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Why Are Secondary School Girls Not Embracing Science?

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WHY ARE SECONDARY SCHOOL GIRLS NOT EMBRACING SCIENCE?
(Thesis format: Monograph)

by

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Abstract

This thesis examines some of the factors that impact upon secondary school girls and the subsequent decisions that they make, whether to continue their study of science, once it becomes an elective area of study. Specifically, the girls were asked about their previous experiences in science classes, their perceptions and beliefs about science teachers, and the girls' attainment or lack of success in science and perceptions about self-efficacy.

For the first component all female students in their grade twelve year were asked to fill out a questionnaire, to determine general perceptions about science learning, based on opinions and personal experiences in school. On the basis of their questionnaire responses, indicating either a strong favourable or unfavourable experience in or attitude to, learning and doing science, 8 of the 39 girls that completed the survey were then chosen to be interviewed.

Using various statistical treatments several themes emerged: Interest, Importance, and Self-Efficacy were found to be statistically significant upon the girls' decisions; while the themes Gender, Teacher, and Difficulty were not. Possible suggestions on how to positively affect these factors, so that they would better encourage, engage and support girls in their learning and doing of science, were discussed. Implications of the findings were also used to determine possible future areas of research, to ensure that ongoing progress is made so that girls have the opportunity to learn and participate in science in ways that engage them, are meaningful to them and their lives, and that allow them to be successful.

Keywords: Science Education, Girls Education, Girls Science Self-Efficacy, Girls Science Education

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Chapter 1 – Introduction

My research interest is to examine young women's perceptions as to why in secondary school, they choose to participate in elective senior science courses such as biology, chemistry, and physics, often the more interesting science courses, at a much lower proportion than their male counterparts. It is my aim to gain a better understanding of the school-related factors, such as the perceptions of students' abilities by the teacher or the teaching style used, that influence some young women's decisions to no longer study science once it is no longer a mandatory credit in school. Why are secondary school girls not regularly embracing science, once it becomes an elective course?

Despite many years of research related to gender and science education, females are still under represented in some senior level high school science courses, specific college and university science programs and majors, and many scientific careers. Research suggests that boys and girls enter school with equal ability, but girls are marginalized in science and math to the degree that they trail their male counterparts in certain scientific interests and participation by the time they complete secondary school. Girls that choose to participate in senior science courses often study biology, while chemistry and physics courses tend to have lower enrollment rates of young women. What is the disconnect that is taking place that causes girls to move away from studies and careers in science, as well as technology, engineering, and mathematics (STEM)? In recent years, policy and research foci have shifted to issues connected to boys' participation in schooling, trying to engage them and make them more successful in certain areas (reading and writing).

Overview and Rationale

Only a small percentage of the students that go into elementary school actually end up pursuing a career in science, mathematics or technology. The exposure to learning science at the elementary school level varies greatly between school boards, between schools within the same board, and even between teachers within the same school. Canadian students perform above the international averages for both math and science at the grade 4 and grade 8 levels (Statistics Canada, 2006), but there is a decline in both interest and performance between grades 4 and 8 in both subjects, with a greater decline being observed in science.

In secondary school in Ontario, mathematics and science are mandatory subjects during the first two years, after which they become elective courses. Many students in their upper years of secondary school stop taking math and science, in 1995 only forty-two percent were enrolled in both math and science during their last year of secondary school (Statistics Canada, 2006). Many students who had done well in math and science in the past, and believed the subjects to be important to succeed in life, but were still unwilling to pursue it as an elective in secondary school or at the post-secondary level.

Though many students may describe math or science as “boring” or “difficult” subjects, the drop in interest and performance level between grades 4 and 8, and the low participation rates during secondary school indicate that there may be influences outside of the education system that impact upon the choices that students make about their courses of study. Perhaps the effect of socio-cultural factors may play a role in students’ perceptions, beliefs, and choices. Do they feel that they may not be able to gain successful employment in STEM fields? Do they feel that STEM fields would not be

very interesting to work in? Do they have certain perceptions of what workers in STEM fields are (or should be) like?

Young women in Ontario continue to choose not to participate in optional science, math, and technology courses at a rate which exceeds that of their male counterparts. Care needs to be taken in reading trends. For example, in the United States between 1983 and 1988 although the percentage of female students enrolling in senior level mathematics and science courses (the percentage of total course enrolment which is female) appeared to increase, female participation rates (the percentage of total females enrolled in a school who were taking a particular course) actually declined (Beauchamp & Feldberg, 1988). In other words, an increase in the proportion of females enrolled in high school math and science courses resulted from a decrease in total male enrolments rather than an increase in female enrolment.

It appears that the number of female math and science students is decreasing (Beauchamp & Feldberg, 1988), but less rapidly than the number of male students, making the overall proportion of female participation in math and science courses greater. This trend is deceiving as one may not initially consider the effect that the participation rate of young men in these subject areas has on the impact on the reported participation rates of their female counterparts. In the Thames Valley District School Board (TVDSB) enrollment of males and females in the mandatory grade nine and ten science courses is the same over the two years, fifty-two percent of students are males and forty-eight percent are female (Killip, 2008). Interestingly, of the students enrolled in a grade eleven science course fifty-two percent are female and forty-eight

percent are male (Killip, 2008). For students in their grade twelve year (or those completing a second "grade 12" year of high school) the numbers flip back again, approximately fifty-two percent are male and forty-eight percent are female (Killip, 2008). These numbers however do not account for the differences in enrollment of males and females in the various senior science streams, biology, chemistry and physics. Many females opt to take biology and not the other two sciences, this information is not observable from looking at the above statistics.

The attainment of a post-secondary education for young Canadian women has greatly increased over the past few decades. In 1971 only 3% of Canadian women held a university degree, in 2001 15% of women had a university degree, and women currently outnumber men at most levels of post-secondary education (Statistics Canada, 2006). Definitely progress in the right direction it would seem, but the overall trend is somewhat misleading as it does not tell the whole story. Though the number of women attending and completing post-secondary education has greatly increased women still remain greatly under-represented in some areas of study, particularly mathematics, physical sciences, engineering and applied sciences (Statistics Canada, 2006). This trend can be seen at all levels of post-secondary education, including college, undergraduate and graduate levels of study (Statistics Canada, 2006). In contrast, women are over represented in other fields of study such as education and health sciences (Statistics Canada, 2006).

In 2010-2011 school year enrolment in Canada for studies in biology; women made up 62.6% of the students in an Undergraduate/Bachelor's program, 60.4% of the students in a Master's program, and 49.7% of the students in a Doctorate program

(CAUT, 2010/2011). During the same year, enrolment of females in a chemistry program was substantially lower; they made up 48.7% of the students in an Undergraduate/Bachelor's program, 43.4% of the students in a Master's program, and 34.0% of the students in a Doctorate program (CAUT, 2010/2011). Young women enrolled in a physics program, had the lowest participation rates of the three main sciences; women made up 20.4% of the students in an Undergraduate/Bachelor's program, 23.9% of the students in a Master's program, and 19.3% of the students in a Doctorate program (CAUT, 2010/2011).

Why is there such a discrepancy in the fields of study between young men and women? From my preliminary research I came to realize that there is no simple answer and there certainly are no concrete factors that can be assigned the bulk of the blame. In fact I am now beginning to appreciate the array of factors that may exist for any given individual, and herein lies the heart of the issue on conducting my research. Depending on the context from which one is approaching the issue any number of factors could contribute to the differences seen in the participation of young men and women in science courses. From my readings I have decided to focus on a few common threads that seem to permeate across various divisions, and have an impact and may influence the choices that young women make that lead them away from the study of science. A number of factors including mixed sex classrooms, limited access to science learning and investigations at a young age, social perceptions and pressures, and even the influence of their teachers can be a driving force in turning girls away from studying science and engineering (Canadian Council on Learning, 2007), and subsequently a career in those areas.

Despite an improved understanding of the teaching strategies that aim to maximize learning in science by both sexes, and even though in many education systems girls achieve as highly or even surpass boys at secondary school level (Rennie & Parker, 1996), the goal of achieving equality in terms of science participation for males and females remains unmet.

Applicability of the Study to Education

The purpose of my research is to examine the possible reasons that young women have for deciding not to pursue the study of science during their senior years of high school. My intention is to get a better appreciation of the factors that influence their decisions, more specifically I am interested in the influences that are directly related to or stem from their experiences in school. Identifying the possible factors that deter young women from continuing their studies in science is the first step to addressing the problem. Once the possible causes have been identified, then they can begin to be addressed, so that that the necessary steps may be taken the to combat the situation as best as we can in the classroom. By effectively changing our practices in the classroom, teachers can encourage and support more young women to pursue scientific learning and knowledge and foster a greater appreciation of science in our world in young women.

This chapter serves as an introduction to my research. Chapter 2 will focus on what the literature has to say on the topic. Chapter 3 will provide an explanation of the research methods and techniques used and will discuss the treatment of the data. Chapter 4 will be a presentation of the actual data collected and the results of the various statistical treatments used. In chapter 5 I will analyze

the data collected and make observations on my findings. Finally, chapter 6 will provide conclusions based on the work done.

Chapter 2 – Current Literature Review

Introduction

Reports, especially in the popular press, have suggested that the science, technology, engineering, and mathematics (STEM) gender gap is disappearing. The mainstream literature and research pertaining specifically to science also seems to drawing the same conclusions about the achievement trends of boys and girls. However, upon closer examination the data reveals that the decrease in the gender gap varies by the area of science and the level of educational and career attainment studied (Britner, 2007).

