school student from parents, school, and peer, all positively mattered for each when all other variables in the model were held constant. This was observed by collectively examining the point estimates for each item within the respective category and the exponentiation of their sum to obtain the odds ratio.

In regard to the Portugal model as a whole, it was important that female students be motivated to learn school science, enjoy and personally value science, and partake in science related activities. Other influencing factors included school instruction allowing students opportunities to conduct experiments and parent view of science career motivation. Peers also were important.

Table 30

Portugal Model by Construct

Variable	Odds ratio	Std. error	Significance
Student			
General value of science	0.81	0.00	***
Personal value of science	1.29	0.00	***
Science activities	1.27	0.02	***
Enjoyment of science	1.29	0.03	***
Instrumental motivation in science	2.33	0.01	***
Self - Do well science	1.99	0.01	***
Parent			
Parent report on science career motivation	2.13	0.01	***
Parent general value of science	0.90	0.01	***
Either parent science-related career	0.81	0.01	***
Sci info – Photosynthesis – family	1.43	0.03	***
Sci info – Continents – family	0.78	0.06	***
Sci info – Genes – family	0.86	0.01	***
Sci info – Climate change – family	1.12	0.04	*
Sci info – Evolution – family	0.63	0.05	***
Sci info – Nuclear energy – family	1.38	0.05	***
Sci info – Health – family	1.16	0.01	***
Peer			
Sci info - Photosynthesis - friends	0.82	0.07	**
Sci info - Continents - friends	0.83	0.09	*
Sci info - Genes - friends	2.03	0.04	***
Sci info - Climate change – friends	0.81	0.03	***
Sci info - Evolution – friends	1.15	0.03	***
Sci info - Nuclear energy – friends	1.12	0.05	*
Sci info - Health – friends	1.28	0.05	***
School			
School preparation for science-related careers	1.17	0.03	***
Science Teaching – interaction	0.85	0.02	***
Science Teaching - Student investigations	1.13	0.02	***
Proportion of girls at school	2.05	0.15	***
Sci info - Continents – school	1.12	0.04	***

Note. $N = 2901$.

* $p < 0.05$ ** $p < 0.01$ *** $p < .001$.

Qatar. ***Descriptive statistics results***. Table 31 shows the variables included in the Qatar country analysis and lists the independent variables by construct (student, parent, peer, and school). The descriptive statistics reflect the total sample inclusive of all variables from which the Qatar model depicted in Table 32 was built. The model ultimately selected a series of variables that were the most important in predicting, among females in Qatar, their intention to major in science postsecondary. The total sample listed in Table 31 is the number of times that specific variable was represented in the Qatar sample. The mean and standard deviation for each respective variable is also stated. All the student indices for the Qatar sample reported a mean value greater than 0 with the exception of science self-efficacy. All school teaching specific indices were above the OECD average of 0. All parent science attitudinal indices were above the OECD average. The PISA index of economic, social, and cultural status was above the OECD average (OECD, 2009b). Science performance was below the OECD average. In regard to derived science content (coded 1 for tick or selected and 0 for no tick or not selected), females in this sample reported that most is learned from school with means closer to 1.

Table 31

Descriptive Statistics for Qatar Sample by Construct

Variable	*N*	Mean	Std. Deviation
Student			
General value of science	5925	.41	1.26
Personal value of science	5909	.50	1.18
Self - Do well science	5699	2.28	.88
Science self-efficacy	5935	-.10	1.28
Science self-concept	5762	.58	1.04
General interest in learning science	5901	.28	1.32
Enjoyment of science	5948	.37	1.10
Science activities	5940	.63	1.11
Instrumental motivation in science	5759	.52	.97
Parent			
Science activities at age 10	3829	.48	.98

Table 31 (continued)

Descriptive Statistics for Qatar Sample by Construct

Variable	*N*	Mean	Std. Deviation
Parent view - importance of science	3814	.63	.86
Parent reports on science career motivation	3822	.55	1.01
Parent general value of science	3817	.33	1.09
Parent personal value of science	3806	.48	1.05
Either parent science-related career	4877	.14	.35
Index of economic, social and cultural status	5963	.20	.94
Sci info - Photosynthesis - family	6064	.04	.19
Sci info - Continents - family	6064	.07	.25
Sci info - Genes - family	6064	.07	.25
Sci info - Climate change - family	6064	.11	.31
Sci info - Evolution - family	6064	.14	.35
Sci info - Nuclear energy – family	6064	.08	.27
Sci info - Health – family	6064	.32	.47
Peer			
Sci info - Photosynthesis - friends	6064	.03	.17
Sci info - Continents - friends	6064	.04	.20
Sci info - Genes – friends	6064	.05	.22
Sci info - Climate change - friends	6064	.05	.22
Sci info - Evolution - friends	6064	.07	.26
Sci info - Nuclear energy - friends	6064	.06	.24
Sci info - Health - friends	6064	.10	.30
School			
School preparation for science-related careers	5861	.17	1.18
Science Teaching - Interaction	5809	.42	1.13
Science Teaching - Hands-on activities	5796	.52	1.17
Science Teaching - Student investigations	5786	.88	1.12
Science Teaching - Focus on applications or models	5788	.37	1.17
Sci info - Photosynthesis - school	6064	.51	.50
Sci info - Continents - school	6064	.56	.50
Sci info - Genes - school	6064	.41	.49
Sci info - Climate change - school	6064	.51	.50
Sci info - Evolution - school	6064	.32	.47
Sci info - Nuclear energy - school	6064	.49	.50
Sci info - Health - school	6064	.40	.49
Participate business/industry lectures	5557	1.93	.83
Participate business/industry visits	5542	1.63	.67
Proportion of girls at school	2024	.49	.45
School activities to promote the learning of science	5557	.59	.89

Table 31 (continued)

Descriptive Statistics for Qatar Sample by Construct

Variable	*N*	Mean	Std. Deviation
Science performance			
Plausible value in science	6265	348.99	81.88
Plausible value in science	6265	349.04	82.76
Plausible value in science	6265	348.92	82.99
Plausible value in science	6265	349.62	82.89
Plausible value in science	6265	348.85	82.10

Regression analysis results. Factors that positively mattered for female secondary school students in Qatar in regards to intention to study science postsecondary included the school, student, parent, and peer.

Most important was student variable and PISA 2006 index instrumental motivation to learn science (odds ratio = 2.45, $p < .001$). Results indicated that, compared with students who were not instrumentally motivated to learn science, those that would had 145% higher odds of their intention to study science postsecondary with all other variables held constant in the model. Several other student variables were important predictors. They included the following: personal value of science index (odds ratio = 1.98, $p < .001$), science self-concept index (odds ratio = 1.38, $p < .001$), general interest in learning science index (odds ratio = 1.17, $p < .001$), and science activities (odds ratio = 1.13, $p < 001$). Like most countries in this analysis, the PISA 2006 science self-belief index self-concept positively mattered, and science self-efficacy was not significant to the Qatar model. Also, the PISA 2006 science attitude index personal value of science was strongly positive (odds ratio = 1.98, $p < .001$), while the PISA science attitude index general value of science was strongly negative (odds ratio = 0.60, $p < .001$). The science attitude variable self-do well in science also positively mattered (odds ratio = 1.84, $p < .001$).

Several school and parent related variables were found to positively matter. They included the following school indices: science teaching and learning with an emphasis on hands-on activities (odds ratio =1.19, $p < .001$) and school preparation for a science career (odds ratio = 1.19, $p < .001$). From the parent construct, the PISA 2006 index parents' report on science career motivation and their related expectations reported a positive relationship (odds ratio = 1.46, $p < .001$). In addition, whether either parent has an occupation in a science field positively mattered (odds ratio = 1.24, $p < .001$).

Science content obtained by a female high school student from peers mattered positively in regard intention to study science postsecondary when all other variables in the model were held equal. This was observed by collectively examining the point estimates for each item within the respective category and the exponentiation of their sum to obtain the odds ratio.

In regard to the Qatar model as a whole, it was important that female students be motivated to learn school science, enjoy and personally value science, and partake in science-related activities. Other influencing factors included school instruction with an emphasis on hands-on activities and school science career preparation as well as parent view of science career motivation. Peers were also important.

Table 32

Qatar Model by Construct

Variable	Odds ratio	Std. error	Significance
Student			
General value of science	0.60	0.03	***
Personal value of science	1.98	0.02	***
Science activities	1.13	0.03	***
Science self-concept	1.38	0.03	***
General interest in science learning	1.17	0.03	***
Instrumental motivation in science	2.45	0.07	***
Self - Do well science	1.84	0.08	***
Parent			
Parent report on science career motivation	1.46	0.03	***
Parent view - importance of science	0.65	0.04	***
Either parent science-related career	1.24	0.06	***

Table 32 (continued)

Qatar Model by Construct

Variable	Odds ratio	Std. error	Significance
Index of economic, social and cultural status	0.79	0.01	***
Sci info – Genes – family	1.30	0.08	**
Sci info – Evolution – family	0.51	0.08	***
Sci info – Nuclear energy – family	0.60	0.13	***
Peer			
Sci info - Genes - friends	1.89	0.12	***
Sci info - Climate change – friends	0.73	0.12	***
Sci info - Evolution – friends	2.40	0.16	**
Sci info - Nuclear energy – friends	1.84	0.09	***
Sci info - Health – friends	1.53	0.06	***
School			
School preparation for science-related careers	1.19	0.02	***
Participate business/industry visits	0.79	0.07	***
Science Teaching - Focus on applications or models	0.74	0.06	***
Science Teaching - Hands-on activities	1.19	0.03	***
Sci info - Continents – school	0.74	0.06	***
Sci info - Genes – school	0.72	0.05	***
Sci info - Climate change– school	1.63	0.10	***
Sci info – Evolution – school	2.70	0.10	***
Sci info – Nuclear energy – school	0.55	0.07	***
Sci info – Health – school	0.71	0.09	***

Note. $N = 577$.

* $p < 0.05$ ** $p < 0.01$ *** $p < .001$.

Turkey. ***Descriptive statistics results***. Table 33 shows the variables included in the Turkey country analysis and lists the independent variables by construct (student, parent, peer, and school). The descriptive statistics reflect the total sample inclusive of all variables from which the Turkey model depicted in Table 34 was built. The model ultimately selected a series of variables that were the most important in predicting, among females in Turkey, their intention to major in science postsecondary. The total sample listed in Table 33 is the number of times that specific variable was represented in the Turkey sample. The mean and standard deviation for each respective variable is also stated. All the student indices for the Turkey sample reported a mean value greater than 0. All school teaching specific indices were above the OECD average of 0 with the exception of school preparation for a science related career and school activities to promote science learning. All parent science attitudinal indices were above the OECD average of 0 with the exception of parent personal value of science. The PISA index of economic, social, and cultural status was less than 0 and below the OECD average (OECD, 2009b). Science performance was also below the OECD average. In regard to derived science content (coded 1 for tick or selected and 0 for no tick or not selected), females in this sample reported that most is learned from school with means closer to 1.

Table 33

Descriptive Statistics for Turkey Sample by Construct

Variable	*N*	Mean	Std. Deviation
Student			
General value of science	4926	.51	1.08
Personal value of science	4924	.34	1.02
Self - Do well science	4818	2.21	.86
Science self-efficacy	4927	.05	1.00
Science self-concept	4799	.18	.99
General interest in learning science	4929	.26	.95
Enjoyment of science	4938	.45	.97
Science activities	4931	.59	.91
Instrumental motivation in science	4835	.36	.97
Parent			
Science activities at age 10	4840	.10	1.02
Parent view - importance of science	4850	.75	.80
Parent reports on science career motivation	4857	.27	.92
Parent general value of science	4844	.06	.95
Parent personal value of science	4825	-.12	.99
Either parent science-related career	4912	.05	.22
Index of economic, social and cultural status	4934	-1.24	1.08
Sci info - Photosynthesis - family	4942	.03	.18
Sci info - Continents - family	4942	.03	.17
Sci info - Genes - family	4942	.03	.17
Sci info - Climate change - family	4942	.09	.28

Table 33 (continued)

Descriptive Statistics for Turkey Sample by Construct

Variable	*N*	Mean	Std. Deviation
Sci info - Evolution - family	4942	.05	.23
Sci info - Nuclear energy – family	4942	.05	.21
Sci info - Health – family	4942	.53	.50
Peer			
Sci info - Photosynthesis - friends	4942	.05	.21
Sci info - Continents - friends	4942	.04	.19
Sci info - Genes – friends	4942	.04	.19
Sci info - Climate change - friends	4942	.05	.21
Sci info - Evolution - friends	4942	.05	.21
Sci info - Nuclear energy - friends	4942	.04	.19
Sci info - Health - friends	4942	.10	.30
School			
School preparation for science-related careers	4915	-.12	1.15
Science Teaching - Interaction	4860	.45	.92
Science Teaching - Hands-on activities	4858	.04	1.12
Science Teaching - Student investigations	4836	.80	1.01
Science Teaching - Focus on applications or models	4833	.10	1.10
Sci info - Photosynthesis - school	4942	.85	.36
Sci info - Continents - school	4942	.81	.39
Sci info - Genes - school	4942	.86	.35
Sci info - Climate change - school	4942	.76	.43
Sci info - Evolution - school	4942	.65	.48
Sci info - Nuclear energy - school	4942	.56	.50
Sci info - Health - school	4942	.47	.50
Participate business/industry lectures	4907	1.53	.66
Participate business/industry visits	4942	1.72	.68
Proportion of girls at school	4942	.43	.22
School activities to promote the learning of science	4907	-.13	1.12
Science performance			
Plausible value in science	4942	427.92	83.05
Plausible value in science	4942	427.41	82.32
Plausible value in science	4942	427.45	82.86
Plausible value in science	4942	427.59	82.87
Plausible value in science	4942	427.67	82.66

Regression analysis results. Factors that positively mattered for female secondary school students in Turkey in regards to intention to study science postsecondary included the student, parent, school, and peer.