Despite the gains made in recent years, fewer females than males pursue careers in the physical sciences, computer science, and engineering (Halpern, D., Benbow, C., Geary, D., Gur, R., Hyde, J., & Gernsbacher, M., 2007). Much of the research reported upon United States data. In order to contextualize these findings, background data is provided here. In the United States 20 percent of all engineering degrees are held by women and only 11 percent of engineers are women (Fouad, 2008). It is true that women and girls have indeed made strong gains in science achievement, course taking, degrees earned, and academic positions held during the past two decades, (National Centre for Education Statistics {NCES}, 2004b; National Science Foundation {NSF}, 2005). In the USA, women are enrolling in graduate science and engineering programs in increasing numbers, and overall enrolment by women is increasing by a larger percentage than the enrolment of their male counterparts, men 3.7%, women 5% (NSF, 2005). Therefore increasing the proportion of female science and engineering graduate students from 36% in 1993 to 42% in 2003 (NSF, 2005) and making gains in closing the gender gap in

graduate science enrolment (NSF, 2005). These gains are especially strong in biology (NCES, 2004).

However, progress is diminishing and masking the true gender gap that still exists in science, as well as the differences in fields and levels. From 1982 to 2000, girls moved ahead of boys in the total number of science courses taken and in the number of biology and chemistry courses taken, although boys continued to take more physical science classes (physics, earth science, and engineering) (Britner, 2008). Girls also take a higher proportion of Advanced Placement (AP) exams in biology and environmental science (Britner, 2008). National Assessment of Educational Progress (NAEP) exams in both 1996 and 2000 indicate that male and female students are achieving at similar levels (NCES, 2004). Again, a closer look at the data reveals remaining gender differences (Britner, 2008), especially at higher levels of achievement and in the physical sciences (NCES, 2001).

In the 1996 NAEP data there were few gender differences in overall scores, however there were gender discrepancies in the number of students attaining proficient levels in the subscales used to evaluate students, in ‘‘ability to analyze scientific procedures and data’’ (males 53%, females 43%) and in ‘‘integrate specialized scientific information’’ (males 13%, females 7%) (NCES, 2004). These higher level critical thinking and analysis skills are necessary for long term success in science. In the 2000 administration of the NAEP, 21% of males achieved at the proficient level while only 16% of females achieved at the same level (NCES, 2004).

Given that girls and boys are in the same learning environments and they are required to take the same classes up to a certain point in their educational lives, we must

accept that there are other factors that affect whether or not girls learn and enjoy science or not. In mandated tests across 10 states in the United States and the analysis of NAEP data, the differences in the achievement between girls and boys was not significant across all grades (Hyde & Mertz, 2009). However similar levels of achievement as their male counterparts, in elementary and secondary school, does not follow the girls into their careers as they are not choosing careers in mathematics and physical sciences as much as boys are (Huebner, 2009). Interestingly, when asked about their own abilities in mathematics at an early age girls rate their ability lower than do boys, even though both boys and girls are achieving at the same level (Herbert & Stipek, 2005). Past research has been important in terms of creating an awareness that girls generally do not fare as well in science classes as do boys. It illustrates for us that this inequity is a social problem that can be fixed.

However, the above explanation has created a stereotype of girls and boys that is too general in its nature and fits no one in particular, while presenting a homogeneous image of both girls and boys as science learners. This research highlights the issue but does not clearly help us to understand the differences in personality and approach, learning, and processing that exist between boys and girls as they pertain to science learning. This in itself is part of the problem as to why we have not been able to better address and rectify the situation so far, considering all the research that has been done on the issue.

Recent studies have all but dismissed the idea that an innate ability between the sexes exists, especially when it comes to the learning of mathematics and sciences (Huebner, 2009). Historical and cultural practices in traditional science instruction may

themselves create and encourage a bias that excludes girls (Carlone, 2001; Eisenhart & Finkel, 1998). They validate the widely held belief that the study of science requires the memorization of difficult and abstract knowledge that is hierarchical, unrelated or not applicable to the real world, and easier for and within the ability of males with natural talent (Voyles, M., Fossum, T., & Haller, S., 2008).

The inequities that girls may face in science are extremely varied and the circumstances are as individual as each of the students themselves. From teachers treating boys and girls differently in the science classroom to the use of textbooks and other resources that are gender biased and favouring boys, these inequities need to be eliminated so that we may increase girls' access to equitable science experiences (Brotman & Moore, 2008).

Themes Present in Current Literature

Gender

Many girls may have an interest in science and may enjoy it so why is it that they are less likely to pursue further studies in science? If we are teaching girls the same things as their male counterparts, then why is there a divergence in their paths of study? Is it that girls are alienated by science? Science may be seen as masculine, competitive, and objective, impersonal qualities that are at odds with our images of what girls are (Brickhouse, N., Lowery, P., & Schultz, K., 2000). The more masculine the branch of science (e.g., physics), the less likely it is that girls will like it or do well. Girls take science courses that are required of them, they do not often choose those that are not required. It has been noted that teachers rarely call on girls in class and if they do, they

ask girls easy questions because they expect less of them (Brickhouse et al., 2000). Girls are more interested in pleasing their teachers than their male counterparts and are therefore more likely to follow the rules rather than bend them or invent them.

However, counter to this, it is suggested by Hammrich, Richardson, & Livingston (2000) that girls tend to work well in groups and in a more cooperative manner than boys, studies show that girls enjoy learning science in interactive social settings as opposed to doing activities where they are isolated such as independent reading, writing, and the taking of notes (Baker & Leary, 2003). The larger classroom setting with everyone working together may be intimidating for many young women who may not be completely confident in their abilities, especially if they are not among the strongest or most dominant of the students (Hammrich, P., Richardson, G., & Livingston, B., 2000). Many girls may not participate freely in this type of environment as they are afraid of looking less intelligent than others in the class, and possibly more so compared to the boys (Hammerich et al., 2000). Working in small groups however does not alleviate these concerns completely and girls still may be restricted in their ability and opportunity to participate. When working in smaller groups, the stronger students (often the more aggressive male students) may take charge and lead the activity, leaving the girls to play a secondary role such as a scribe (Brickhouse et al., 2000).

A number of writers suggest that girls are disadvantaged in science before they even get to school because they are encouraged to play with dolls rather than blocks. As children it seems that we encourage and support their nurturing side far more than we encourage and support their curiosity and their desire to investigate and create, what they see in the media only works to reinforce the messages that they may be receiving from

the people and world around them. In a study of computer and video games by the group Children Now, it was found that 17% of games have female characters and of these games, 50% of the women are not actively participating characters but instead are props, tend to faint, have high pitched voices, and are highly sexualized (Children Now, 2001).

Girls rarely accompany their fathers while they fix items around the house. Parents rarely purchase chemistry sets or microscopes for their girls, nor do they take them camping as much (Baker & Leary, 2003). From a young age girls are taught to be supportive and helpful whereas boys are given more opportunities to be independent, assertive and in charge.

As adolescents, girls become interested in being attractive to boys, they take on more feminine roles that often exclude science (Brickhouse et al., 2000). It is at this point too, Britner (2008) argues, that many girls seem to come to the conclusion that boys do not like smart, aggressive, or competitive girls. It is possible that girls who are very capable in science and mathematics stifle their own abilities so that they do not look too smart in those areas, making them seem more attractive to boys. These girls fail to investigate and ignore their abilities fully in the area of science while they still possess them. The same girls become women who cannot and do not engage in science (Britner, 2008).

In order to fully understand learning in science, we need to know much more than whether students have learned the proper scientific explanation for a certain topic, process, or idea. We need to know how students are being engaged in science, the actual mechanisms at work, and how this is related to how they self-identify and who they perceive themselves to be (what communities of practice do they participate in) such as

being a good student, athletic, or popular, and who they want to be (what communities of practice they aspire to participate in) such as a teacher, a parent, or a doctor (Brickhouse et al., 2000). As students alter their beliefs about themselves and subsequently transform their identities, the required knowledge and skills for being and participating as a part of the new communities are learned and developed. So if students are to learn science and become engaged in science they must develop identities compatible with scientific identities (Haussler & Hoffman, 2003), they must be able to see themselves in that way as being capable of learning and doing science.

Individual identity and how we see ourselves is not necessarily single or stable. A person can be a part of, or aspire to be a part of many different communities simultaneously. The communities students participate in are very likely to change, particularly for adolescents who have not yet fully investigated or formed an entirely stable or complete view of themselves. It is therefore important to examine students' multiple social identities, to understand how students are constructed and construct themselves as girls, as members of a particular racial of ethnic group, as a smart girl or a "nice" girl, or as an athlete, and how these identities overlap in important ways with students' views of scientific identities (Haussler & Hoffman, 2003).

Teacher Influences

As educators we try to be fair in our practices and treat our students equally. However, treating all of our students equally may not be what is best for the students, some may need more from us than others. Some students may need different things from us than other students require, therefore providing each student with exactly the same

learning experiences and opportunities may not really be beneficial or fair to all students in the end. This may be at the root of the issue as to why girls and boys experience different levels of success in science learning.

Research as to why women are not pursuing careers in science and technology implicates the educational system and process as a factor influencing women's career choices (Sanders, 2005). Researchers have proposed two ways that education may fail girls. First, teachers may inadvertently favour boys, especially in areas that society considers to be in the traditionally male dominated, by providing them with more and better instruction. Also, gender bias may occur in classrooms if boys and girls differ in their interests and attitudes, prior experiences, achievement, self-confidence, or in learning styles such as cooperative methods versus competitive goal structure, and asking for added assistance from the teacher (Voyles et al., 2008).

As a result of differential treatment, experiences, and situations girls and boys can have very different ideas towards and levels of participation in science. At this time in our world one may not expect gender biases in teacher interactions with or expectations for our students or in current resources used in the science classroom, but they still do exist. New resources still possess ideas or messages that may impact the perceptions and abilities of the students using them, Whiteley (1996) and Elgar (2004) identified science textbooks from Jamaica and Brunei that were written with strong male biased and gender stereotyped patterns. Interestingly enough Dhindsa (2005) found that students in Brunei have the general perception of gender equity in their classroom environments while American students had a perception of gender inequity (Guzzetti & Williams, 1996). Guzzetti & Williams reported that girls in affluent schools in the Southwestern states

were especially aware of inequitable classrooms situations and of the gender biases in their textbooks and other resources.

Consistent with these findings studies from multiple countries show biases in classroom interactions between female students and teachers as well as between the girls and the scientific work being investigated (She, 1999; Kahle & Meece, 1994). These studies found evidence that girls often manipulate scientific apparatus less frequently than their male counterparts; more surprising however is that this pattern continues to occur in classes with experienced teachers that are concerned with gender equity (Guzzeti & Williams, 1996; Jovanovic & Steinbach, 1998). There are circumstances that exhibit quite the opposite of this trend, in a district of Hawaii girls are equally engaged in the use of scientific equipments as the boys are (Greenfield, 1997). In this specific district students participate in hands on scientific experiments in elementary school developing an interest and proficiency for doing science at a young age.

Teachers have been found to give boys both more praise and more criticism (Drudy & Chathain, 2002), call on boys more often and accept more things blurted out from boys, and they tend to follow up more often and at greater length with the responses from boys (Martin & Newcomer, 2002). Teachers at times help girls by completing the task for them whereas with boys they explain the underlying concepts but expect the boys to do it themselves (Sadker & Sadker, 1994). A number of studies have shown that boys are more often asked higher level questions (Martin & Newcomer, 2002) than girls. Interestingly several studies have reported that both male and female teachers show such biases towards their students (Martin & Newcomer, 2002), indicating that the practice is so ingrained in us that we are not even aware that we are doing it.

Teacher awareness and teacher education about gender biases occurring in the classroom and specifically girls' limited opportunities to experience and engage in science are necessary to address the issue of equity and access of science for girls. Clearly as educators we are not fully aware of the ideas or biases that we ourselves possess and pass on to our students. Educating new teachers about gender issues that they may be blind to, as part of their course coverings, may not be a bad idea. When new teachers were mentored by or collaborated with experienced teachers that were attuned to issue of gender equity the student teachers were shown to participate in more equitable classrooms interactions with their students (Bailey, Scantlebury, & Johnson, 1999; Scantlebury, K., Johnson, E., Lykens, S., Clements, R., Gleason, S., & Lewis, R., 1996).

Perhaps even something as basic as encouraging and helping teachers to be more reflective about their teaching methods, gender equity issues, and applying more gender equitable practices in their teaching could be helpful in at least starting to address the issue (Bullock, 1997). In a study by Bullock (1997) it was discovered that even though teachers may be open and even enthusiastic initially about addressing issues of gender equity in the classroom, as they faced the many daily challenges such as limited resources, low academic skills, or satisfactory performance by their students they became less concerned with the issues surrounding gender equity in their teaching.

Self-Efficacy

Although the significance of vicarious experiences in predicting self-efficacy for girls in physical science is moderated by the low structure coefficient, it is well established that modeling is a powerful source of learning (Schunk, 1999). It therefore

would be beneficial to expose both male and female students to a variety of models in all of the sciences. Ji, Lapan, and Tate (2002) found that the social-cultural context played a strong role in students' career plans, in that students expressed higher interest and stronger self-efficacy for occupations which they perceived to involve a higher percentage of their own gender.

Ivie et al. (2002) suggested that parents play a strong role in developing girls' ''self-esteem'' however, as they then referred to a ''strong belief in one's intellectual ability'' and ''confidence in one's ability'' this seems more a reference to self-efficacy than to self-esteem. Qualitative data from their study strongly supports the importance of social persuasions to a strong and resilient confidence and self-efficacy in women who pursued a career in physics. Respondents also spoke of the value of vicarious influences, both negative and positive. Many of them were strongly influenced by family members in science fields and by female professors and researchers who encouraged them and inspired them. However, a majority felt that the view held by much of society that physics is inappropriate for women was a significant hurdle which they had to overcome. It is prudent to remember that social persuasions need not be intentional to be effective and are not limited in their effect to those to whom they are addressed (Pajares & Usher, 2006).

The role of identity in students' learning of and engaging in science has yet to be fully understood. Much of the research so far has taken on a rather simplistic approach to determining the differences between the attitudes towards science and how the learning of science is constructed differently between the sexes. The simple binary division that is most often used, distinguishing between the sexes (Brotman & Moore, 2008) and

applying it to learning ability, does very little except to merely scratch at the surface of the issue. Girls and boys cannot be treated as two unitary groups (Brotman & Moore, 2008). There are many girls and women that are interested in science, enjoy it, and actively engage in it. What is it about these girls and women that is different from those who do not develop an interest in science or enjoy it?

A critique that comes up repeatedly is that in the past, studies that deal gender and the learning of science fail to look past that singular focus (Atwater, 2000). Most studies fail to even consider the other various aspects of an individual (such as language, ethnicity, religion, class and lifestyle) that all play vital roles and interact to define an individual and their experiences (Atwater, 2000). Failing to acknowledge the many factors that contribute to one's identity, it can be then said that the white females are the norm in many of these studies that focus on gender and scientific learning (Atwater, 2000; Scantlebury & Baker, 2007).

In learning science (or any other subject for that matter), students need to view their own multidimensional identities as coinciding with the pursuit of the science, or they need to perceive themselves as being compatible or alike to the scientific identities (Brickhouse et al., 2000). If we cannot find commonalities between ourselves and those that we identify as having scientific knowledge or capable of doing science then we are less likely to put ourselves in the same category as those individuals or see ourselves as capable of accomplishing the same things (Britner & Pajares, 2006).

According to Brickhouse (2001) learning and what one chooses to learn is based on one determining what kind of person one is and also the kind of person that they would like to be, and then participating in the activities that would serve to make one part

of the relevant communities in which involvement is sought. So identity formation is essential to learning (Brotman & Moore, 2008) and as gender is a part of identity it is integral to learning. It is important to remember however that gender is one of numerous factors that contribute to the formation of one's identity; there is a diversity that exists in males and females in their interest and ability to learn science (Brickhouse et al., 2000). Understanding how and why girls learn science, or are not succeeding at science, means appreciating and knowing far more about them than knowing they are girls (Brickhouse et al., 2000).

In a study of minority girls and girls from low income families it was demonstrated that the girls had difficulty adopting a scientific identity (Brickhouse & Potter, 2001). Girls in the study often approached science and developed scientific identities in a manner different from their peers that fell outside of their ethnic or socio-economic groupings. The study found that girls that approached science and learning in ways more consistent with traditional gender and school norms were received in a more positive manner by teachers than those that did not. Girls that wanted to be competent in science but who did not want to take on the identity often associated with belonging to a school science community faced many challenges in their learning as they were not accepted the same way that their more traditional peers were. This illustrates how schools or teachers may marginalize students that are interested and confident about their abilities in science simply by rejecting their unconventional approach or scientific identities.

In 2004, Carlone conducted a study of girls, from a predominantly white and upper middle class suburb, in a school implementing a reform based curriculum. The goal of the curriculum was to be more inclusive and to encourage and promote "broader

meanings of science and scientist". The girls resisted classroom practices that strayed from more traditional methods of instruction and that challenged their identities as good students (Carlone, 2004). The curriculum was rejected by the girls who favoured more traditional approaches to learning science, approaches that did not impact their ability to get good grades and maintain their image a good students (Carlone, 2004).

In their learning girls often construct identities for themselves as being strong writers and readers, much more readily than they construct a scientific identity for themselves. Looking at elementary school resources and the access that girls have to a good choice of science related books, the reading material was found to be available and appealing to the girls, interestingly though the parents often underestimated their daughters' interest in this genre of reading material (Brotman & Moore, 2008). In considering the major bookstores that would be frequented by many of these families it was found that the selection of scientific reading for girls was limited, instead what was found was the marketable and traditional reading materials that young girls often read that reinforces and perpetuates stereotypical ideas about girls and girlhood (Brotman & Moore, 2008).

Society needs to break free of the traditionally held stereotypes about science and gender and allow for and promote varying identities that defy stereotypical norms. The ways that students buy into or challenge dominant beliefs about science and gender greatly affect their ability to form their own scientific identity. An individual may justify their interest and proficiency in science as being a result of their possession of qualities, traits and skills, that other girls who do not enjoy or perform well in science, fail to possess or master. Another individual may construct their scientific identity because they

may not view themselves as possessing the same “feminine” traits that other girls may exhibit more, traits that often have not been presented as being compatible with science, learning science, or being a scientist (Hughes, 2001). Who we are and how we define ourselves is not fixed, positioning theory contradicts the belief that who we are and how we define ourselves cannot be changed, it suggests that people have the ability to take on an shifting array of qualities or positions (Davies, 1994). As individuals and as a society we have the ability to take our familiar and accepted notions about gender and science and to challenge and change those beliefs.