Several student variables were important predictors. They included the following: enjoyment of science index (odds ratio = 1.98, $p < .001$), personal value of science index (odds ratio = 1.89, $p < .001$), instrumental motivation to learn science index (odds ratio = 1.70, $p < .001$), science self-concept index (odds ratio = 1.26, $p < .001$), and science activities (odds ratio = 1.21, $p < .001$). Like most countries, the PISA 2006 science attitude index personal value of science mattered positively (odds ratio = 1.89, $p < .001$) and the PISA 2006 science attitude index general value of science negatively (odds ratio = 0.78, $p < .001$). Of the PISA 2006 science self-belief indices, science self-concept mattered positively (odds ratio = 1.26, $p < .001$) and science self-efficacy negatively (odds ratio = 0.87, $p < .001$). The science attitude variable self-do well in science mattered positively (odds ratio = 1.24, $p < .001$).

Other important predictors of female intention to study science postsecondary included the parent and school constructs. Related to parents, the PISA 2006 index parents' report on science career motivation and their related expectations reported a positive relationship (odds ratio = 1.98, $p < .001$) as did either parent maintained a science occupation (odds ratio = 1.17, $p < .001$). The school construct index concerning preparation for a science related career also positively mattered (odds ratio = 1.17, $p < .001$).

Science content obtained by a female high school student from peers, when all other variables in the model were held constant, was a positive factor in regard intention to study science postsecondary. This was observed by collectively examining the point estimates for each item within the respective category and the exponentiation of their sum to obtain the odds ratio.

In regard to the Turkey model as a whole, it was important that female students be motivated to learn school science, enjoy and personally value science, partake in science-related activities, and have confidence in their related ability. Other influencing factors included school science career preparation as well as parent view of science career motivation and whether either parent worked in a science occupation. Peers also were important.

Table 34

Turkey Model by Construct

Variable	Odds ratio	Std. error	Significance
Student			
General value of science	0.78	0.01	***
Personal value of science	1.89	0.02	***
Science activities	1.21	0.01	***
Science self-efficacy	0.87	0.01	***
Science self-concept	1.26	0.03	***
Enjoyment of science	1.98	0.02	***
Instrumental motivation in science	1.70	0.01	***
Self - Do well science	1.24	0.00	***
Parent			
Parent report on science career motivation	1.98	0.02	***
Parent general value of science	0.85	0.02	***
Either parent science-related career	1.17	0.07	***
Sci info – Photosynthesis – family	0.58	0.08	***
Sci info – Genes – family	1.46	0.05	***
Sci info – Health – family	0.89	0.02	***
Peer			
Sci info - Continents - friends	1.63	0.05	***
Sci info - Genes - friends	0.76	0.05	***
Sci info - Climate change – friends	1.63	0.11	***
Sci info - Evolution – friends	0.66	0.03	***
Sci info - Nuclear energy – friends	0.81	0.06	**
Sci info - Health – friends	1.22	0.03	***
School			
School preparation for science-related careers	1.17	0.01	***
Participate business/industry lectures	0.88	0.03	***
Science Teaching – interaction	0.89	0.02	***
Science Teaching - Student investigations	0.82	0.03	***
Proportion of girls at school	0.87	0.07	*

Table 34 (continued)

Turkey Model by Construct

Variable	Odds ratio	Std. error	Significance
Sci info - Genes – school	1.13	0.05	**
Sci info - Climate – school	0.80	0.02	***
Sci info – Nuclear energy – school	0.87	0.03	***

Note. *N* = 4177.

* $p < 0.05$ ** $p < 0.01$ *** $p < .001$.

Trends Across all Countries

Across every country included in this analysis, school, parent, and student constructs were found to be important in predicting female student intention to study science postsecondary. There were two variables that reported a positive odds ratio value with relatively large magnitudes for every country included in the analysis.

One included the PISA 2006 student variable concerning instrumental motivation to learn science. This index had an odds ratio value low of 1.66 (Macao-China) and a high of 4.19 (Korea). For the pooled all-countries model, the odds ratio value was 2.52, which shows how strong this characteristic positively associated with a female's intention to study science postsecondary. The questions that the index was derived from included both the usefulness and value of science. Both were cited in literature as being important to female science participation (George, 2003; VanLeuvan, 2004, p. 251).

The other independent variable that reported an odds ratio value relatively large for all countries in this analysis included the PISA 2006 parent index on science career motivation. For the pooled all-countries model, the odds ratio value was 1.82. This index was derived from questions that reflect parent expectations that their child shows an interest in science, will likely study science postsecondary, and also may work in a science field some day. Research has shown that one of the most important mediating factors determining whether a female student will pursue science involves her parents (George & Kaplan, 1998; Jacobs et al., 1998; Norby, 1997; Rayman & Brett, 1995; Seymour & Hewitt, 1997; Simpson & Oliver, 1990; Strenta et al., 1994; Ware et al., 1985). Parental support has been discussed in literature as an important influencing factor for female choice in a science career. In fact, a parent's belief that science is important and potentially leads to a stable career plays a significant part in influencing a daughter's choice to major in a science discipline (Seymour & Hewitt, 1997). Studies have also shown that parent expectation in their child's ability is significant, and parent encouragement can directly influence the child's self-concept of his or her own science ability (Bleeker & Jacobs, 2004; George, 2000; George & Kaplan, 1998; Jacobs et al., 1998; Rayman & Brett, 1995; Strenta et al., 1994). For this index, Qatar reported a low odds ratio value of 1.46, while New Zealand, Portugal, and Germany each reported odds ratio values above 2.0 with 2.31, 2.13, and 2.05, respectively.

Another variable that positively mattered for the majority of countries in this analysis included a student interest PISA 2006 index measuring science enjoyment. This index was derived from questions pertaining to sincere interest and innate joy when doing science. The results confirmed the important role of science interest in predicting science major choice as found in literature (Jacobs et al., 1998; Strenta et al., 1994; VanLeuvan, 2004).

Of the three student science attitude variables, two were observed to be positively associated with female intention to study science postsecondary for almost every country included in this analysis with some exceptions. First, the student attitude variable concerning self-do well in science reported a positive odds ratio value for every country with the exception of Denmark and Germany where this variable was not found to be significant. Also consistent across virtually every country, with the exception of Hong Kong-China, was a PISA 2006 student attitude index personal value of science. The personal value of science had a low, but positive odds ratio in Colombia and Italy and highs reported in Qatar, Turkey, and New Zealand with 1.98, 1.89, and 1.88, respectively. This is in contrast to the PISA 2006 student attitude index general value of science. In regard to general value of science index, every country in this analysis reported an odds ratio value of less than 1.00. The PISA index personal value of science reinforced the perception of science utility and value, which has been found to be personally important to females, while the PISA index general value of science emphasizes the potential wide-reaching social impact.

Also consistent for all countries studied in this analysis, with the exception of Germany, which did not report this independent variable as significant, was the PISA 2006 student interest index involving participation in specific science activities, such as watching television programs, reading science books or magazines concerning science topics, or attending a science club. While not always above 1.30, Qatar and Korea each reported positive yet low odds ratio values of 1.13 and Colombia, Bulgaria, and Iceland reported positive and high odds ratio values of 1.58, 1.47, and 1.46, respectively. The science activities PISA index is indicative of science interest, and a science interest component was found to be an important predictor of female science major choice (Jacobs et al., 1998; Strenta et al., 1994; VanLeuvan, 2004).

In regard to the student construct science self-belief, the PISA 2006 science self-concept index positively mattered more than the PISA 2006 science self-efficacy index for the majority of countries included in this analysis. Science self-concept involves a student's belief in his or her academic ability, and science self-efficacy concerns a student's confidence (OECD, 2007, p. 133). The majority of countries (New Zealand, Germany, Denmark, Croatia, Italy, Iceland, Korea, Hong Kong-China, Macao-China, Qatar, Turkey, as well as the pooled model) reported a positive odds ratio value for science self-concept. Colombia, Bulgaria, Luxembourg, and

Portugal did not have any of significance. This was in contrast to science self-efficacy, where countries New Zealand and Turkey reported an odds ratio value below 1.0. Only Bulgaria and Italy reported an odds ratio value above 1.0 and not very important, 1.11 and 1.15 respectively. All other countries did not report an odds ratio value of significance. Science self-concept was a more important predictor of a female's intention to study science postsecondary compared to the other self-belief variable involving science self-efficacy.

Although significant, there were some inconsistencies among several parent variables for various countries. For instance, having a parent working in a science field mattered for all countries with the exception of Germany, where this PISA 2006 index (either parent working in science field) was not found to be significant and therefore, did not matter in regard to the dependent variable of intention to study science postsecondary. In Colombia, Italy, Portugal, and Macao-China this variable was below 1.0. All other countries in this analysis reported a positive relationship. Norby (1997) stated that having a parent employed in a science-related career positively affected a daughter's science career selection. Another parent variable was the PISA 2006 parent index concerning the child's science activities at age 10. This variable was only significant in Croatia with a negative odds ratio value (0.89), which is indicative of it being a less important consideration.

Schools were found to be an important factor in encouraging female participation in science (Besecke & Reilly, 2006; George & Kaplan, 1998; Ware & Lee 1988). Few of the associated variables, however, were consistently important across all countries. The PISA 2006 index for school science career preparation was a positive factor for Bulgaria, Portugal, Qatar, and Turkey. Related to affording students opportunities to participate in industry lectures or visits, the variable pertaining to industry lectures positively mattered for female students in

Iceland with an odds ratio value of 1.13 and Macao-China with an odds ratio value of 1.14. Germany, Denmark, and Turkey reported an odds ratio value for this variable below 1.0. The variable for industry visits mattered for New Zealand, Bulgaria, Denmark, Croatia, Macao-China, and Qatar. However, all respective countries reported an odds ratio value below 1.0. Industry visits does not appear to be an important predictor of a female's intention to study science postsecondary. Moreover, only 4 of the 15 countries reported that the PISA 2006 school index science teaching and learning with a focus on interaction, mattered and all four with odds ratio values below 1.0. The PISA 2006 school index science teaching and learning with a focus on hands-on activities positively mattered for Croatia, Macao-China, and Qatar, and the PISA 2006 school index science teaching and learning with a focus on investigations in the classroom positively mattered for New Zealand, Croatia, and Portugal. Two PISA 2006 school indices that mattered, however only negatively for specific countries, included science teaching and learning with an emphasis on interaction and science teaching and learning with an emphasis on models or applications.

Region Comparisons

Countries included in this analysis were also considered collectively by region to help determine if any patterns were noted, which may require further examination in subsequent research. Based on the results by country, following is a summary of findings across different regions, including Asian and European regions. There were several variables that mattered for all countries in regard to a female student's intention to study science postsecondary. With exceptions noted, they included the following for all countries:

- The PISA 2006 student index instrumental motivation in science was a positive predictor across every country included in this analysis.

- The PISA 2006 parent index parent view on science career motivation was a positive predictor across every country included in this analysis.
- The PISA 2006 student interest index science-related activities was a positive predictor, with the exception of Germany where it was not found to be significant for the country model.
- The PISA 2006 student interest index enjoyment of science was a positive predictor, with the exception of Qatar where it was not found to be significant for the country model.
- The PISA 2006 student attitude index personal value of science was a positive predictor, with the exception of Hong Kong-China where it was not found to be significant for the country model.

This analysis included New Zealand from the Oceania region and Colombia from the Latin America and the Caribbean region. Because there was only one country from each of these regions, comparisons could not be made. There were, however, several countries from the European region and the Asia Pacific region. More specifically, from the European region were Bulgaria, Germany, Denmark, Croatia, Iceland, Italy, Luxembourg, and Portugal. The countries from the Asian region included Hong Kong-China, Korea, Macao-China, and Qatar. Since Turkey can be included in both regions, it was removed for purposes of cultural comparisons. In regard to countries in the Asian and European regions, findings are summarized in Table 35 in addition to being listed below.

Asian region.

Student:

- From the countries in the Asian region, 4 of 4 (100%) reported the following PISA 2006 student indices positively mattered: student index instrumental motivation, student interest index science related activities, student self-belief index science self-concept, and self do-well in science variable.