In summary, whole gains have been made in the area of girls learning science and mathematics; this is evident in the increase of women earning degrees in STEM subject areas over the past few decades. However, many young girls are not even open to considering studying science or mathematics once it is no longer a compulsory credit in secondary school. Therefore we still need more understanding of why young girls do not participate in the learning of science quite as much or as actively as their male counterparts, and why they also do not enjoy it as much or perceive it to be as useful in their own personal lives as boys often do. Thus, this study will aim to gain a better understanding into why some girls choose to exclude science from their studies altogether once it becomes an elective area of study, and also gain some insight into why many girls do not appreciate science or enjoy learning it as much as boys do. Chapter 3 outlines the procedures following in this study.

Chapter 3 – Research Methods

There were two stages to the research that I conducted. The first stage involved surveying a sample of senior high school girls, both those that chose to no longer study science as well as those who chose to continue their study of science, after completing the mandatory intermediate science courses for secondary school graduation. The second stage involved choosing a smaller group of girls from the larger group surveyed, to gain a more comprehensive understanding of why they chose to not continue their study of science in their senior years of high school.

Introduction

The purpose of my research interest is to investigate the perceptions of young women in secondary school and why they choose to participate (or not participate) in elective senior science courses such as biology, chemistry, and physics, (often the more interesting science courses) at a lower proportion than their male counterparts. After being in the same compulsory grade nine and ten general science courses as the boys, what is the difference in terms of the experiences that the girls have compared to that of the boys, that leads many young women to no longer want to study science? It is my aim to gain a better understanding of school-related factors, such as the perceptions of students' abilities by the teacher or the teaching style used, that influence some young women's decisions to no longer study science once it is no longer a mandatory credit.

Grade nine and grade ten general science courses are mandatory in Ontario and all students must complete these courses in order to receive their Ontario Secondary

School Diploma (OSSD) and graduate from secondary school. After students have completed the mandatory grade nine and ten science courses they are not required to take any senior science course. However it is only after the necessary intermediate level science courses, that is grade nine and grade ten general science, does the secondary school science curriculum break down the study of science into the more focused biology, chemistry, and physics streams.

In both male and female students the proportion of individuals participating in senior science courses drops after the completion of the required secondary school courses, the drop however is more pronounced with female students, especially in the areas of physics and chemistry. Since I am interested in the factors that affect young women in high school and their decision to continue or cease their study of science, I will be enrolling female students to conduct my research.

Ethical Issues

Students interviewed were asked to share their personal experiences in their previous science courses: their beliefs and expectations of their success in science courses while they were enrolled in the courses; their perceptions of their science teachers; their ideas of how their science teachers perceived their abilities as a student; and their opinions on the methods of teaching will all be discussed. From the interviews I hoped to gain some insight into the learning experiences of the young women and how their experiences may have impacted their subsequent educational decisions and choices.

Since I asked the interview participants to be very open and honest with me it was my intention to use students that knew me, either as one of their previous

science teachers or just as a teacher in their school that they were familiar with. It is my hope that this may have alleviated some or all of the apprehensions that the girls may have had about sharing their personal experiences, some of which may be negative.

I chose to use grade twelve students as they were not in a position to have me as a teacher anymore. If students plan on studying science after they have completed the compulsory science credits they most often choose to do so in their grade eleven year. Only a small number of students choose to enroll in their first senior science course during their grade twelve year. This meant that none of the students participating, in both the survey and the interview phases, were likely to have me as a teacher again. This is the reason that I chose the grade twelve cohort as my larger study group to survey and also to select my interview participants from. I did not want any of the students to feel pressured to participate. I also did not want them to feel that they needed to answer in any specific manner or that they should censor out any of their thoughts, perceptions, or opinions for fear of any later repercussions if they were to have me as a teacher again.

Research Methods

A mixed methods approach was used in this study. A survey and statistical analysis provided information on how girls responded to statements concerning variables identified in the literature. This data was used to investigate differences in the perception of science education held by those continuing with the study of science and those who did not. The survey then provided a basis for the interview questions used with the selected students for the second part of the study.

Information was collected in two ways. First, a survey was distributed to all grade twelve female students, those who have not taken a senior science course ever as well as those who chose to study senior elective science courses. Based on their responses, specifically strong negative responses, volunteers were identified to be interviewed to gain a more in-depth view of their perspectives on why they chose to cease their study of science. Participants whose responses indicated that they believed that they were just not good at science or it was too hard, as influences on their choice of their courses were accepted to be interview subjects.

The purpose of the survey was to acquire an understanding of girls' attitudes about their previous experiences in science courses, to get an idea of their experiences and perceptions about learning science from sources outside of the classroom (such as parents and the media), and to see how all those aspects had an impact upon their decisions to either continue or discontinue their studies in science once it was no longer a compulsory credit course. The survey consisted of twenty statements to which a Lickert scale response was sought (see Figure 1). The statements were largely written to align with factors identified from the literature.

The survey statements addressed girls' perceptions of the difficulty of learning science and their own ability in science as well as their beliefs around what role gender played in achieving success in science. Statements to the impact that aspects of previous science teachers had on the girls' continuing to study science; did they feel that they might have continued their studies in science, that they might have been more interested and enjoyed it more, or that they might have been more successful in science, if they had had different science teachers along the way? The importance and relevance of science in

the world and whether they thought that one would use scientific knowledge in their daily lives, was also addressed.

The survey was given to all girls in their grade 12 year at a Southwestern Ontario secondary school. They girls were told that participation in the survey was optional and that it would have no impact on their grades. A total of 37 girls chose to respond, 17 of whom had not continued their studies in science once it was no longer a compulsory credit, and 21 of whom had chosen to continue with their studies in science.

In Figure 3.1, the items categorized with each characteristic are identified: **Im** – Importance of science; **In** – Interest in science; **T** – Teacher as an influence; **D** – Difficulty in learning science; **G** – Gender; and **SE** – Self efficacy. These markings were not on the survey form presented to the students.

Why Are Secondary School Girls Not Embracing Science?

1. List the courses that you are enrolled in for the current school year?
2. Explain why you chose those courses.
3. What do you plan to do after you finish secondary school? If you intend on pursuing post-secondary education, what program or area of study do you think you might consider?
4. Did you ever consider taking any science courses after you completed the required science courses needed to graduate from secondary school? If so, why did you decide against any further study of science?

For the following statements circle the number that best describes your feelings.

Please use this scale to answer the statements that follow:

1- Strongly disagree

2- Disagree

3- Somewhat Agree

4- Agree

5- Strongly Agree

Science is an important aspect in our lives and the world. **Im**	1	2	3	4	5
Understanding science can make life easier. **Im**	1	2	3	4	5
Everyone should have an understanding of the science around them.**Im**	1	2	3	4	5
The science being taught in the classroom is interesting. **In**	1	2	3	4	5
The science being taught in the classroom is useful. **Im**	1	2	3	4	5
A good teacher can make learning science more fun. **T**	1	2	3	4	5
Some people are just not good at science. **SE**	1	2	3	4	5
My teachers had an impact on my choosing to not study science **T**	1	2	3	4	5
If I had different teachers I may have enjoyed learning science more.**T**	1	2	3	4	5
If I had different teachers I may have continued my study of science.**T**	1	2	3	4	5
In past science courses, the teachers thought I was a capable student.**T**	1	2	3	4	5
Science is a hard subject. **D**	1	2	3	4	5
Most girls are not good at science. **G**	1	2	3	4	5
Only smart people do well in science. **D**	1	2	3	4	5
Boys are naturally better at science. **G**	1	2	3	4	5
Science is a confusing subject. **D**	1	2	3	4	5
I find science interesting. **In**	1	2	3	4	5
I find science useful. **Im**	1	2	3	4	5
I enjoyed learning science. **In**	1	2	3	4	5
I am not a science person. **SE**	1	2	3	4	5

Figure 3.1: Initial Survey Given to All Participants

Analysis of the Survey

Following the administration and coding of the responses, statistical analysis using SPSS compared the responses of the girls not continuing to study science with those girls that chose to do so. First, a cross-tabulation compared responses on each item in the survey. This was followed by the formation of variables, based upon the characteristics identified above, shown in the table that follows. In Table 3.1, and subsequent discussion, the use of the letter "S" refers to the "statement number."

Table 3.1: Survey Response Variables: Calculation

Calculation Equation	Range	Neutral Value
Importance = S1 + S2 + S3 + S5 + S18	5-25	15
Interest = S4 + S17 + S19	3-15	9
Teacher = S6 + S8 + S9 + S10 + S11	5-25	15
Difficulty = S12 + S14 + S16	3-15	9
Gender = 6 – S13 + S15	2-10	6
Self-efficacy = 12 – S7 – S20	2-10	6

In the case of negatively worked items, rescoring involved subtracting the initial response score from 6, so that for example, an "Agree" which carried a score of 4 became the equivalent of a 2 ("Disagree") for the scores having positive statement. T-tests were then used to compare the responses of the two groups of girls on each variable (S1–S20).

The Interview

After the surveys were given an initial analysis, 8 girls who had not chosen to continue their studies in science (and had exhibited a willingness to participate) were selected to be interviewed, the overall academic success of the girls as a group exhibited abilities right across the spectrum. Selection was based upon an indicated willingness to participate, and to reflect a diverse range of attitudes as indicated by their survey responses.

Why Are Secondary School Girls Not Embracing Science

1. When you were taking science courses did you enjoy them? Why or why not?
2. Did you consider yourself to be good at science? Why or why not?
3. Do you think boys and girls are equally capable of doing well in science? Why?

   Do you think science teachers treat male and female students differently? If so, then how? Do you think that society views males and females as equally capable in scientific study/work? Explain.
4. Do you believe that some people are just naturally smarter or better at science and that is why they are more successful in science courses? What qualities or skills do you believe that these individuals possess that make them more successful at science?
5. Do you feel that science teachers treat students that do better in their classes differently than students that may not be doing as well? Do they give them more help or offer them more support and encouragement?
6. Did you ever get advice from anyone about your choice of courses? Did the subject of you taking any science courses ever come up as part of these discussions?

Figure 3.2: Interview Questions

Analysis of the Interview

The interview was semi-structured and was conducted on an individual basis with each of the 8 girls, in an empty classroom in their school so that they would be most comfortable and open. The interviews lasted on average approximately thirty minutes, responses were manually recorded as well as by tape recorder, so that they could later be transcribed.

After transcription of the interviews, the actual transcripts were cut up into the individual questions. Each girl's answer for a specific question was then compared with the responses of the other girls, looking for common threads or themes that emerged. From the answers that were received, themes were developed, based on commonalities illustrated in the girls' responses to the questions.

Chapter 4 – Survey and Interview Results

The statistical analysis of the girls' survey responses is limited by the size of the sample. Never the less, there are some observations of interest to be made. A comparison of the responses to the individual items given in the questionnaire provided some insight into the views of the girls in general, and into what differentiated those choosing to continue their studies in science from those who did not. For the purposes of presentation, items will be discussed by the type of issue addressed rather than in the order that they appeared on the instrument. The items have been divided into six themes: importance, interest, teacher, difficulty, gender, and self-efficacy. After the consideration of individual items, the results formed by creating scales by the addition of individual responses will be discussed.

Importance

"Importance" as a theme can be described as whether or not the girls felt that science was important in their own lives, in the lives of others, as well as in the world around them.

While those taking science overwhelmingly agree (18 of the 21 girls) that science is important in our lives and the world, the responses from those not continuing to study science are more equivocal, with 7 of the 17 girls responding with less than agreement (see Table 4.1).

Table 4.1: Science is an important aspect in our lives and the world. (S1)

	Chose Science?		**Total**
	Not Science	**Science**	
Strongly Disagree	1	0	1
Disagree	0	0	0
Somewhat Agree	6	3	9
Agree	4	10	14
Strongly Agree	6	8	14
Total	**17**	**21**	**38**

There is disagreement between the two groups of girls whether understanding science can make one's life easier. In those that chose to continue their studies in science there was clear agreement within the group, with 17 of the 21 girls agreeing with the statement. In those that did not choose to continue their studies in science, the group was close to being evenly split, 8 of the 17 girls agreed with the statement while 9 of the 17 indicated less than agreement (see Table 4.2) .

Table 4.2: Understanding science can make life easier. (S2)

	Chose Science?		**Total**
	Not science	**Science**	
Strongly Disagree	0	0	0
Disagree	3	0	3
Somewhat Agree	6	4	10
Agree	6	12	18
Strongly agree	2	5	7
Total	**17**	**21**	**38**

In general there is agreement that everyone should understand the science around them, within both groups and across two groups. Those continuing their studies in science show a very clear agreement with the statement, with 18 of the 21 girls supporting the positive view. The difference between the groups is not strong, with 12 of 17 of the girls not continuing their studies in science agreeing with the statement (see Table 4.3).

Table 4.3: Everyone should have some understanding of the science around them. (S3)

	Chose Science?		**Total**
	Not Science	**Science**	
Strongly Disagree	0	0	0
Disagree	0	0	0
Somewhat Agree	5	3	8
Agree	8	10	18
Strongly Agree	4	8	12
Total	**17**	**21**	**38**

When asked whether the science being taught in the classroom is useful there was no real consensus within the groups or across the groups. In those choosing to continue studying science 12 of the 21 were in agreement while the other 9 indicated less than agreement. In the group not choosing to further study science 7 of the 17 agreed with the statement while 10 of the 17 indicated less than agreement (see Table 4.4).

Table 4.4: The science being taught in the classroom is useful. (S5)

	Chose Science?		**Total**
	Not Science	**Science**	
Strongly Disagree	0	0	0
Disagree	3	2	5
Somewhat Agree	7	7	14
Agree	6	11	17
Strongly agree	1	1	2
Total	**17**	**21**	**38**

There was a general, but not strong, consensus across the groups that the girls found science useful. In those choosing to continue their studies in science 16 of the 21 agreed with the statement while the other 5 girls indicated less than agreement. In the group not choosing to study science 10 of the 17 girls were in agreement with the statement while the other 7 responded with less than agreement (see Table 4.5).

Table 4.5: I find science useful. (S18)

	Chose Science?		**Total**
	Not Science	**Science**	
Strongly Disagree	1	0	1
Disagree	0	0	0
Somewhat Agree	6	5	11
Agree	7	11	18
Strongly Agree	3	5	8
Total	**17**	**21**	**38**

Interest

The theme of interest can be described as whether the girls were engaged by the science they were learning and doing, and whether they enjoyed learning and doing the science that was being presented to them.

When asked whether the science being taught in the classroom was interesting the two groups responded very differently. The girls that chose to continue their studies in

science were split as a group with 12 of the 21 girls feeling that the science was interesting while the other 9 responded with less than agreement to the statement. In the groups that chose to not continue their study of science there was general agreement with 12 of the 17 girls indicating less than agreement with the statement and only 5 of them feeling that the science was interesting (see Table 4.6) .

Table 4.6: The science being taught in the classroom is interesting. (S4)

	Chose Science?		**Total**
	Not Science	**Science**	
Strongly Disagree	1	0	1
Disagree	1	2	3
Somewhat Agree	10	7	17
Agree	5	10	15
Strongly Agree	0	2	2
Total	**17**	**21**	**38**

As with the last statement, the two groups of girls again responded very differently when asked whether they themselves found science interesting. There was general agreement within the group that chose to continue their studies of science with 16 of 21 girls saying that they found science interesting. In those not studying science 11 of the 17 girls indicated less than agreement with the statement and only 6 of them said that they found science interesting (see Table 4.7).

Table 4.7: I find science interesting. (S17)

	Chose Science?		**Total**
	Not Science	**Science**	
Strongly Disagree	1	0	1
Disagree	3	1	4
Somewhat Agree	7	4	11
Agree	3	10	13
Strongly Agree	3	6	9
Total	**17**	**21**	**38**

When asked whether they enjoyed learning science the girls choosing to continue studying science were split as a group, 13 of the 21 girls said that they enjoyed learning science while the other 8 responded with less than agreement to the statement. In the girls that did not choose to study science there was a much stronger consensus within the group with only 4 of the 17 girls indicating they enjoyed learning science while the rest indicated they did not (see Table 4.8).

Table 4.8: I enjoyed learning science. (S19)

	Chose Science?		**Total**
	Not Science	**Science**	
Strongly Disagree	4	1	5
Disagree	3	1	4
Somewhat Agree	6	6	12
Agree	3	9	12
Strongly Agree	1	4	5
Total	**17**	**21**	**38**

Teacher

The teacher as a theme addressed an array of aspects related to teachers and their effect in the classroom. It examined not only the impact that teachers had on the girls learning, enjoying, and choosing to continue their studies in science, but it also addressed

the girls' perception of whether or not they felt that their teachers had seen them as students capable of being successful in their science courses. The purpose of the grouping of these items under this theme was to determine whether or not teachers had a substantial impact on the way girls learned science and whether they played a real role in whether or not the girls continued to study science after it was no longer a compulsory subject.

In general there was disagreement with the idea that the teachers the girls had experienced could impact on whether the girls chose to continue or cease their study of science. In those choosing to continue their studies in science 18 of the 21 girls responded with less than agreement while 12 of the 17 girls, in the group not choosing science, responded with less than agreement to the statement (see Table 4.9).

Table 4.9: My teachers had an impact on my no longer choosing to study science. (S8)

	Chose Science?		**Total**
	Not Science	**Science**	
Strongly Disagree	2	4	6
Disagree	9	8	17
Somewhat Agree	1	6	7
Agree	4	3	7
Strongly Agree	1	0	1
Total	**17**	**21**	**38**

When asked whether they felt that having different teachers might have allowed them to enjoy science more, there was general agreement within the groups and across the groups. Of those continuing to study science only 5 of the 21 girls felt that different teachers might have affected how much they enjoyed science, in the group that did not choose to continue studying science only 5 of the 17 girls felt that different teachers might have impacted their enjoyment learning science (see Table 4.10).

Table 4.10: A good teacher can make learning science more fun. (S6)

	Chose Science?		**Total**
	Not Science	**Science**	
Strongly Agree	0	0	0
Disagree	0	0	0
Somewhat Agree	3	0	3
Agree	3	8	11
Strongly Agree	11	13	24
Total	**17**	**21**	**38**

Similar to the previous questions, when asked if having different teachers might have increased their chances of studying more science there was a strong consensus within the two groups and across the groups. In those choosing to continue studying science 17 of the 21 girls responded with less than agreement to the statement while 14 of the 17 girls, in the group not choosing science, responded with less than agreement (see Table 4.11).