- From the countries in the Asian region, 4 of 4 (100%) reported that the PISA 2006 student attitude index general value of science negatively mattered.
- From the countries in the Asian region, 4 of 4 (100%) of countries reported that the PISA 2006 student self-belief index science self-concept mattered positively. This was in contrast to the other self-belief factor, science self-efficacy, which was not found to be significant for any Asian country.
- From the countries in the Asian region, 3 of 4 (75%) reported a positive odds ratio value for the PISA 2006 student interest index enjoyment of science. Qatar did not report the index enjoyment of science as significant.
- From the countries in the Asian region, 3 of 4 (75%) reported a positive odds ratio value for PISA 2006 student attitude index personal value of science. Hong Kong-China did not report the index personal value of science as significant.
- From the countries in the Asian region, 2 of the 4 (50%) reported that the PISA 2006 student general interest in learning science index was important and all positively. Korea and Macao-China did not report the index as significant.

Parent:

- From the countries in the Asian region, 4 of 4 (100%) reported the PISA 2006 parent index parent view on career motivation was positive.
- From the countries in the Asian region, 4 of 4 (100%) of Asian countries reported that PISA 2006 parent index parent view on the importance of science learning mattered, however all negatively.

- From the countries in the Asian region, 3 of 4 (75%) reported a positive odds ratio value for parent occupation in science field. Macao-China reported that this variable negatively mattered with an odds ratio value of 0.87.

School:

- From the countries in the Asian region, 3 of 4 (75%) reported that the PISA school index science teaching with an emphasis on hands-on activities mattered, 50% positively and 25% negatively. Hong Kong-China did not report this variable as significant.

European region.

Student:

- From the countries in the European region, 8 of 8 (100%) reported that the following PISA 2006 student indices positively mattered: index for instrumental motivation of science, student interest index enjoyment of science, and student attitude index personal value of science.
- From the countries in the European region, 8 of 8 (100%) reported that the PISA 2006 student attitude index general value of science mattered, though negatively.
- From the countries in the European region, 7 of 8 (88%) reported that the PISA 2006 student science interest index science related activities positively mattered. Germany did not report this index as significant.

Parent:

- From the countries in the European region, 8 of 8 (100%) reported that the PISA 2006 parent index parent view on science career motivation was positive.
- From the countries in the European region, 5 of 8 (63%) reported either parent having an occupation in a science field positively mattered. In Italy and Portugal, this variable

negatively mattered with odds ratio values of 0.92 and 0.81, respectively. This factor was not significant to the Germany model.

School:

- From the countries in the European region, 7 of 8 (88%) reported that the variable proportion of girls enrolled in school mattered. Sixty-three percent had positive odds ratio values and 25% negative. Bulgaria did not report this index to be significant.

Table 35

Results Compared by Countries in the European and Asian Regions

Variable	*Total*		>1		<1	
	Asian	*Euro*	Asian	Euro	Asian	Euro
	Student					
Instrumental motivation in science	4/4 (100%)	8/8 (100%)	4/4 (100%)	8/8 (100%)	-	-
Enjoyment of science	3/4[a] (75%)	8/8 (100%)	3/4 (75%)	8/8 (100%)	-	-
Personal value of science	3/4[b] (75%)	8/8 (100%)	3/4 (75%)	8/8 (100%)	-	-
General interest in learning science	2/4 (50%)	0/8 (0%)	2/4 (50%)	-	-	-
Science activities	4/4 (100%)	7/8[c] (88%)	4/4 (100%)	7/8 (88%)	-	-
General value of science	4/4 (100%)	8/8 (100%)	-	-	4/4 (100%)	8/8 (100%)
Science self-concept	4/4 (100%)	5/8[d] (63%)	4/4 (100%)	5/8 (63%)	-	-
Science self-efficacy	0/4 (0%)	2/8[e] (25%)	-	2/8 (25%)	-	-
Self do well in science	4/4 (100%)	6/8[f] (75%)	4/4 (100%)	6/8 (75%)	-	-
	Parent					
Science activities at age 10	0/4 (0%)	1/8[g] (13%)	-	-	-	1/8 (13%)
Parent view - importance of science	4/4 (100%)	1/8[h] (13%)	-	-	4/4 (100%)	1/8 (13%)

Table 35 (continued)

Results Compared by Countries in the European and Asian Regions

Variable	*Total*		>1		<1	
	Asian	*Euro*	Asian	Euro	Asian	Euro
Parent reports on science career motivation	4/4 (100%)	8/8 (100%)	4/4 (100%)	8/8 (100%)	-	-
Parent general value of science	0/4 (0%)	3/8[i] (38%)	-	1/8 (13%)	-	2/8 (25%)
Parent personal value of science	0/4 (0%)	3/8[j] (38%)	-	1/8 (13%)	-	2/8 (25%)
Either parent science-related career	4/4 (100%)	7/8[k] (88%)	3/4 (75%)	5/8 (63%)	1/4 (25%)	2/8 (25%)
Index of economic, social and cultural status	2/4[l] (50%)	3/8[m] (38%)	-	1/8 (13%)	2/4 (50%)	2/8 (25%)
	School					
Participate in business/industry lectures	1/4[n] (25%)	3/8[o] (38%)	1/4 (25%)	1/8 (13%)	-	2/8 (25%)
Visits to local business/industry	2/4[p] (25%)	3/8[q] (38%)	-	-	2/4 (50%)	3/8 (38%)
Science teaching – focus on applications or models	2/4[r] (50%)	4/8[s] (50%)	-	-	2/4 (50%)	4/8 (50%)
Science teaching – focus on hands on activities	3/4[t] (75%)	2/8[u] (25%)	2/4 (50%)	1/8 (13%)	1/4 (25%)	1/8 (13%)
Science teaching - focus on interaction	1/4[v] (25%)	2/8[w] (25%)	-	-	1/4 (25%)	2/8 (25%)
Science teaching – focus on investigations	0/4 (0%)	2/8[x] (25%)	-	2/8 (25%)	-	-
School activities to promote science learning	1/4[y] (25%)	1/8[z] (13%)	-	1/8 (13%)	1/4 (25%)	-
Proportion of girls at school	2/4[aa] (50%)	7/8[bb] (13%)	1/4 (25%)	5/8 (63%)	1/4 (25%)	2/8 (25%)
School preparation for science career	2/4[cc] (50%)	2/8[dd] (25%)	1/4 25%	2/8 (25%)	1/4 (25%)	-

[a]Not sig. for Qatar.
[b]Not sig. for Hong-Kong China.
[c]Not sig. for Germany.
[d]Not sig. for Bulgaria, Luxembourg, and Portugal.
[e]Not sig for Croatia, Denmark, Germany, Iceland, Luxembourg, and Portugal.
[f]Not sig. for Denmark and Germany.
[g]Only sig. for Croatia.
[h]Only sig. for Italy
[i]Only sig for Denmark, Iceland, and Portugal.
[j]Only sig. for Denmark, Germany, and Iceland.
[k]Germany not sig.
[l]Only sig. Hong-Kong China and Qatar.
[m]Only sig. for Bulgaria, Germany, and Iceland.

Table 35 (continued)

Results Compared by Countries in the European and Asian Regions

[n]Only sig. for Macao-China.
[o]Only sig. for Denmark, Germany, and Iceland.
[p]Only sig. for Macao-China and Qatar.
[q]Only sig. for Bulgaria, Croatia, and Denmark.
[r]Only sig. for Korea and Qatar.
[s]Only sig. for Bulgaria, Croatia, Denmark, and Italy.
[t]Only sig. for Korea, Macao-China, and Qatar
[u]Only sig. for Croatia and Denmark.
[v]Only sig. for Hong-Kong China.
[w]Only sig. for Croatia and Portugal.
[x]Only sig. for Croatia and Portugal.
[y]Only sig. for Macao-China.
[z]Only sig. for Germany.
[aa] Not sig. for Hong-Kong China and Qatar.
[bb]Not sig. for Bulgaria.
[cc]Only sig. for Korea and Qatar.
[dd]Only sig. for Bulgaria and Portugal.

The following presents a summary of Asian and European country models for female intention to study science postsecondary.

What appears to matter to both Asian and European regions?

Positively matters:

- Student constructs instrumental motivation to learn science, science activities, joy of science, personal value of science, and science self-concept.
- Parent view on science career motivation.

Negatively maters:

- Student construct general value of science.

What appears to matter to European countries and not consistently among Asian countries?

Positively matters:

- School construct proportion of girls enrolled at school.

Negatively matters:

- Parent construct general and personal value of science.

What appears to matter to Asian countries and not consistently among European countries?

Positively matters:

- Student construct general interest in science.
- Hands-on activities at school.

Negatively matters:

- Parent construct parent view on the importance of learning science.

Chapter 5

Conclusions, Further Research, and Policy Implications

The goal of this study was to perform an exploratory analysis of a comprehensive list of potential predictors identified from literature to determine which, if any, influence a female's intention to study science postsecondary, which is indicative of future study when in higher education and possible career choice. The method of logistic regression identified the predictors that were significantly associated with the outcome. The findings of this study suggest that external factors, such as those considered from the environment, are indeed important in determining a female's intention to study science postsecondary. The postulated model guiding this analysis, which was based on prior research, recognized that factors pertaining to the student, parent(s), school, and peer(s) are all important. The findings of this study provided further refinement by demonstrating that for the 15 countries included in this analysis from the Oceania, Latin America, European, and Asian regions, there were some overarching and consistent factors that are positively associated with females' intentions to study science postsecondary. These findings essentially paint a portrait of females who intend to study science postsecondary, which can be used to suggest additional research as well as assist in mitigating the female scientist conundrum observed worldwide by recommending related strategies.

Females' Intentions to Study Science Postsecondary: Major Findings

Student construct. In regard to the student construct, female students' instrumental motivation to learn school science was seen as a strong predictor of their intentions to study science postsecondary as observed in the pooled all-countries model and in each individual country model. Female students who intend to study science postsecondary do so because it is useful to them, will help them in the work they choose to do later, and will help improve their career prospects, as per the individual questions and questionnaire responses from which this PISA 2006 index was derived (OECD, 2009a, p. 456). According to George (2003), science extracurricular activities fuel female perception regarding the value or "utility of science" and, potentially lead to increased science study choice (p. 446).

In addition to student instrumental motivation to learn science, four other student variables were consistently noted to be positive predictors among the majority of the countries included in the analysis. First, the science interest variable concerning enjoyment of science was seen as a very important predictor for the pooled country model and each individual country model with the exception of Qatar. As per the individual questions and questionnaire responses from which this PISA index was derived, this finding confirmed that females who intend to study science postsecondary have fun doing science, enjoy reading and acquiring science knowledge, and are interested in learning about science (OECD, 2009a, p. 456). Another science interest variable that positively mattered in the majority of countries included in this analysis, with the exception of Germany, involved an array of science activities that a female student engages in, such as watching a television program about science or reading a book or magazine about science (OECD, 2009a, p. 457). Science enjoyment and interest were both found to be important factors in science career choice (Jacobs et al., 1998) as well as STEM related careers in general (VanLeuvan, 2004). The third student variable and constant positive predictor, with the exception of Hong Kong-China, was the index concerning personal value of science and the fourth self-do well in science, with the exception of both Germany and Denmark. Results suggest that females feel it is important to do well in science and are personally connected to the subject. Besecke and Reilly (2006) found that women in a science career frequently mentioned high science achievement as an important factor to science career success. The general value of science variable was not a positive predictor for the pooled all-countries model as well as every individual country even though aspects of the index, as devised by OECD, included a social impact or service component, which was occasionally noted in literature as important to students (Burkam et al., 1997; Chiu, 2010; Sax & Harper, 2007; Strenta et al., 1994; Taasoobshirazi & Carr, 2008; VanLeuvan, 2004; Ware et al., 1985) especially those with a particular interest in biology (Strenta et al., 1994). Lastly and not as all encompassing as the previously mentioned student variables, is science self-concept or belief in science ability, which was found to be a positive predictor for the pooled all-countries model and the majority of individual country models with Colombia, Bulgaria, Luxembourg, and Portugal as the exceptions. In each of the latter, science self-concept was not significant to their country model. Science self-concept can contribute to science attitude (George, 2000) and appears to develop early from a variety of experiences involving parents and teachers (Burkam et al., 1997; Taasoobshirazi & Carr, 2008).

Parent construct. As identified in literature and confirmed in this study, parent support is an influencing factor for female science choice (Rayman & Brett, 1995). Within the parent construct, the parents' view on science career motivation was identified as a persistent and strong predictor in the pooled all-countries model and in each individual country model. This related PISA 2006 index included parents' expectations that their child shows an interest to study science or work some day in a related field (OECD, 2009a, p. 463). In fact, a parent's belief that science is important and potentially leads to a stable career plays a significant part in influencing a daughter's choice to major in a science discipline (George, 2000; George & Kaplan, 1998; Rayman & Brett, 1995; Strenta et al., 1994; Taasoobshirazi & Carr, 2008). This may also be conveyed through a parent's occupation, which when in a science field, serves as positive predictor to a female's intention to study science postsecondary as seen in 11 of the 15 countries included in this analysis. Norby (1997) stated that having a parent with a science-related occupation positively affected a daughter's science career selection. The results of this study also generally support the finding by Ware and Lee (1988) that socioeconomic status was not a predictor of science college choice for females since it was not found to be positive in the majority of countries included in this analysis with Germany and Bulgaria the exceptions.

Peer construct. A female student's peer group was also noted to matter in regard to female intention to study science postsecondary. As Eccles (1999) stated, children become more aware of peers as they age. The peer variable was noted as a positive predictor in 10 of the 15 countries included in this analysis, accounting for 67%. Most of the literature discussion concerning the peer role in female science participation, however, concerned perceived stereotypes and group pressure (Eccles, 1994; George, 2000; Jacobs et al., 1998; Sax & Harper, 2007; Simpson & Oliver, 1990; van Langen & Dekkers, 2005). Some feel that peers are an important factor influencing female insecurity about expressing a science interest, and in fact, a female's peer group could actually deter future science participation (Breakwell et al., 2003). Breakwell et al. (2003), for example, found that a female who liked science was often thought of "less feminine," which could result in the group bias against her (p. 449). This specific characteristic was not measured by the PISA 2006 peer variable and was therefore noted as a limitation, which future research should address.

School construct. Literature also acknowledged the impact of schools in regard to female science participation. The only school construct that was noted as a positive predicator in the pooled all-countries model as well as in several individual country models was the teaching and learning variable concerning science investigations. Female students find it critical to actively conduct their own investigations and design related experiments. A similar variable concerned teaching and learning with an emphasis on hands-on activities, which was the second most often reported school variable as a positive predictor of female intention to study science postsecondary. References in regard to female science participation and the importance of conducting experiments as well as hands-on activities were often cited in literature (Burkam et al., 1997; Ornstein, 2006; Seymour & Hewitt, 1997; Taasoobshirazi & Carr, 2008; Udo et al., 2004).

Cross-Country Characteristics

In addition to the student, family, school, and peers, culture can influence a female's science participation (OECD, 2007). While culture is a broad entity with a wide-ranging definition, examining characteristics among regions can help facilitate cautious inferences in regard to culture that likely require further research. This study, which involved 15 countries, considered the influence of countries from a variety of regions in further detail. Eight countries were from the European region, five from the Asian region, one from Oceania, and another from Latin America. With only one country each from the Oceania and Latin America regions, no comparisons could be made. There were, however, a few findings among the countries from the Asian and European regions that may be of interest. One observation includes the commonality among positive predictors particularly concerning the student variables. Specifically, the majority of countries in both regions reported that the student variables involving instrumental motivation to learn science, science activities, enjoyment of science, personal value of science, and science self-concept consistently and positively mattered to both regions. Still, there were some notable differences. In European countries, but not always Asian countries, the proportion of females enrolled at school positively mattered. Some research has suggested that single sex environment facilitates female science participation (Rayman & Brett, 1995; Turner & Bowen, 1999). Acknowledged more often as a positive factor in the Asian countries were the variables related to student general interest in specific science disciplines and school teaching involving hands-on activities. Among the Asian countries, the parent variable view on the importance of learning science consistently negatively mattered, but it was not found to be significant among the European countries. These differences may not be an element so much of culture as it could be of education system (van Langen & Dekkers, 2005) and would again warrant further study.

Opportunities for Further Research

The common factors observed across a variety of countries from different regions illuminate what is important to females who intend to study science postsecondary. The findings, at the same time, serve as a springboard for further research prompting questions, such as how do these factors develop and why are these factors, in particular, seen as important to females as well as what is the relationship among the factors to each other, if any? Since this was a quantitative study using a secondary data set, further research should involve multiple tracks that will likely provide a deeper understanding in regard to female intention to study science. Ultimately and ideally, focus groups in a variety of countries may offer answers to the sought-after questions. Interviews could provide specific anecdotal evidence. With these methods, carefully designed questions at a variety of construct levels could furnish valuable insight.

Specifically, it may be of value if future studies could look more closely into how these factors originate by focusing on parents. As found in the results of this study, parents are an important predictor of a female's intention to study science postsecondary. It appears that parents' belief that their child will study or work in a science field someday is significant. According to literature, such expectations could directly influence the child's science self-beliefs

(Bleeker & Jacobs, 2004; George, 2000). In this study, science self-concept was noted as a consistent positive predictor of female intention to study science postsecondary. Chapman et al. (2000) inferred that self-concept, specific to a particular subject such as science, is formulated by the first few years of beginning school. According to George (2000), science self-concept is an important determinant of science attitude, which when positive likely leads to lifelong science learning (George, 2000). As a result, it would be important to interview parents and female students asking questions concerning parental influence and student development of science self-concept to understand the findings in additional detail.

On the seemingly opposite end of the spectrum of science self-concept is science anxiety, which was mentioned in literature as a deterrent to science learning, leading to negative feelings towards science and ultimately, diminished, if not absent, science participation (George, 2000; Mallow, 1994; Udo et al., 2004; Xie, 2005). Presumably science anxiety is low in females who acknowledge both self-do well in science and belief in their science academic ability. Both self-do well in science and science self-concept were consistently noted across all countries as positive predictors to female intention to study science postsecondary. All of this leads to yet another question: What can be done to ensure that females develop their science self-concept and continue to build academic confidence since identified as an important self-belief indicator and contributor of science participation? Also, since science self-concept was suggested to form early when a female student is in primary school (Chapman et al., 2000), what can parents and respective teachers do to ensure its firm foundation? The question might therefore be extended to ask how do parents and teachers encourage science self-concept more and science anxiety less? Another question concerns the female perception of science being personally useful and valuable, and how is this view facilitated? Females actively participating in science activities were also seen as important in this study. What about these activities foster female science interest? Jacobs et al. (1998) found that without interest it seems unlikely that females will choose science for future study or major choice.

Additional questions remain as to the impact of peers, teachers, and cross-country characteristics. The peer variables in the PISA 2006 did not incorporate the group dynamic and accompanying stereotypic belief that requires further attention. Moreover, studies have shown that teachers are a strong influence in regard to female student science participation (Besecke & Reilly, 2006; George, 2000, 2003; Simpson & Oliver, 1990; Strenta et al., 1994; Ware & Lee, 1988), yet the PISA 2006 questions related more to instruction, and additional input should be obtained concerning the teacher's role and teaching style in the science classroom. A field study involving women and men working in a science profession noted that women, but not men, credited their teachers as reasons why they maintained an interest in science and aspired to study science (Besecke & Reilly, 2006). In fact, teachers were often cited as someone who provided the support to pursue a goal in science even with noted barriers, such as family discouragement, gender stereotypes, or peer/classroom harassment (Besecke & Reilly, 2006). Focus groups and interviews can target what about the teacher role is significant to females and their intention to study science. The conditions of female students' learning experiences should be investigated in detail, which often determines female classroom participation (Salter & Persaud, 2003). Focus groups and interviews could also help provide crucial feedback to aid in increasing female participation in various racial-ethnic groups, which remains an underrepresented resource as cited by both the National Science Board (2012) and the National Science Foundation (2013) and in need of further study. Muller et al. (2001) highlighted the importance of studying race/ethnicity in regard to gender disparities in science rather than grouping all women of all races collectively.

Additional research in regard to educational systems and not necessarily cultural values, as discussed by Chiu and Klassen (2010) in relation to effects on math self-beliefs, may explain differences observed between countries although further research is required. Literature suggested that the structure or characteristics of a nation's educational system are a potential influence in regard to gender differences in science participation (Hanson, Schaub, & Baker, 1996; McDaniel, 2010; van Langen & Dekkers, 2005). While there were consistent predictors associated with female intention to study science postsecondary for all countries included in this analysis, there were some observed differences. For instance, in the European region countries but not Asian countries, the variable concerning parent occupation in a science related field and proportion of girls enrolled at schools were both positive predictors. Conversely, in the Asian countries but not European countries, student general interest in science, which involved specific science disciplines, positively mattered. Hands-on activities completed at school were also important in some Asian countries. What about this learning approach influences female intention to study science? Future research should include interviews and focus groups of females in respective countries as well as examining the nation's educational system and science curriculum to help determine impact, if any.

It would also be noteworthy to repeat this study in 2015 when again the domain in the PISA assessment concerns science. Perhaps at that time, in addition to attempting to validate this study's results, relationships among predictor variables could be examined. Path analysis with logistic regression models could be analyzed to understand the direct and indirect effects among predictor variables. Male students may be considered for inclusion to evaluate if the predictors associated with female intention to study science postsecondary are similar. In addition, it would be highly advantageous if OECD could encourage other countries to participate in the optional parent questionnaire. Given the importance of the parent construct to female science participation and the persisting global underrepresentation, it is critical to consider data from additional countries. In the PISA 2006 survey, the countries that opted to complete the parent questionnaire were only from the following regions: Asia, Europe, Oceania, and Latin America. Countries from North America, such as the United States and Canada, should consider taking part in the parent survey, thus widening the cross-country analysis to obtain an increased global perspective of female intention to study science postsecondary. President Obama in his 2009 address to the National Academy of Science Annual Meeting discussed concerns for female science underrepresentation and called for the exploration in regard to possible explanations (Obama, 2009). Given this charge, it would be especially insightful if the United States participated in the optional PISA parent questionnaire with a focus on science. Achieving such far-reaching comparisons should be of interest to all economies given the persisting underrepresentation and need to fill science positions as dictated by the policies of several nations (PCAST, 2010; UNESCO, 2007).

In many previous studies, there was a focus related to female science attrition once in college (Brownlow et al., 2002; Mallow, 1994; McDade, 1988; Rayman & Brett, 1995; Sax & Harper, 2007; Smyth & McArdle, 2004; Strenta et al., 1994; Udo et al., 2004; Ware et al., 1985). According to a plethora of sources cited in Smyth and McArdle (2004), a loss of greater magnitude in regard to science participation occurs precollege (p. 354). Hilton & Lee (1988) likewise confirm that there is a more substantial loss of potential science majors when students “transition from high school to college” (p. 523). The findings of this study help increase understanding as to why a female intends to study science. It provides a proactive approach that will hopefully give policy makers needed information to make changes and improve women's participation in science earlier in the science educational pipeline.

Policy Implications

Policies exist worldwide to increase female participation in science. The United Nations Educational, Scientific and Cultural Organization (UNESCO) called upon all countries to help increase the number of female scientists (UNESCO, 2007). The European Union, inclusive of 28 member countries, has implemented policy to increase the number of female scientists (UNESCO, 2007) in addition to the United States (Obama, 2009; PCAST, 2010). Still, however, the underrepresentation in science persists as acknowledged by the European *She Figures* (European Union, 2009) and the National Science Foundation's biennial report *Women, Minorities, Persons with Disabilities in Science and Engineering* (NSF, 2013). According to UNESCO (2007) and for the majority of countries analyzed in this study, the number of females enrolled in a first university degree program is more than males, yet females on average comprise far fewer science researchers. The female scientist conundrum is complex and strategies, as a result, must address the multifaceted hierarchy from the most inclusive national level to the least inclusive individual student. Given the original intent of this study to address the outflow from the science education pipeline precollege (i.e., intention to study science postsecondary), which is upstream from the other critical juncture involving college science major commitment, the focus of the policy discussion involves several influential entities from student, school, parent, science industry, as well as nation.

Interventions to Encourage Females in Science

This study showed that females intend to study science postsecondary when they are instrumentally motivated to do science, enjoy science, personally value science, have belief in their ability to do science, and are interested in science. Strategies to encourage female science participation should, therefore, be focused on measures that positively contribute to a student's disposition towards science. Such interventions must be facilitated by an alliance of constructs identified in this research as positively associated with female intention to study science postsecondary. This partnership includes female students, schools, parents, and related industry.

Student construct. Instrumental motivation was consistently reported among all 15 countries included in this analysis as a strong predictor of female students' intentions to study science postsecondary. The individual PISA 2006 survey questions from which the instrumental motivation index was derived indicate that female students feel it is important to make an effort in school science subjects because it is the area in which they may want to study or work in later and it is useful to them (OECD, 2009a, p. 456). Applying strategies according to Carol Dweck's research and as discussed in the 2010 AAUW report *Why so few*? may instill the optimism necessary to drive female instrumental science motivation (Hill et al., p. 30).

Dweck (2009) promoted the "growth mindset", which is based on the idea that ability is not fixed and can be acquired. This premise seems linked to brain plasticity (Halpern, 2012; Halpern et al., 2007, p. 3; McEwen, 2005; Norden, 2007) and supportive of the studies showing that female students, through task exposure and practice, can enhance spatial skills (Brownlow et al., 2003; Halpern et al., 2007). Female students, regardless of intellect, can be susceptible to the feeling that they do not have the ability (science self-concept) and may, decide not to participate in science in some way. Dweck (2009) supported the idea that "those who believe that their intelligence can be developed - are eager learners" and strive to expand it and those that do not may shun it (p. 9).