Table 4.11: If I had different teachers I may have continued my study of science. (S10)

	Chose Science?		**Total**
	Not Science	**Science**	
Strongly Disagree	2	2	4
Disagree	8	8	16
Somewhat Agree	4	7	11
Agree	1	3	4
Strongly Agree	2	1	3
Total	**17**	**21**	**38**

When asked whether they felt that their science teachers had perceived them as a capable student the two groups responded opposite of one another. In those not choosing science only 6 of the 17 girls felt that their teachers had thought of them as a capable student in science, while 16 of the 21 girls in the group choosing science, felt that their teachers had thought of them as a capable student in science (see Table 4.12).

Table 4.12: In past science courses, the teachers thought I was a capable student. (S11)

	Chose science?		**Total**
	Not Science	**Science**	
Strongly Disagree	1	0	1
Disagree	6	1	7
Somewhat Agree	4	4	8
Agree	6	10	16
Strongly Agree	0	6	6
Total	**17**	**21**	**38**

For the issue of whether or not the girls felt that if they had had a different teacher for their science courses might they have enjoyed learning science more, there was a general consensus among the two groups of girls. In those choosing to continue their studies in science, 9 of the 21 girls disagreed with the statement and 5 of the 21 girls agreed with it. In those girls not choosing to continue their studies in science, 9 of the 17 girls disagreed with the statement and 5 of the 17 girls agreed with the statement (see Table 4.13).

Table 4.13: If I had different teachers I may have enjoyed learning science more. (S9)

	Chose Science?		**Total**
	Not science	**Science**	
Strongly Disagree	1	2	3
Disagree	8	7	15
Somewhat Agree	3	7	10
Agree	2	2	4
Strongly Agree	3	3	6
Total	**17**	**21**	**38**

Difficulty

Difficulty as a theme involves how the girls perceived the learning of science to be as an experience. A categorizing of "difficult" would indicate that the girls consider the learning science more challenging compared to other subjects that they studied, and that being successful in science would require more than an average effort.

There was general agreement across the two groups when asked whether or not they felt that science was a hard subject, though there was no real consensus within either group. In those not choosing to continue their studies in science 11 of the 17 girls responded in agreement while 14 of the 21 girls, in the group choosing science, responded in agreement (see Table 4.14).

Table 4.14: Science is a hard subject. (S12)

	Chose Science?		**Total**
	Not Science	**Science**	
Strongly Disagree	1	0	1
Disagree	1	2	3
Somewhat Agree	4	5	9
Agree	6	9	15
Strongly Agree	5	5	10
Total	**17**	**21**	**38**

Again there was general agreement across the two groups when asked if they felt that only smart people do well in science, there was also a strong consensus within the groups this time. Of those choosing to continue learning science 19 of the 21 girls disagreed with the statement while 12 of the 17 girls, in the group not choosing further studies in science, disagreed with the statement (see Table 4.15).

Table 4.15: Only smart people do well in science. (S14)

	Chose Science?		**Total**
	Not Science	**Science**	
Strongly Disagree	3	5	8
Disagree	5	7	12
Somewhat Agree	4	7	11
Agree	3	2	5
Strongly Agree	2	0	0
Total	**17**	**21**	**38**

When asked if they felt science was a confusing subject the two groups answered differently. In those not choosing to study science there was a bit of a split with 10 of the 17 girls agreeing that science was a confusing subject. Of the girls choosing to study science further there was more of a consensus with only 6 of the 21 agreed that science was a confusing subject (see Table 4.16).

Table 4.16: Science is a confusing subject. (S16)

	Chose Science?		**Total**
	Not Science	**Science**	
Strongly Disagree	0	1	1
Disagree	3	4	7
Somewhat Agree	4	10	14
Agree	5	3	8
Strongly Agree	5	3	8
Total	**17**	**21**	**38**

Gender

When looking at the issue of gender a weak relationship exists between how girls perceive their ability to be successful in science and whether or not they choose to study it after it is no longer a required course. Though they all said that boys were not naturally better at science they still indicated that being female may in some way be related to them

not being as successful in science as their male counterparts. There was a weak but significant correlation in the belief that gender may play a role in one's ability to succeed, and subsequently in them choosing to take additional science courses.

There was general agreement within the two groups as well as across the groups when asked whether they believed that most girls are not good at science. There was a strong consensus amongst most of the girls in their disagreement with the idea that most girls are not good at science. In those choosing to continue their studies in science 20 of the 21 girls responded with less that agreement. In those not choosing to study science 13 of the 17 girls responded with less than agreement (see Table 4.17).

Table 4.17: Most girls are not good at science. (S13)

	Chose Science?		**Total**
	Not science	**Science**	
Strongly Disagree	6	15	21
Disagree	7	5	12
Somewhat Agree	3	1	4
Agree	1	0	
Strongly Agree	0	0	01
Total	**17**	**21**	**38**

As with the previous statement there was a strong consensus amongst the girls, both within the groups and across the two groups, in their feelings towards the idea that boys are naturally better at science. In those choosing to study science 21 of the 21 girls responded with less than agreement while 16 of the 17 girls, in the group choosing to not study science, responded with less than agreement (see Table 4.18).

Table 4.18: Boys are naturally better at science. (S15)

	Chose Science?		**Total**
	Not Science	**Science**	
Strongly Disagree	8	13	21
Disagree	6	6	12
Somewhat Agree	2	2	4
Agree	1	0	1
Strongly Agree	0	0	0
Total	**17**	**21**	**38**

Self-Efficacy

There is a tendency, in the girls that do not take science, to be more inclined to agree with the statement “most girls are not good at science” and also to identify with the statement “I am not a science person”. Perhaps it is their way of explaining or justifying to themselves why they experience difficulties or are not successful in science. There exists a weak correlation between girls and their perceived self-efficacy in science and

whether or not they choose to study it further. The less they see themselves as a ”science person”, the more likely they are to believe that some people are “just not good at it”.

When asked if they felt that some people are just not good at science there was a general agreement in the girls. Of those continuing to study science there was a split with 13 of the 21 girls indicating that they felt that some people are just not good at science. In those choosing to not study science there was more of a consensus within the group with 14 of the 17 girls responding in agreement to the statement (see Table 4.19).

Table 4.19: Some people are just not good at science. (S7)

	Chose Science?		**Total**
	Not Science	**Science**	
Strongly Disagree	0	0	0
Disagree	1	1	2
Somewhat Agree	2	7	9
Agree	6	7	13
Strongly Agree	8	6	14
Total	**17**	**21**	**38**

When asked if they identified themselves as being a “science person”, someone who has a natural ability to do well in science, there was disagreement between the two groups (those that chose to study science and those that did not). Of those continuing to study science only 6 of the 21 girls indicated that they felt that some people are just naturally good at science, and identifying themselves as such. In those choosing to not study science there was more of a consensus within the group with 11 of the 17 girls responding in agreement to the statement (see Table 4.20).

Table 4.20: I am not a science person. (S20)

	Chose Science?		**Total**
	Not Science	**Science**	
Strongly Disagree	2	5	7
Disagree	0	5	5
Somewhat Agree	4	5	9
Agree	2	1	3
Strongly Agree	9	5	14
Total	**17**	**21**	**38**

The girls as a group felt that science is important in the world and in people’s lives (society in general, not necessarily their own lives) and they mostly agreed that understanding science can make one’s life easier. When asked if they felt that the science being taught in the classroom was useful they were less in agreement, in general they felt

that some of it was useful but that much of it was not useful to one's life. The same trend was noticed when they were asked about whether or not they themselves find science useful, some agreed with the statement "I find science useful" while others disagreed. Interestingly, even though the group as a whole felt that science is important in the world and in the lives of people, they did not really feel that everyone needs to be able to understand the science around them. In general the group's results indicated that to the girls, there was no relationship between the importance of science in the world and the need for everyone to understand the science around them. Perhaps this is because the girls can see and appreciate the importance of science in the world and to society (research and things which are developed from it) but it is not a part of their day-to-day world. Maybe it is their belief that since everyone does not use science directly (or even indirectly) we all don't need to understand it.

There exists a weak but significant correlation between the belief that understanding science can make one's life easier and whether or not the girls chose to study science. Of those that chose to study science, in 21 of the 38 girls studied, there was a link for them between their perceptions of science making one's life easier and them choosing to study science. For these same girls there also existed a moderate correlation between whether or not they felt that their science teachers thought that they were a capable student in science. The girls were more likely to choose to continue their studies in science if they felt that their science teachers thought that they were capable students in the area of science. In all the girls there was a strong disagreement with the statement (most girls are not good at science), 33 of the 38 disagreed or strongly disagreed. There

was a weak but significant correlation between that and the girls choosing to study science as an elective course.

When it came to being interested in science more of the girls that chose to continue their studies in science said that they found science interesting compared to the girls who did not, 16 of the 21 that chose to study science indicated that they found it interesting while only 9 of the 17 that chose not to study science said that they found it interesting. Interestingly, the statistical data only showed a weak but significant correlation between the girls' interest and their choosing to further study science after it is no longer required of them. In relation to interest the girls were asked whether or not they enjoyed learning science, of the girls that chose to further study science 13 of the 21 indicated that they did enjoy learning science while only 4 of the 17 that chose to stop studying science said that they enjoyed learning science. A weak but significant correlation existed between the enjoyment of one learning science and the girls choosing to continue their studies in it. When asked whether they identified with the statement "I am not a science person" (someone that is good at science and understands it easily), 6 of the 21 girls that chose science identified with the statement while 11 of the 17 girls that did not chose science identified with the statement. The data showed a weak but significant correlation between the girls self-identifying with being a science person and their choosing to further study science as an elective.