According to Dweck (1986), "effective learning and performance" is based on "psychological factors, other than ability, that determine how effectively the individual acquires and uses skills" and specifically cited motivation as the principle influence (p. 1040). This reasoning helps explain the underrepresentation among females in science. In one study, when a science test was administered and females maintained the view that they were not as good as males in science, they performed more poorly than males (Brownlow et al., 2003). This was in contrast to when female students were told that the test was gender equitable, which resulted in equal achievement (Schmader, 2005). How students "construe" or "interpret events" and the brain processes it undeniably affects learning (Dweck, 1986, p. 1040; Norden, 2007). Positive emotions or experiences promote learning, while negative emotions inhibit it (Norden, 2007). If a female student reports a negative science self-concept, often the result of an accumulation of experiences, she will not likely choose to participate in science (Brownlow et al., 2002). Moreover, literature shows that science attitude grows less positive starting in middle school and declines further in high school (George, 2000; Kahle & Rennie, 1993; Lupart, Cannon, & Telfer, 2004; Taasoobshirazi & Carr, 2008; VanLeuvan, 2004). Could it be that the accumulation of negative thoughts related to science learning and lack of science experiences is not sufficient to manifest itself in primary school? Perhaps that is why the decline in science attitude is more apparent in subsequent years when it is enough to impair a female's effort to persevere when science becomes more challenging.

Dweck discussed "adaptive motivational patterns" and "maladaptive patterns" (p. 1040); both can be displayed regardless of intellect (Dweck, 1986, p. 1041). Adaptive patterns characterize someone who pursues challenges when presented with obstacles and maladaptive describes someone who avoids challenges and maintains low perseverance often resulting in anxiety (Dweck, 1986, p. 1040) and feelings of inadequate ability (Dweck & Legget, 1988, p. 258). Dweck and Legget (1988), in relation to adaptive and maladaptive behavior, showed that children who avoided a challenge when a task grew difficult were at first the same in ability as those who show the adaptive pattern (p. 256). They further stated that students showing high skill mastery could also exhibit maladaptive behavior (p. 256). Dweck and Legget (1988) further described the adaptive motivation pattern as being "mastery-oriented" and maladaptive as "helpless" (p. 257). The findings in the current investigation show that instrumental motivation is a strong predictor of female intention to study science postsecondary, which likely stems from the students' emphasis on effort, which according to Dweck and Legget (1988) is critical to problem-solving. This describes making an effort because it will help the female student in what she wants to do later on: study, work, and/or career (Dweck, 2006, p. 7). Effort is critical and provides the necessary motivation to persevere through an obstacle or challenge (Dweck, 1986, p. 1041; Dweck & Legget, 1988). Dweck stressed that, in lieu of performance or achievement, the learning process effort should be highlighted. In a study by Licht, Linden, Brown, and Seton (1984) involving fifth grade students, female students waned with challenging problems and would rather those they felt confident in performing. This finding was inclusive of some of the intellectually competent female students (Licht et al., p. 4). These findings appear related to the outcome of a study by Ackerman, Kanfer and Beier (2013) who analyzed the "traits" of women and men who pursued or left a STEM major in college. Their study showed that women who left a STEM major had a low math and science self-concept, but high skill mastery (p. 921). Women who left a STEM major for another major, compared to men, also exhibited higher anxiety (p.

923). In regard to issues concerning low female science participation, the findings by Dweck (1986), Licht et al. (1984), and Ackerman et al. (2013) could imply that females who do not feel they are good at science, regardless of actual skill level, do not consider future science studies and opt out of the science pipeline rather than persist.

School construct. With literature acknowledging that a decrease in science interest is noted among females in the middle school years (George, 2000; Kahle & Rennie, 1993; Lupart, Cannon, & Telfer, 2004; Taasoobshirazi & Carr, 2008; VanLeuvan, 2004), and science self-concept can be formed by the primary school years (Chapman et al., 2000; Eccles, 1994), schools share a critical role in developing interventions and promoting positive science education. As discussed by Trumper (2006), the American Association for the Advancement of Science (AAAS) Project 2061 is a long-term initiative to improve science education, which includes the enhancement of positive science learning attitudes (p. 48). Literature has confirmed that teachers can significantly influence a female student's science attitude including persistence and are therefore, a critical catalyst (Besecke & Reilly, 2006; George, 2000; Strenta et al., 1994; Ware & Lee, 1988).

To encourage females in science, instruction needs to foster female student interest in science (Burkam et al., 1997). The question is how to generate female science interest? The findings in this study showed that above all other types of classroom instruction, female students have an interest in conducting their own scientific investigations and want to design related experiments. In addition to experimentation, science instruction involving hands-on activities, was acknowledged in this study by females from several countries as a positive means to promote their intention to study science postsecondary. In fact, a large study using National Educational Longitudinal Study (NELS) data verified the importance of hands-on experimentation for student learning and in particular, for females (Burkam et al., 1997). Some have even found that hands-on activities are so important to female science learning in the middle and high school years that they can make up for their fewer out-of-school science experiences (Burkam et al., 1997; Kahle & Rennie, 1993). Moreover, Ornstein (2006), who conducted a study concerning hands-on experimentation and science attitude, found that "classrooms that frequently provided more challenging, open-ended experimentation and inquiry appeared to produce more positive student attitudes toward science than did classrooms where this type of inquiry was not used very frequently" (p. 294). This was particularly true when students had opportunities to formulate and test their individual hypotheses (Ornstein, 2006), which were noted as positive predictors associated with female intention in science postsecondary as per this analysis. This relates to the finding that "active involvement in lab work is more critical than the quantity of lab work" (Burkam et al., 1997, p. 322). Also found to be an important predictor to female intention to study science postsecondary was the integration of career preparation for science-related careers. At the same time, respective career education can provide additional understanding of a particular career's orientation, engage prospective interest, as well as clarify stereotypical misconceptions that females may have in regard to a science occupation. Lastly, school promotion of science clubs, fairs, competitions, and related field trips were cited as important predictors to females in this study.

Female instrumental motivation and the desire to perform laboratory science experimentation, both recognized by females in this study as important predictors of intention to study science postsecondary, are intimately related to academic curriculum, and interventions must include related opportunities. This has implications for schools that implement curriculum, policy makers who determine the respective entities, and especially for nations who strive to address female underrepresentation in science. Through professional development, schools need to provide opportunities for teachers to learn how to incorporate the classroom instruction techniques cited by females in this study as important to their intention to study science postsecondary.

Foremost is experimentation and hands-on activities. As per the PISA classroom instruction student investigation index, this study showed that it is important for female students to design their own experiments, to be given the chance to choose their own experiments, and are asked to do an investigation or test out their own ideas (OECD, 2009a, p. 459). The science teaching hands-on activities index also involves practical experimentation inclusive of design and concluding inferences (OECD, 2009b, p. 333). To ensure that a female student can achieve her fullest science potential, schools need to seriously reflect upon their curriculum to ensure that students engage in relevant hands-on laboratory experiences. Since the years in "late elementary and early middle school have emerged as critical periods" for nurturing female science interest, (AAUW, 1992; Yanowitz & Vanderpool, 2004, p. 353), schools should consider modifying curricula and implementing programs to ensure that experimentation opportunities are available as early as primary school and extending throughout the middle and high school years. To reach all students, respective experiences should be included in every core science course. However, if this is not feasible, then schools should consider offering a science research elective, open to all interested students with the desire to perform hands-on and authentic research, beginning as early as middle school. A suggestion would include a stratified research course with ample opportunity for independent investigation, which would lead to more sophisticated experimentation means when in high school. Another suggestion to make time for quality science investigation would include a modification of Bergmann and Sams's "flipped classroom" learning model where course content would still be viewed outside of class via instructional videos and the like; however, instead of using class time for homework review, meaningful experimentation could take place (Bergmann & Sams, 2014; Sams & Bergmann, 2013; Tucker, 2012). To facilitate female interest in science, instruction needs to provide opportunities of investigation and experimentation as well as career education, all of which involve aspects of real-life science.

The question that remains outside the scope of this analysis is how can these very important activities, which were identified to be critical to a female's intention to study science, be incorporated into instruction? Yaeger and Dweck (2012) indicated that, "educational reform efforts have focused on increasing rigor in curricula and instruction" (p. 306). In the wake of increasing content and testing, schools need to find and make time in their curriculum to allow for this critical learning experience and one associated with females' future science study. Testing may have its place (Bishop, 2000), but the struggle is to find balance between its instructional preparation and incorporation with opportunities to cultivate female science participation and not curtail it (Battey, Kafai, Nixon, & Kao, 2007). Allowing students to investigate a question in-depth, test their hypothesis, and conduct experimentation provides the critically challenging and motivating opportunities necessary to grow as well as build confidence to pursue science study. In fact, the process of experimentation is highly influential in that it models the characteristics of the adaptive motivational pattern to seek and persist during challenges (Dweck, 1986), where quite possibly retesting and reformulating a hypothesis are often needed. There is a direct transfer from being involved in the process of science through active experimentation to making the effort and learning how to face adversity going forward, which will ultimately encourage females to be instrumentally motivated. The "growth mindset," suggested by Dweck's research (1986, 2009) is fostered by science experimentation.

Lastly in regard to student intervention, Dweck (1986) mentioned that a maladaptive motivation pattern could lead to anxiety (p. 1040). To encourage a positive science attitude, schools can model strategies after those being practiced at the Science Anxiety Clinic at Loyola University Chicago (Udo et al., 2004, p. 442). According to Udo et al. (2004), one strategy that fosters female student learning skills includes techniques on how to effectively take notes and complete problems in addition to hands-on experiences. Other tactics employ methods to lower negativity or science anxiousness (Udo et al., 2004, p. 442). Some of this may stem from the high performance standard a female appears to place on herself in regard to science learning (Hill et al., 2010, p. xv), which appears evident in this study with females noting that doing well in science is an important predictor to their intention to study science postsecondary. Applying strategies encouraged at the Loyola University's Science Anxiety Clinic (Udo et al., 2004) along with the idea of the "growth mindset" proposed by Carol Dweck's research and as discussed in the 2010 AAUW report (Hill et al., 2010), may be very beneficial to a female student feeling optimistic about her science studies and pursing a future science career.

Parent construct. This study showed that parents who have expectations that their daughter will study and possibly have a career in science were observed to be an important predictor in female intention to study science postsecondary. Such parent beliefs likely instill or contribute to the female students' much needed science self-confidence that ultimately shapes their science attitude. Parents need to encourage their daughters in science and allow them to experience science activities early in their development, which increases science exposure and likely contributes to their science self-esteem (Burkam et al., 1997 George, 2000; Rayman & Brett, 1995; Taasoobshirazi & Carr, 2008; VanLeuvan, 2004).

Female students acknowledged parents and teachers as "important to their decisions to pursue science" more often than males (Strenta et al., 1994, p. 536). As a result, families and schools need to work together to improve female science participation. Rayman and Brett (1995) suggested that colleges instruct parents on actions to encourage females' science participation possibly during freshman orientation or the annual family weekend event (p. 405); however, this study acknowledges that it would be of far-reaching benefit if schools, as early as primary, provide similar events to increase parental support and awareness.

A partnership with science-related industry. The findings in this study also identified opportunities in industry as important predictors to female intention to study science postsecondary. Industry needs to actively partner with schools to encourage females to enter science fields. In several countries, visits to industry were identified as an influential factor to female intention to study science postsecondary. In fact, opportunities facilitating student interaction with women scientists have been reported as transformative in fostering a female's science interest (Besecke & Reilly, 2006). In fact, women reported that interaction with a female role model in science or mentor was highly influential in their intention to major in science, while men did not report this experience as critical to their science. Companies need to work with schools to facilitate much needed career education. This can be done through providing industry lectures, as noted as an important predictor to female intention to study science in this analysis. Other events should include opportunities to connect with female scientists in person or via videoconference, pursue research, engage in a summer programs, participate in internships, job shadow, and achieve scholarships (Packard & Nguyen, 2003).

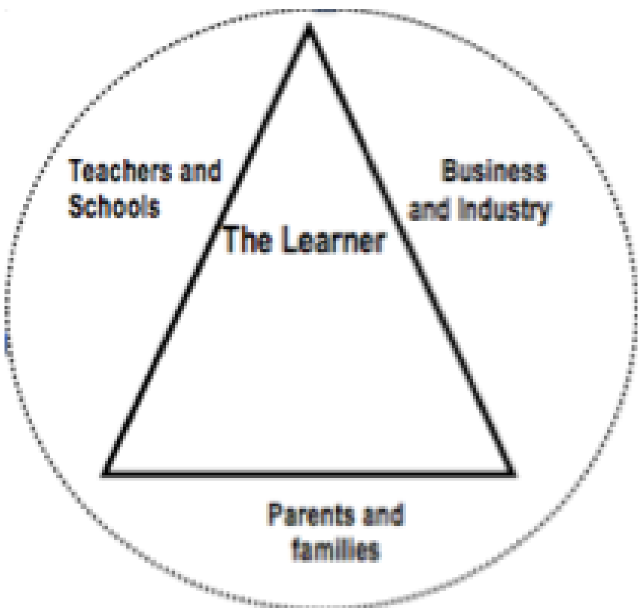

Figure 2. Female science-learning triangle.

There is a definite female science-learning triangle inclusive of the major stakeholders critical to facilitating female science participation, which seems to emerge from related literature and the findings in this study, which is depicted in Figure 2. Parents, schools, and industry all share a responsibility in fostering females in science. A study to determine the factors that influenced a female's career plans showed that internships and support from parents, teachers, and mentors were critical factors (Besecke & Reilly, 2006). Having positive supportive relationships help women to maintain positive images of science (Packard & Nguyen, 2003).

As previously mentioned, there is a hierarchy responsible for facilitating promising female science participation. Once again, enhancing female science participation is a partnership. Parents need to empower their daughters and teachers their female students and promote the "growth mindset" (Dweck, 2006). Female students need to know that the brain is plastic (Halpern, 2012, p. 375; McEwen, 2005; Norden, 2007, p. 139), which is the basis for new learning (Halpern et al., 2007; Norden, 2007; McEwen, 2005). Schools need to provide opportunities to conduct laboratory experimentation. Industry needs to be enlisted to help facilitate mentoring relationships due to its deemed importance to female science participation (Besecke & Reilly, 2006; Packard & Nguyen, 2003).

Parents, schools, teachers, and industry were all identified as influential factors in this analysis. Superimposed on the learning triangle is each nation's governing system, which is depicted by the dotted circle surrounding the science-learning triangle. Through a nation's continued policies to improve female representation in science and their educational systems, they have the critical ability to effect change by ensuring factors observed as important predictors, such as the opportunity to perform authentic science investigations, are incorporated in national science curriculum early in a female's educational pipeline.

Conclusion

Influence and transformation not complacency. The results of this study helped determine the portrait of a female that intends to study science postsecondary. Findings showed that the female who plans to study science postsecondary finds enjoyment in science learning and is engaged in a variety of science activities from watching science-related television programs, to reading science literature or attending a science club. She is also instrumentally motivated to learn science, finding utility in its study. The female student personally values science and has belief in her content ability, expressing ease in comprehending related learning. Moreover, she has parents who maintain a positive view of science career motivation with expectations that their daughter will study science postsecondary and possibly have a related career. In addition, one or both parents work in a science field. At school, this female student values science experimentation and relishes the opportunity to perform her own investigations. Her peers help frame this self-portrait.

Knowing these characteristics can help mitigate the female scientist conundrum that continues to prevail in the majority of countries. Calls for action have been made worldwide with the hope to understand and the intent to rectify female science underrepresentation. In this study, females from 15 nations acknowledged, with consistency, predictors of importance in their intention to study science postsecondary. Hill et al. (2010), in their The AAUW report *Why so few*?, stated that inclusive of "first-year college students, women are much less likely than men to say that they intend to major in science, technology, engineering, or math" (p. xiv). Hill et al. (2010) also reported the time "between high school and college is a critical moment when many young women turn away from a STEM career path" (p. 5) as well as recognized that "the foundation for a STEM career is laid early in life…" (p. xv). The findings of this study show that female science underrepresentation will likely persist if provisions are not made early in a female's educational science pipeline and sustained throughout to incorporate the factors that females have acknowledged as important in their intention to study science postsecondary. The global community should utilize data, such as from this study, to proactively address the issues that are deterring females from choosing science as an intended major and drive educational reform.

With international data noting long lasting and prevailing female underrepresentation in science, one questions when implemented policy and action will finally suffice to turn the corner. Complacency to accept female underrepresentation in science as is and not do anything to modify school science curricula to include more opportunities for science investigation as deemed important in this analysis, for example, will only perpetuate the female scientist conundrum. Instead, with the thoughts of Emma Willard, who opened Troy Female Seminary in 1821 with the belief that females should learn science, and Mary Lyon who started Mount Holyoke requiring an intensive lab based science curriculum, along with many of the great women scientists of the 20th century, including Marie Curie, Rosalind Franklin, Jane Goodall, Rachel Carson, Barbara McClintock, and others, a path must continue to be forged so that the small gains observed over the years will not diminish but instead, grow (Kohlstedt, 2004, p. 2; Thelin, 2004; Tindall & Hamil, 2004).

References

Ackerman, P. L., Kanfer, R., & Beier, M. E. (2013). Trait complex, cognitive ability, and domain knowledge predictors of baccalaureate success, STEM persistence, and gender differences. *Journal of Educational Psychology*, *105*(3), 911. Retrieved from http://search.proquest.com/docview/1426371023?accountid=13793

Adams, C. M. (1996). Gifted girls and science: Revisiting the issues. *The Journal of Secondary Gifted Education*, *7*, 444–458. Retrieved from http://search.proquest.com/docview/62589665?accountid=13793

Allison, P. D. (2012). *Logistic regression using SAS theory and application* (2nd ed.). Cary, NC: SAS Institute.

Altbach, P. G., Reisberg, L., & Rumbley, L. E. (2009). *Trends in global higher education: Tracking an academic revolution. United Nations Educational, Scientific and Cultural Organization.* A report prepared for the UNESCO 2009 World Conference on Higher Education 2009. Retrieved from http://unesdoc.unesco.org/images/0018/001832/183219e.pdf

Altbach, P. G., Reisberg, L., & Rumbley, L. E. (2010, March-April). Tracking a global academic revolution. *Change*. Retrieved from http://www.changemag.org/Archives/Back%20Issues/March-April%202010/tracking-global-full.html

American Association of University Women (AAUW) Educational Foundation. (1992). *How schools shortchange girls*. Washington, DC: Author. Retrieved from http://www.aauw.org/files/2013/02/how-schools-shortchange-girls-executive-summary.pdf

American Association of University Women (AAUW) Educational Foundation. (1998). *Gender gaps, where schools still fail our children*. Washington, DC: Author. Retrieved from http://www.aauw.org/learn/research/upload/GGES.pdf

Austin, P. C., & Steyerberg, E. W. (2012). Interpreting the concordance statistic of a logistic regression model: Relation to the variance and odds ratio of a continuous explanatory variable. *BMC Medical Research Methodology, 12*(82), 1–8. Retrieved from http://www.biomedcentral.com/content/pdf/1471-2288-12-82.pdf

Austin, P. C., & Tu, J. V. (2004). Bootstrap methods predictive models. *The American Statistician*, *58*(2), 131–137.

Bandura, A. (1997). *Self-efficacy*. New York, NY: Freeman.

Barnett, R., & Rivers, C. (2004). *Same difference: How gender myths are hurting our relationships, our children, and our jobs*. New York, NY: Basic Books.

Battey, D., Kafai, Y., Nixon, A. S., & Kao, L. L. (2007). Professional development for teachers on gender equity in the sciences: Initiating the conversation. *Teachers College Record, 109*(1), 221–243. Retrieved from http://search.proquest.com/docview/61934326?accountid=13793

Bergmann, J., & Sams, A. (2014). Flipped learning: Maximizing fact time. *T + D*, *68*(2), 28–31. Retrieved from http://search.proquest.com/docview/1500363435?accountid=13793

Berk, K. N. (1978). Comparing subset regression procedures. *Technometrics*, *20*(1), 1.

Besecke, L. M., & Reilly, A. H. (2006). Factors influencing career choice for women in science, mathematics, and technology: The importance of a transforming experience. *Advancing Women in Leadership, 21*, N_A-N_A. Retrieved from http://search.proquest.com/docview/218163174?accountid=13793

Bess, J. L., & Dee, J. R. (2008). *Understanding college and university organization: Theories for effective policy and practice* (Vol. I). Sterling, VA: Stylus Publishing.

Bishop, J. (2000). Do curriculum-based exit exam systems enhance student achievement? *Psychology, Public Policy, & Law*, *6*(1), 199–215.

Bleeker, M. M., & Jacobs, J. E. (2004). Achievement in math and science: Do mothers' beliefs matter 12 years later? *Journal of Educational Psychology, 96*(1), 97–109. Retrieved from http://search.proquest.com/docview/62115921?accountid=13793

Breakwell, G. M., Vignoles, V. L., & Robertson, T. (2003). Stereotypes and crossed-category evaluations: The case of gender and science education. *British Journal of Psychology, 94*, 437–455. Retrieved from http://search.proquest.com/docview/199596499?accountid=13793

Brownlow, S., McPheron, T. K., & Acks, C. N. (2003). Science background and spatial abilities in men and women. *Journal of Science Education and Technology*, *12*(4), 371-380.

Brownlow, S., Smith, T. J., & Ellis, B. R. (2002). How interest in science negatively influences perceptions of women. *Journal of Science Education and Technology, 11*(2), 135–144. Retrieved from http://search.proquest.com/docview/62306439?accountid=13793

Burkam, D. T., Lee, V. E., & Smerdon, B. A. (1997). Gender and science learning early in high school: Subject matter and laboratory experiences. *American Educational Research Journal, 34*(2), 297–331. doi:10.3102/00028312034002297

Bussey, K., & Bandura, A. (1999). Social cognitive theory of gender development and differentiation. *Psychological Review*, *106*(4), 676–713. doi:10.1037/0033-295X.106.4.676

Catsambis, S. (1995). Gender, race, ethnicity, and science education in middle grades. *Journal of Research of Science Teaching*, *32*, 243–257. Retrieved from http://search.proquest.com/docview/62655550?accountid=13793

Chambers, D. W. (1983). Stereotypic images of the scientist: The Draw-a-Scientist test. *Science Education, 67*(2), 255–265. Retrieved from http://search.proquest.com/docview/63526446?accountid=13793

Chapman, J. W., Tunmer, W. E., & Prochnow, J. E. (2000). Early reading-related skills and performance, reading self-concept, and the development of academic self-concept: A longitudinal study. *Journal of Educational Psychology*, *92*(4), 703–708.

Chiarelott, L., & Czerniak, C. (1987). Science anxiety: Implications for science curriculum and teaching. *The Clearing House*, *60*(5), 202–205. Retrieved from http://www.jstor.org/stable/30186668

Chiu, M. (2010). Effects of science interest and environmental responsibility on science aspiration and achievement: Gender differences and cultural supports. *Educational Research and Evaluation*, *16*(4), 345-370. Retrieved from http://search.proquest.com/docview/822504876?accountid=13793

Chiu, M. M., & Klassen, R. M. (2010). Relations of mathematics self-concept and its calibration with mathematics achievement: Cultural differences among fifteen-year-olds in 34 countries. *Learning & Instruction*, *20*(1), 2–17.

Constantinople, A., Cornelius, R., & Gray, J. (1988). The chilly climate: Fact or fiction? *The Journal of Higher Education*, *59*(5), 527–550. doi:10.2307/1981702

Dweck, C. S. (1986). Motivational processes affecting learning. *American Psychologist*, *41*(10), 1040–1048.

Dweck, C. S. (2006). *Mindset. The new psychology of success*. New York, NY: Random House.

Dweck, C. S. (2009). Who will the 21st-century learners be? *Knowledge Quest, 38*(2), 8–9.

Dweck, C. S., & Leggett, E. L. (1988). A social-cognitive approach to motivation and personality. *Psychological Review*, *95*(2), 256–273. Retrieved from http://search.proquest.com/docview/214223154?accountid=13793

Eccles, J. S. (1994). Understanding women's educational and occupational choices: Applying the Eccles et al. model of achievement-related choices. *Psychology of Women Quarterly, 18*(4), 585–609. Retrieved from http://search.proquest.com/docview/62733648?accountid=13793

Eccles, J. S. (1999). The development of children ages 6 to 14. The Future of Children, 9(2), 30-44. Article DOI: 10.2307/1602703

European Commission. (2002). *Education and training in Europe: Diverse systems, shared goals for 2010*. European Commission Directorate-General for Brussels, Belgium: European Commission.

European Union. (2009). *She figures: 2009 Statistics and indicators on gender equality in science.* Retrieved from http://ec.europa.eu/research/science-society/document_library/pdf_06/she_figures_2009_en.pdf

Fiore, D. J. (2004). *Introduction to educational administration standards, theories, and practice*. Larchmont, NY: Eye on Education.

Fort, D. C., & Varney, H. L. (1989). How students see scientists: Mostly male, mostly white, and mostly benevolent. *Science and Children, 26*(8), 8-13. Retrieved from http://search.proquest.com/docview/63147820?accountid=13793

Fouad, N. A., Kantamneni, N., Smothers, M. K., Chen, Y., Fitzpatrick, M., & Terry, S. (2008). Asian American career development: A qualitative analysis. *Journal of Vocational Behavior, 72*(1), 43–59. doi:1 0.1016/j.jvb.2007.10.002

Frawley, T. (2005). Gender bias in the classroom: Current controversies and implications for teachers. *Childhood Education, 81*(4), 221–227. Retrieved from http://search.proquest.com/docview/210389789?accountid=13793

Geiger, J. F., & Litwiller, R. M. (2005). Spatial working memory and gender differences in science. *Journal of Instructional Psychology, 32*(1), 49–57. Retrieved from http://search.proquest.com/docview/213906186?accountid=13793

George, R. (2000). Measuring change in students' attitudes toward sciences over time: An application of latent variable growth modeling. *Journal of Science Education and Technology*, *9*(3), 213–225. Retrieved from http://www.jstor.org/stable/40186571

George, R. (2003). Growth in students' attitudes about the utility of science over the middle and high school years: Evidence from the longitudinal study of American youth. *Journal of Science Education and Technology*, *12*(3), 439–448. Retrieved from http://www.jstor.org/stable/40188748

George, R., & Kaplan, D. (1998). A structural model of parent and teacher influences on science attitudes of eighth graders: Evidence from NELS:88. *Science Education*, *82*, 93–109.