Grouping of Survey Criteria (S1-S20)

Subsequent to the analysis of the individual items, the statement items were then grouped into scales identified as representing some variables relevant to the decisions of girls to

pursue their study of science. As stated in Chapter 3, the items were originally constructed with this data reduction in mind.

The variable scales were as follows (see Figure 4.1). As some statements were worded with negative meaning, those were re-coded by subtracting the value of the response from 6; items are identified as positive (+) or negative (-).

Importance

1. Science is an important aspect in our lives and the world. +
2. Understanding science can make life easier. +
3. Everyone should have some understanding of the science around them. +
5. The science being taught in the classroom is useful. +
18. I find science useful. +

Importance = S1 + S2 + S3 +S5 + S18

Interest

4. The science being taught in the classroom in interesting. +
17. I find science interesting. +
19. I enjoyed learning science. +

Interest = S4 + S17 + S19

Teacher

6. A good teacher can make learning science more fun. +
8. My teachers had an impact on my choosing to no longer study science. +
9. If I had different teachers I may have enjoyed learning science more. +
10. If I had different teachers I may have continued my study of science. +
11. In past science courses, the teachers thought I was a capable student. +

Teacher = S6 + S8 + S9 + S10 + S11

Difficulty

12. Science is a hard subject. +
14. Only smart people do well in science. +
16. Science is a confusing subject. +

Difficulty = S12 + S14 + S16

Gender

13. Most girls are not good at science. -
15. Boys are naturally better at science. +

Gender = 6 - S13 + S15

Self-Efficacy

7. Some people are just not good at science. -
20. I am not a science person. -

Self-Efficacy = 12 - S7 - S20

Figure 4.1 Variable Scales Coding

The descriptive statistics for the scales are presented below in Figure 4.21. Reliability estimates were obtained for each, using Cronbach's α as a measure of internal consistency, and they displayed a good level of reliability in the range of .71 to .86, with the exception of the self-efficacy scale, only moderately so at .59 (see Table 4.22).

It is worth noting that the girls in both groups tended to see science as important. The girls not pursuing science were equivocal as a group, in expressing interest in the subject. While the girls choosing science were near neutral as a group concerning their self-efficacy in science, the non-science girls clearly saw themselves as lacking efficacy. It is also notable that both groups of girls saw science as only moderately difficult and that they strongly held that gender was not an issue. (See Table 4.21)

Table 4.21: Descriptive Statistics for Scales Used

Grouping Category (Chose/ Did not choose Science)	Mean	Standard Deviation	Range of possible scores	Midpoint	Standard Error Mean
Importance					
Science	20.1	2.8	5 - 25	15	.62
Not Science	18.1	3.0			.74
Interest					
Science	11.2	2.2	3 - 15	9	.49
Not Science	9.0	2.6			.62
Teacher					
Science	16.5	2.9	5 - 25	15	.64
Not Science	15.4	4.1			1.00
Difficulty					
Science	9.2	2.4	3 - 15	9	.52
Not Science	10.2	3.0			.73
Gender					
Science	2.8	1.2	2 - 10	6	.26
Not Science	3.8	1.8			.44
Self-Efficacy					
Science	6.7	2.1	2 - 10	6	.45
Not Science	8.2	1.9			.47

Table 4.22: Scales: Reliability Estimates

Variable	Reliability (Cronbach's α)
Importance	.78
Interest	.79
Teacher	.71
Difficulty	.76
Gender	.86
Self-Efficacy	.59

The mean scores for the responses from the two groups of girls, **Chose Science** and **Did not choose Science**, were then compared using the independent samples t-test (Table 4.23). Significant results were found for the variables *Science is Important* ($t=2.027$, $p<.05$), *Science is Interesting* ($t=2.867$, $p<.007$) and *Efficacy* ($t=-2.289$, $p<.028$). Given the small sample size, it is also noted that *Gender* approached yielding a significant result, given the use of a two-tailed test ($t=-1.936$, $p<.061$). All t-tests met the Levine's F test for equality of variances between groups. While these differences were significant, when the effect sizes were calculated, the significant effect sizes as calculated using the point bi-serial correlation showed a mild to reasonably strong effect, with Cohen's d (Nowicki and Hinson, ND) indicating the mean differences being of the order of between 0.65 and 0.93 of pooled variance (see Table 4.23).

Table 4.23 Independent Samples t-Test and Effect Size

	t-test for Equality of Means						
	t	**df**	**Sig. (2-tailed)**	**Mean Difference**	**Cohen's d**	**Cohen's U**	**Effect Size *r***
Importance	**2.08**	36	**.050**	**1.9**	**0.68**	**0.75**	**0.32**
Interest	**2.86**	36	**.007**	**2.2**	**0.98**	**0.84**	**0.43**
Teacher	.97	36	.337	1.1			
Difficulty	-1.14	36	.260	-1.0			
Gender	**-1.94**	36	***.061***	**-1.0**	**-0.65**	**0.74**	**-0.30**
Efficacy	**-2.29**	36	**.028**	**-1.5**	**-0.76**	**0.78**	**-0.36**

Three of the variables (importance, interest, self-efficacy) show significant differences, and one (gender), approaches significance. Interest in science was the strongest differentiating variable (t = 2.869) with the effect size r = 0.43, and Cohen's d indicated a difference in the means of 0.96 of the pooled standard deviation. A sense of self-efficacy between the girls showed a differentiating variable of (t = -2.289) with the effect size r = -0.36, and Cohen's d indicated a mean difference of -0.76 of the pooled standard deviation. Importance amongst the girls showed a differentiating variable of (t = 2.027) with the effect size r = 0.32, and Cohen's d indicated a difference of means of 0.68

of pooled standard deviation. For the variable gender, which comes close to being significant, it had a differentiating variable of (t = -1.936) with the effect size r = 0.65, and Cohen's d indicated a difference of means of 0.30. The effect size is 0.30 and Cohen's d is -0.65.

From Cohen's U (non-overlap U) we can see that the average girl among those selecting science will see science as more important than 75% of the girls not continuing to study science. Similarly, the average girl in the group selecting science will express a higher level of interest than 84% of the girls that did not choose to continue studying science. The scale related to believing gender differences existed indicates that the average girl who did not choose to study science, was likely to believe such differences existed more strongly than 75% of those that chose to study science. Care needs to be taken in the interpretation of the results of the scale for self-efficacy, as it rated a high score for low self-efficacy. Hence, the average girl who did not choose to study science will express lower self-efficacy than 78% of those that did choose to study science.

Chapter 5 – Interview Analysis: The Students' Views

This chapter first presents the interview summaries for each of the 8 girls interviewed. These descriptions are followed by a collating of the girls' responses as they related to the variables identified in the literature and the survey.

Student 1

Student 1 has never really enjoyed science, she has always experienced difficulty with it. She directly correlates her enjoyment of learning science to how successful she was in science courses, "I don't really enjoy them because I never really did well in science." She believes that she might have done better in science courses had she had a better understanding of the material being studied. Student 1 indicated that she had had a fair interest in biology and that she worked at it to some degree, but that her efforts did not pay off and her mark never reflected the effort she put in. She felt that no matter how hard she worked in her science courses she never experienced success in them. Student 1 attributes this lack of success to her not possessing some natural ability at science which she believes may make one more successful at it, she says "I'm not a science person, some people are just better at it." Student 1 does admit however, that she did not work to her full potential in biology and that she could have worked harder. Because she put in some effort but did not see the results she hoped for she did not have the desire to work harder but admits that perhaps she could have done better had she increased her effort.

Though student 1 believes that some people are just naturally better at understanding science she does not feel that this is related to sex. She feels that both male

and female students have an equal ability to do well in science and that success in science courses is based on the individual, their level of interest in science, and how much effort they are willing to put into their course work. Student 1 believed that people that were good in science liked math and problem solving, that they enjoyed school and learning, that they are smart, and that they worked hard and studied a lot. “Some people seem to just be better at science. It is easier for them and they don’t have to work as hard.”

Student 1 felt that for the most part, teachers treat their male and female students in the same manner. She did express the belief that teachers may ask male students the harder questions or may interact with them more in class, she thought that this may be due to the fact that they were among the more successful students in the class and that it may not have had so much to do with their sex. On the issue of society and its views on the abilities of males and females in scientific study and vocations, student 1 felt that society sees males and females as being closer to being equal in their abilities than it has in previous times. She does however state that even though society may be closer to accepting that males and females have equal abilities in science that it is not at the point where males and females are considered to be equal. She bases this conclusion on the roles that men and women fill in the real world as well as on the stereotypes of male and female roles and abilities that she sees on television.

Student 2

Student 2 strongly expressed the belief that she was not good at science. She found science to be a difficult subject and as it was not a subject that she enjoyed at all she felt that her dislike of science only made learning science harder, “…I don’t find science to be a real easy subject and it’s definitely not a subject I like very much so I

would find it harder." She equated disliking science with having no interest in it. When asked what she found difficult about science she communicated that she did not construct a meaningful understanding of the topics being studied, she felt that she only ever possessed a superficial understanding of what she was being taught. She expressed frustration at lacking a deeper understanding of the material that she was learning, and since learning science often builds on earlier concepts that have been taught, she felt that this lack of a complete and meaningful understanding of earlier concepts inhibited her learning of later concepts and ideas. Student 2 admitted that she did not put forth a very strong effort in her science courses, she also stated that she was not interested in science. She said that she gave her science courses a "good effort" but did not do well, she went on to say that if science was something that she was more interested in she would have worked harder.