Giedd, J. (2005, December). *Sexual dimorphism in the developing brain*. Paper presented at the National Academies Convocation on Maximizing the Success of Women in Science, Engineering: Biological, Social, and Organizational Components of Success, Washington, DC.

Gurian, M., Henley, P., & Trueman, T. (2001). *Boys and girls learn differently: A guide for teachers and parents*. San Francisco, CA: Jossey-Bass.

Gurian, M., & Stevens, K. (2004). With boys and girls in mind. *Educational Leadership, 62*(3), 21–26 Retrieved from http://search.proquest.com/docview/62079887?accountid=13793

Guzzetti, B.J., & Williams, W.O. (1996). Changing the patterns of gendered discussion: Lessons from science classrooms. *Journal of Adolescent & Adult Literacy, 40*(1), 38. Retrieved from http://search.proquest.com/docview/216927139?accountid=13793

Hagger, M. S., Stevenson, A., Chatzisarantis, N. L. D., Gaspar, P. M. P., Ferreira, J. P. L., & Ravé, J. M. G. (2010). Physical self-concept and social physique anxiety: Invariance across culture, gender and age. *Stress and Health, 26*(4), 304. Retrieved from http://search.proquest.com/docview/759412415?accountid=13793

Hall, R. M., & Sandler, B. R. (1982). *The classroom climate: A chilly one for women?* Project on the Status and Education of Women. Washington, DC: Association of American Colleges. Retrieved from http://search.proquest.com/docview/63567096?accountid=13793

Halpern, D. F. (2000). *Sex differences in cognitive abilities* (3rd ed.). Mahwah, NJ: Lawrence Erlbaum Associates.

Halpern, D. F. (2004). A cognitive-process taxonomy for sex differences in cognitive abilities. *American Psychological Society*, *13*(4), 135–139.

Halpern, D. F. (2005, December). *Biopsychosocial contributions to cognitive performance.* Paper presented at the National Academies Convocation on Maximizing the Success of Women in Science, Engineering: Biological, Social, and Organizational Components of Success, Washington, DC.

Halpern, D. F. (2012). *Sex differences in cognitive abilities* (4th ed.). New York, NY: Psychology Press.

Halpern, D. F., Benbow, C. P., Geary, D. C., Gur, R. C., Hyde, J. S., & Gernsbacher, M. A. (2007). The science of sex differences in science and mathematics. *Psychological Science in the Public Interest*, *8*(1), 1–51.

Hanson, S. I., Schaub, M., & Baker, D. P. (1996). Gender stratification in the science pipeline. A comparative analysis of seven countries. *Gender & Society*, *10*(3), 271–290.

Hayes, J., Price, R., & York, R. (2013). A simple model for estimating enrollment yield from a list of freshman prospects. *Academy of Educational Leadership Journal*, *17*(2), 61–68.

Higher Education Research Institute. (2007). *Survey of the American freshman: Special tabulations*. Los Angeles, CA: Author.

Hill, C., Corbett, C., & St. Rose, A. (2010). *Why so few? Women in science, technology, engineering, and mathematics. American Association of University Women.* (Library of Congress Control Number: 2010901076). Retrieved from American Association University of Women (AAUW) website: http://www.aauw.org/files/2013/02/Why-So-Few-Women-in-Science-Technology-Engineering-and-Mathematics.pdf

Hilton, T. L., & Lee, V. E. (1988). Student interest and persistence in science: Changes in the educational pipeline in the last decade. *Journal of Higher Education, 59*(5), 510–526. Retrieved from http://search.proquest.com/docview/63113555?accountid=13793

Hosmer, D. W., Lemeshow, S., & Sturdivant, R. X. (2013). *Applied logistic regression* (3rd ed.) Hoboken, NJ: John Wiley & Sons.

Huber, R. A., & Burton, G. M. (1995). What do students think scientists look like? *School Science & Mathematics*, *95*, 371–377.

Institute for Digital Research and Education. UCLA. (n.d.). *SAS annotated output. Proc logistic*. Retrieved from http://www.ats.ucla.edu/stat/sas/output/sas_logit_output.htm

International Labour Organization. (ILO). (2009, March). *Global employment trends for women*. Retrieved from http://www.ilo.org/wcmsp5/groups/public/@dgreports/@dcomm/documents/publication/wcms_103456.pdf

Jacobs, J. E., & Eccles, J. S. (1992). The impact of mothers' gender role stereotypic beliefs on mothers' and children's ability perceptions. *Journal of Personality and Social Psychology*, *63*, 932–944.

Jacobs, J. E., Finken, L. L., Griffen, N. L., & Wright, J. D. (1998). The career plans of science-talented rural adolescent girls. *American Educational Research Journal*, *35*(4), 681–704.

Jones, M., & Howe, A. (2000). Gender differences in students' experiences, interests, and attitudes toward science and scientists. *Science Education*, *84*(2), 180.

Jones, M. G., & Wheatley, J. (1990). Gender differences in teacher-student interactions in science classrooms. *Journal of Research in Science Teaching, 27*(9), 861–874. Retrieved from http://search.proquest.com/docview/62832276?accountid=13793

Kahle, J. B., & Lakes, M. K. (1983). The myth of equality in science classrooms. *Journal of Research in Science Teaching*, *20*(2), 131-140.

Kahle, J. B., Matyas, M. L., & Cho, H. H. (1985). An assessment of the impact of science experiences on the career choices of male and female biology students. *Journal of Research in Science Teaching*, *22*, 385–394.

Kahle, J. B., & Rennie, L. J. (1993). Ameliorating gender differences in attitudes about science: A cross-national study. *Journal of Science Education and Technology, 2*(1), 321–334. Retrieved from http://search.proquest.com/docview/62791558?accountid=13793

Kass, S. J., Ahlers, R. H., & Dugger, M. (1998). Eliminating gender differences through practice in an applied visual spatial task. *Human Performance*, *11*(4), 337.

Kelly, A. (1985). The construction of masculine science. *British Journal of Sociology of Education*, *6*(2), 133–154.

Klassen, R. M. (2004). Optimism and realism: A review of self-efficacy from a cross-cultural perspective. *International Journal of Psychology*, *39*(3), 205–230.

Kohlstedt, S. (2004). Sustaining gains: Reflections on women in science and technology in 20th-century United States. *NWSA Journal*, *16*(1), 2–26.

Lee, J. D. (2002). More than ability: Gender and personal relationships influence science and technology involvement. *Sociology of Education, 75*(4), 349–373. Retrieved from http://search.proquest.com/docview/216500709?accountid=13793

Lee, J. (2009). Universals and specifics of math self-concept, math self-efficacy, and math anxiety across 41 PISA 2003 participating countries. *Learning and Individual Differences*, *19*, 355–365.

Lee, M. A., & Mather, M. (2008). U.S. labor force trends. *Population Bulletin, 63*(2). Retrieved from http://dalmasetto.com/pdfs/US_labour_stats.pdf

Lent, R. W. (2005). A social cognitive view of career development and counseling. In S.D. Brown & R.T. Lent (Eds.), *Career development and counseling: Putting theory and research to work* (pp. 101-127). Hoboken, NJ: Wiley.

Li, D., Oranje, A., & Jiang, Y. (2009). On the estimation of hierarchical latent regression models for large-scale assessments. *Journal of Educational and Behavioral Statistics, 34*(4), 443–463.

Licht, B. G., Linden, T. A., Brown, D. A., & Seton, M. A. (1984, August). *Sex differences in achievement orientations: An "A" student phenomenon*. Paper presented at the Annual Convention of the American Psychological Association, Toronto, Canada.

Lupart, J. L., Cannon, C., & Telfer, J. (2004). Gender differences in adolescent academic achievement, interests, values and life-role expectations. *High Ability Studies*, *15*(1), 25–42.

Mallow, J. V. (1994). Gender-related science anxiety: A first binational study. *Journal of Science Education and Technology*, *3*(4), 227–238. Retrieved from http://www.jstor.org/stable/40186292

Maple, S. A., & Stage, F. K. (1991). Influences on the choice of math/science major by gender and ethnicity. *American Educational Research Journal*, *28*, 37–60.

Martin, M.D, Mullis, I.V.S., Foy, P., & Stanco, G.M. (2012). Chestnut Hill. MA: TIMSS & PIRLS International Study Center, Boston College. Retrieved http://timss.bc.edu/timss2011/downloads/T11_IR_S_Chapter1.pdf

McDade, L. A. (1988). Knowing the "right stuff": Attrition, gender, and scientific literacy. *Anthropology and Education Quarterly, 19*(2), 93–114. Retrieved from http://search.proquest.com/docview/63217686?accountid=13793

McDaniel, A. (2010). Cross-national gender gaps in educational expectations: The influence of national-level gender ideology and educational systems. *Comparative Education Review*, *54*(1), 27–50.

McEwen, B. (2005, December). *Environment-genetic interactions in the adult brain: Effects of stress on learning*. Paper presented at the National Academies Convocation on Maximizing the Success of Women in Science, Engineering: Biological, Social, and Organizational Components of Success, Washington, DC.

Morgan, C., Isaac, J. D., & Sansone, C. (2001). The role of interest in understanding the career choices of female and male college students. *Sex Roles, 44*(5), 295–320. Retrieved from http://search.proquest.com/docview/225379950?accountid=13793

Muller, P. A., Stage, F. K., & Kinzie, J. (2001). Science achievement growth trajectories: Understanding factors related to gender and racial-ethnic differences in precollege science achievement. *American Educational Research Journal, 38*(4), 981–981. Retrieved from http://search.proquest.com/docview/200440347?accountid=13793

National Science Board. (2012). *Science and engineering indicators 2012*. *Appendix tables* (NSB 12-01). Arlington, VA: National Science Foundation. Retrieved from http://www.nsf.gov/statistics/seind12/appendix.htm

National Science Foundation, National Center for Science and Engineering Statistics. (2013). *Women, minorities, and persons with disabilities in science and engineering: 2013* (Special Report NSF 13-304). Arlington, VA. Available at http://www.nsf.gov/statistics/wmpd/

Nicholls, G. M., Wolfe, H., Besterfield-Sacre, M., & Shuman, L. J. (2010). Predicting STEM degree outcomes based on eighth grade data and standard test scores. *Journal of Engineering Education*, *99*(3), 209–223.

Norby, R. F. (1997). Evaluating progress in gender equity in careers for women in science and technology: The impact of role modeling on women's career choices. *Electronic Journal of Science Education, 1*(3). Retrieved from http://search.proquest.com/docview/62232996?accountid=13793

Norden, J., (2007). *Understanding the brain*. [DVD]. Chantilly, VA: The Teaching Company.

Obama, B., The White House, Office of the Press Secretary. (2009, April). *Remarks by the President at the National Academy of Sciences Annual Meeting*. Retrieved from http://www.whitehouse.gov/the_press_office/Remarks-by-the-President-at-the-National-Academy-of-Sciences-Annual-Meeting

Obama, B. The White House, Office of the Press Secretary. (2013, February). *Remarks by the President in the state of the union address*. Retrieved from http://www.whitehouse.gov/the-press-office/2013/02/12/remarks-president-state-union-address

Organisation for Economic Co-operation and Development. (1999). *Classifying educational programmes. Manual for ISCED-97 implementation in OECD countries*. Retrieved from http://www.oecd.org/education/skills-beyond-school/1962350.pdf

Organisation for Economic Co-operation and Development. (2007). *PISA 2006 science competencies for tomorrow's world. Volume I: Analysis*. Paris, France: OECD Publishing.

Organisation for Economic Co-operation and Development. (2009a). *PISA data analysis manual*

(SAS 2nd ed.). Paris, France: OECD Publishing.

Organisation for Economic Co-operation and Development. (2009b). *PISA 2006 technical report*. Retrieved from http://www.oecd.org/pisa/pisaproducts/42025182.pdf

Organisation for Economic Co-operation and Development. (2012). *Education at a glance 2012: OECD indicators.* Retrieved from http://dx.doi.org/10.1787/eag-2012-en

Ornstein, A. (2006). The frequency of hands-on experimentation and student attitudes toward science: A statistically significant relation. *Journal of Science Education and Technology, 15*(3-4), 285–297. Retrieved from http://search.proquest.com/docview/62008113?accountid=13793; http://dx.doi.org/10.1007/s10956-006-9015-5

Packard, B. W., & Nguyen, D. (2003). Science career-related possible selves of adolescent girls: A longitudinal study. *Journal of Career Development, 29*(4), 251–263. Retrieved from http://search.proquest.com/docview/220430294?accountid=13793

Peng, C., Lee, K., & Ingersoll, G. M. (2002). An introduction to logistic regression analysis and reporting. *Journal of Educational Research*, *96*(1), 3-14.

Peng, C., So, T., Stage, F., & St. John, E. (2002). The use and interpretation of logistic regression in higher education journals: 1988–1999. *Research in Higher Education*, *43*(3), 259–293.

President's Council of Advisors on Science and Technology. (2010, September). *Report to the president. Prepare and inspire: K-12 education in science, technology, engineering, and math (STEM) for America's future*. Retrieved from http://www.whitehouse.gov/sites/default/files/microsites/ostp/pcast-stemed-report.pdf

President's Council of Advisors on Science and Technology. (2012, February). *Report to the president. Engage to excel: Producing one million additional college graduates with* *degrees in science, technology, engineering, and mathematics*. Retrieved from http://www.whitehouse.gov/sites/default/files/microsites/ostp/pcast-engage-to-excel-final_feb.pdf

Rayman, P., & Brett, B. (1995). Women science majors: What makes a difference in persistence after graduation? *Journal of Higher Education, 66*(4), 388–414. Retrieved from http://search.proquest.com/docview/62768492?accountid=13793

A researchers' labour market: Europe-a pole of attraction? The European charter for researchers and the code of conduct for their recruitment as a driving force for enhancing career prospects. (2006, June). European Presidency Conference, Vienna Austria. Retrieved from http://www.eua.be/eua/jsp/en/upload/report_web%20221006.1161606166446.pdf

Robertson, C. R., & Hoffman, J. J. (2000). How different are we? An investigation of Confucian values in the United States. *Journal of Managerial Issues*, *12*(1), 34–47.

Sadker, M., & Sadker, D. (1986). Sexism in the classroom: From grade school to graduate school. *Phi Delta Kappan, 67*(7), 512–515. Retrieved from http://search.proquest.com/docview/63336042?accountid=13793

Sadker, M., & Sadker, D. (1994). *Failing at fairness: How America's schools cheat girls*. New York, NY: Charles Scribner's Sons.

Sahlberg, P. (2006). Education reform for raising economic competitiveness. *Journal of Educational Change*, *7*(4), 259–287. doi:10.1007/s10833-005-4884-6

Salter, D.W. (2003). Exploring the "chilly classroom" phenomenon as interactions between psychological and environmental types. *Journal of college Student Development*, *44*(1), 110-121.

Salter, D. W., & Persaud, A. (2003). Women's views of the factors that encourage and discourage classroom participation. *Journal of College Student Development, 44*(6), 831–844. doi:10.1353/csd.2003.0077

Sams, A., & Bergmann, J. (2013). Flip your students' learning. *Educational Leadership, 70*(6), 16–20.

Sax, L. J. (1994). Retaining tomorrow's scientists: Exploring the factors that keep male and female college students interested in science careers. *Journal of Women and Minorities in Science and Engineering, 1*(1), 45–61. Retrieved from http://search.proquest.com/docview/62423942?accountid=13793

Sax, L., & Harper, C. (2007). Origins of the gender gap: Pre-college and college influences on differences between men and women. *Research in Higher Education*, *48*(6), 669–694. doi:10.1007/s11162-006-9046-z

Schaubroeck, J., Lam, S. S. K., & Xie, J. L. (2000). Collective efficacy versus self-efficacy in coping responses to stressors and control: A cross-cultural study. *Journal of Applied Psychology, 85*(4), 512–525. doi: 10.1037/0021-9010.85.4.512

Schmader, T. (2005, December). *Contextual influences on performance*. Paper presented at the National Academies Convocation on Maximizing the Success of Women in Science, Engineering: Biological, Social, and Organizational Components of Success, Washington, DC.

Seymour, E. (1995). The loss of women from science, mathematics, and engineering undergraduate majors: An explanatory account. *Science Education, 79*(4), 437–473. Retrieved from http://search.proquest.com/docview/62758048?accountid=13793

Seymour, E., & Hewitt, N. (1997). *Talking about leaving: Why undergraduates leave the sciences.* Boulder, CO: Westview Press.

Simpkins, S. D., Davis-Kean, P., & Eccles, J. S. (2006). Math and science motivation: A longitudinal examination of the links between choices and beliefs. *Developmental Psychology, 42*(1), 70–83. Retrieved from http://search.proquest.com/docview/62098804?accountid=13793

Simpson, R. D., & Oliver, J. S. (1990). A summary of major influences on attitude toward and achievement in science among adolescent students. *Science Education, 74*(1), 1–18. Retrieved from http://search.proquest.com/docview/63071549?accountid=13793

Smyth, F. L., & McArdle, J. J. (2004). Ethnic and gender differences in science graduation at selective colleges with implications for admission policy and college choice. *Research in Higher Education, 45*(4), 353–381. Retrieved from http://search.proquest.com/docview/62071004?accountid=13793

Spelke, E. S. (2005). Sex differences in intrinsic aptitude for mathematics and science? A critical review. *American Psychologist, 60*(9), 950–958, Retrieved from http://search.proquest.com/docview/62087161?accountid=13793

Stage, F. K., & Maple, S. A. (1996). Incompatible goals: Narratives of graduate women in the mathematics pipeline. *American Educational Research Journal, 33*(1), 23–51. doi:10.3102/00028312033001023

Steenbergen, M. R., & Jones, B. S. (2002). Modeling multilevel data structures. *American Journal of Political Science, 46*(1), 218–237.

Strenta, A. C., Elliot, R., Adair, R., Matier, M., & Scott J. (1994). Choosing and leaving science in highly selective institutions. *Research in Higher Education, 35*(5), 513–547. Retrieved from http://search.proquest.com/docview/62729030?accountid=13793

Taasoobshirazi, G., & Carr, M. (2008). Gender differences in science: An expertise perspective. *Educational Psychology Review, 20*(2), 149–169. doi:10.1007/s10648-007-9067-y

Tang, N., Fouad, N. A., & Smith, P. L. (1999). Asian Americans' career choice: A path model to examine factors influencing their career choices. *Journal of Vocational Behavior*, *54*, 142–157.

Tatsuoka, M. M. (1973). Multivariate analysis in educational research. *Review of Research in Education*, *273*. doi:10.2307/1167201

Thall, P. F., Russell, K. E., & Simon, R. M. (1997). Variable selection in regression via repeated data splitting. *Journal of Computational and Graphical Statistics, 6*(4), 416–434.

Thall, P. F., Simon, R., & Grier, D. A. (1992). Test-based variable selection via cross-validation. *Journal of Computational and Graphical Statistics*, *1*(1), 41–61.

Thelin, J. R. (2004). *A history of American higher education*. Baltimore, MD: The Johns Hopkins University Press.

Tindall, T., & Hamil, B. (2004). Gender disparity in science education: The causes, consequences, and solutions. *Education, 125*(2), 282–295. Retrieved from http://search.proquest.com/docview/196430320?accountid=13793

Trumper, R. (2006). Factors affecting junior high school students' interest in physics. *Journal of Science Education and Technology*, *15*(1), 47–50.

Trusty, J. (2002). Effects of high school course-taking and other variables on choice of science and mathematics college majors. *Journal of Counseling & Development*, *80*(4), 464–474. Retrieved from http://search.proquest.com/docview/218956310?accountid=13793

Trusty, J., Robinson, C. R., Plata, M., & Ng, K.-M. (2000). Effects of gender, socioeconomic status, and early academic performance on postsecondary educational choice. *Journal of Counseling & Development*, *78*(4), 463–472. Retrieved from http://search.proquest.com/docview/218965102?accountid=13793

Tucker, B. (2012). The flipped classroom. *Education Next*, *12*(1) Retrieved from http://search.proqust.com/docview/1237826701?accountid=13793

Turner, S. E., & Bowen, W. G. (1999). Choice of major: The changing (unchanging) gender gap. *Industrial and Labor Relations Review, 52*(2), 289–313. Retrieved from http://search.proquest.com/docview/62477882?accountid=13793

Udo, M. K., Ramsey, G. P., & Mallow, J. V. (2004). Science anxiety and gender in students taking general education science courses. *Journal of Science Education and Technology, 13*(4), 435–446. Retrieved from http://search.proquest.com/docview/62078334?accountid=13793

United Nations, Educational, Scientific and Cultural Organization. (2007). *Science, technology, and gender: An international report.* Retrieved from http://unesdoc.unesco.org/images/0015/001540/154045e.pdf

U.S. Congress Joint Economic Committee. (2012). *STEM education: Preparing for the jobs of the future*. A report by the Joint Economic Committee Staff, Senator Bob Casey, Chairman. Retrieved from http://www.jec.senate.gov/public/index.cfm?a=Files.Serve&File_id=6aaa7e1f-9586-47be-82e7-326f47658320

U.S. Department of Commerce Economics and Statistics Administration. (2011). *New Commerce Department report shows fast-growing STEM jobs offer higher pay, lower unemployment*. Retrieved from http://esa.doc.gov/news/2011/07/14/new-commerce-department-report-shows-fast-growing-stem-jobs-offer-higher-pay-lower-u

van Langen, A., & Dekkers, H. (2005). Cross-national differences in participating in tertiary science, technology, engineering and mathematics education. *Comparative Education, 41*(3), 329–350. Retrieved from http://search.proquest.com/docview/62145675?accountid=13793

VanLeuvan, P. (2004). Young women's science/mathematics career goals from seventh grade to high school graduation. *Journal of Educational Research, 97*(5), 248–248. Retrieved from http://search.proquest.com/docview/62121816?accountid=13793

Ware, N. C., & Lee, V. E. (1988). Sex differences in choice of college science majors. *American Educational Research Journal, 25*(4) 593–614. Retrieved from http://search.proquest.com/docview/63025834?accountid=13793

Ware, N. C., Steckler, N. A., & Leserman, J. (1985). Undergraduate women: Who chooses a science major? *The Journal of Higher Education, 56*(1), 73–84. doi: 10.2307/1981723

Williams, J. (2005, December). *Moving beyond the "chilly climate" to a new model for spurring organization change.* Paper presented at the National Academies Convocation on Maximizing the Success of Women in Science, Engineering: Biological, Social, and Organizational Components of Success, Washington, DC.

Xie, Y. (2005, December). *Social influences on science and engineering career decisions*. Paper presented at the National Academies Convocation on Maximizing the Success of Women in Science, Engineering: Biological, Social, and Organizational Components of Success, Washington, DC.

Yaeger, D. S., & Dweck, C. S. (2012). Mindsets that promote resilience: When students believe that personal characteristics can be developed. *Educational Psychologist*, *47*(4), 302. Retrieved from http://search.proquest.com/docview/1114028156?accountid=13793

Yager, R. E., & Yager, S. O. (1985). Changes in perceptions of science for third, seventh, and eleventh grade students. *Journal of Research in Science Teaching, 22*, 347–358 doi: 10.1002/tea.3660220405

Yanowitz, K. L., & Vanderpool, S. S. (2004). Assessing girls' reactions to science workshops. *Journal of Science Education and Technology, 13*(3), 352–259. Retrieved from http://www.jstor.org/stable/40186654

APPENDIX

Model Assessment and Goodness of Fit Metrics

In this study, logistic regression was used to determine the relationship of numerous independent variables with the dichotomous outcome variable of female intention to study science postsecondary. In other words, logistic regression predicted the "logit of an event outcome from a set of predictors" (Peng, Lee, & Ingersoll, 2002, p. 6). As per Austin and Steyerberg (2012), "When the outcomes are binary, the c-statistic, which is equivalent to the area under the Receiver Operating Characteristic (ROC) curve, is a standard measure of the predictive accuracy of the logistic regression model" (abstract, p. 1). The area under the ROC curve and therefore c statistic ranges from 0.5 to 1.0 (Peng, Lee, & Ingersoll, 2002, p.8; Hosmer et al., 2013). A c statistic of "0.5 corresponds to the model randomly predicting the response, and a 1 corresponds to the model perfectly discriminating the response" (Institute for Digital Research and Education, UCLA, n.d., "Association of Predicted Probabilities," para. 5). As stated by Allison (2012) and Peng, Lee and Ingersoll (2002), the cut off is often determined by the researcher and dependent on the type of research performed. According to Hosmer et al. (2013), however, there are, some general rules, which are listed below (p. 177):

- If $ROC = 0.5$, the model has no discrimination.
- If $0.5 < ROC < 0.7$ the model is said to have poor discrimination
- If $0.7 \leq ROC < 0.8$ the model has acceptable discrimination
- If $0.8 \leq ROC < 0.9$ the model has excellent discrimination
- If $ROC \geq 0.9$ the model has outstanding discrimination

Table A1 depicts the c statistic for each model in this analysis. As noted, the c statistic for each model denotes excellent discrimination. As per Hosmer et al. (2013), "When the model fits the validation data set one can have some confidence that the values of the individual coefficients in the model approximate to a good degree the covariate effect in the validation setting (p. 211).

Table A1

Country Specific Goodness of Fit Metrics Test Set

Model	C statistic	Model assessment[a]
Pooled All Country	.88	Excellent
Bulgaria (BGR)	.86	Excellent
Colombia (COL)	.86	Excellent
Germany (DEU)	.86	Excellent
Denmark (DNK)	.87	Excellent
Hong Kong-China (HKG)	.87	Excellent
Croatia (HRV)	.85	Excellent
Iceland (ISL)	.87	Excellent
Korea (KOR)	.87	Excellent
Luxembourg (LUX)	.86	Excellent
Macao-China (MAC)	.86	Excellent
New Zealand (NZL)	.87	Excellent
Portugal (PRT)	.87	Excellent
Qatar (QAT)	.86	Excellent
Italy (ITA)	.87	Excellent
Turkey (TUR)	.87	Excellent

Note. [a]Hosmer, Lemeshow, and Sturdivant, 2013, p. 211.