Student 2 did not feel that there was a link between learning science and being successful in it and one's sex. She felt that if one was interested in science and enjoyed it that they could be successful in it. When asked about how science teachers treat male and female students, she suggested that teachers may treat males and females differently though she had not witnessed it herself. When asked to elaborate student 2 said that she thought that female science teachers may push their female students harder because they know that the female students are capable of being successful in science even if the female students may not perceive themselves as such. She suggested that female science teachers may act and be seen as role models for female students studying science, showing young girls that women can be successful at science, but she also said that these female teachers would still treat their male students fairly. This suggests that perhaps she

feels that male science teachers may not push their female students as much as their female colleagues do.

When asked about general abilities in science student 2 said that she didn't feel that some people are necessarily smarter but then she goes on to say that they are better at science, and that they just seem to understand it better and easier, "It's not that they are naturally smarter, some people are better at it, if they enjoyed the subject then they excel at it, some people can just understand it." She felt that if people enjoyed science then they were more likely to excel at it, since they enjoyed learning science then they tried harder in those courses than people who may not enjoy science as much, and as a result experienced more success in science courses. Student 2 did not feel that there were specific skills or abilities that one might possess that might make them more successful in science.

On the issue of fairness and how teachers treat their male and female students, student 2 did not believe that teachers treat their male and female students differently, instead she felt that at times the "smarter" students may be given more attention or encouragement. She felt that science teachers may be more supportive of students that are successful in their courses in that they may try to further stir their interest in science and encourage them to continue their studies in the area, she did not feel teachers would discourage students from studying science just because they were not very successful in it. In discussing societal views on the abilities of males and females in science, student 2 felt that society has come a long way in its acceptance of equal between the sexes, but that it has not achieved equality and that stereotypes still exist. It was her feeling that in the area of scientific research that a man would be considered more credible than a

woman when reporting their findings, because of their sex and based on the belief that men are smarter than women in science. Based on the media, portrayals on television, and looking at who often has the more powerful jobs, student 2 feels that society still sees men as being more capable in science than women.

Student 3

Student 3 expressed an extremely strong dislike of learning science. Interestingly though, she cannot place exactly when this dislike emerged or what happened to cultivate it, "…I strongly dislike science. I'm not sure what happened and why I didn't like it, I've never liked it." She recalls that in elementary school and in grade nine and ten, she never enjoyed science class and she never had an interest in science. Since she was not interested in science ever she never felt the urge to put in any extra effort into studying in her science courses or doing extra research or seeking extra help. This lack of extra effort is what she attributes to her lack of success in her science courses, "…because I was never really interest so I never really had that extra push to go and do extra studying and extra research and everything so I never really achieved success in science." Being an honours student, the low 70s that student 3 achieved in her science courses were not perceived as being successful marks for her.

On the issue of male and female ability and being successful at science, student 3 does not associate success in learning science with one's sex. It is her belief that success is based on the individual and that there are both males and females that are capable and successful in science, and equally so. When asked about societal views on the scientific abilities of males and females, student 3 felt that society definitely views males and females as unequal. She points to men doing "higher up" jobs in general but especially in

science and engineering as an indicator of how and where society views and values male and female contributions, she continues on to say that women are perceived as being more capable of doing more social sciences. When asked where she sees this message being expressed, student 3 said “everywhere, magazines, tv shows”. She went on to say that it was an implied message, men were portrayed as the top lawyer or scientist or researcher and women were seen in roles supportive to the men.

When asked about people having a natural ability in science, student 3 said felt that people that do well in science have some natural ability but also that their success can depend on their interest. She felt that if girls are exposed to science at a young age they are more likely to develop an interest in it and that interest will be propagated further on in their studies as they continue their schooling. When asked what skills a person successful in science might have, student 3 answered, “Well definitely they are interested in more the math science areas. They are not more driven because you can be driven in any subject but there is just something about them, they’re not different but part of them is”.

On the topic of how teachers treat their students, student 3 suggested that she felt that teachers treated the students that did well in their courses better than those who did not, this perception was based on the personal experiences of student 3, “…from past experiences, in other courses the teachers treated me better than students that don’t do as well.” She felt that she did not get as much attention from her science teachers as the more successful students since she didn’t have a high level of interest in science, she wasn’t into discussing science with them, and she wasn’t doing her homework regularly (which she felt the teachers knew).

Student 4

Student 4 did not feel that she was good at science. She attributed this to her never having had an interest in them, and taking science courses because that was required of her. When asked about her lack of interest she answered, "Because my teacher in elementary school was bad and really boring, and we didn't really do much science. When I got to high school it was too late." Aside from her lack of interest in science student 4 felt she did not do well in her science courses because she would not "remember stuff easily" and she felt that there were a lot of details one had to remember when learning science. When asked about the components of science that did not require memorization she said that she found mathematical calculations boring and stated that she was not good at math. When pressed further on whether she truly did not like math and calculations or if she had just not been successful at those things, student 4 said that she had never been good at them.

In discussing the abilities of male and female students in learning and doing science, student 4 indicated that she did not feel that ability had to do with one's sex but instead it was directly linked to one's enjoyment of the subject matter being learned. When asked about how science teachers treat their students she felt that males and females were treated equally by their teachers. She did feel however that teachers might encourage or address student needs more if a student had been applying a consistent effort and interest all the time as opposed to just sometimes during the course, "…Well if a person has a question and they always asked a lot of questions, then the teacher would answer them first because they have been asking questions since the start of the course." When asked about how she feels society views the abilities of males and females in learning and doing science, student 4 felt that in recent years the gap in society's

perceptions of the abilities of males and females has narrowed and said that “before that women weren’t necessarily supposed to take sciences or math courses but more the social sciences”.

Student 4 did not feel that natural ability had any impact on whether a person was successful in science or not, she felt that if one liked science that they would work hard at it and that would allow them to be successful. When asked what skills, abilities, or traits she felt that people who were successful in science possessed she answered, “memorizing and math and stuff”, interestingly the exact things that she felt was not good at.

Student 5

Student 5 actually enjoyed learning science but did not want to put in the necessary effort and do all the work that was required to be successful at it. “The concept to learn was interesting but after that, actually doing the work or figuring it out, I didn’t want to do that. It was interesting to learn but I didn’t want to put in the time”. Student 5 felt that she was good at science and always did well in her science courses, her science marks fell in the 70s range. When asked about the specifics in science learning that she did not enjoy she responded, “I just didn’t like the science part, the concepts were good but the labs and calculations and stuff like that I didn’t like doing”.

When asked whether she thought males and females were equally capable in learning science she said that she did not feel that sex played a part in potential success. She elaborated that some males do well in science as do some females just as some males do poorly in science and the same with females. Student 5 believed that there was some natural ability in those that are successful in learning science, she felt that they might find it easier to learn because their minds were more open to math or science, and that some

people can understand science more quickly or easily. When asked about the qualities that a person successful in science might possess, student 5 suggested that one need's to be observant and curious about what they observe in the world around them, that they have a strong interest in how things work. She felt that they can see and appreciate how things go together and see the pieces of a puzzle in front of them and put it together to form the bigger picture or idea in their head.

In discussing teacher attitudes towards male and female students, student 5 felt that teachers treated males and females equally, she felt that both sexes received the same assistance and encouragement. Student 5 also felt that teachers did not treat the more successful students in their course any better than those who were not. It was her perception that teachers might pose the hard questions to the more successful students or participate in a more detailed discussion on a scientific topic with them because they knew that some students were more into it than others. She also felt that the teacher might encourage these students more in further scientific studies or pursuits based on their interest.

When asked about societal views on the abilities of males and females in science, student 5 expressed that she felt that society was far from accepting equal ability between the sexes, "I don't think society views males and females as equal in learning or working in science. It might be better than during past times but it is still not equal." When asked how she had come to this conclusion she referenced television and the roles that men and women play, saying that women still are found predominantly in the supporting roles (to men) and that men were still portrayed in the powerful or technical position. When asked why she thought we still had this type of portrayal in the media, student 5 said it was

because we are more used to men in these types of positions and consequently we trusting them in those ways. She went on to say that if a woman were to do the same thing that she might not be taken as seriously as men are perceived at more knowing or better in some fields.

Student 6

Student 6 felt that some of the topics that were taught in science courses were not useful to her life and that she'd never need to know them, "…they were interesting some of the stuff we learned but some was really boring too. Some of the topics we learned were not interesting and were not useful to my life and I'd never need to know them." Though she thought that some of the topics were interesting she found many to be uninteresting and boring to learn. Science courses were typically among her hardest subjects and her lowest grades, she felt that she had put in effort but she could not do well in science. She was unsure of whether or not a greater interest on her part in the topics being learned would have translated into a better grade for her, she articulated that perhaps if she had been more interested she may have put in a stronger effort (though she emphasizes that she did put in a good effort) and perhaps that may have caused her to earn a better grade.

When asked about her opinion on the ability of both sexes to be successful in science Student 6 feels that boys may have an easier time learning science and subsequently do better at it, "…I think many boys have an easier time with it. Maybe because they are just better at it or their minds understand and process those kinds of things better, or maybe because they are expected to be better at technical and hard things and may be pushed or encouraged more in those areas." She cannot explain why she has

come to that conclusion but indicates that this trend (in her view) is more obvious in physics and mathematics courses. She did not feel that teachers treat male and female students differently and are willing to provide the same level of assistance to both male and female students. She went on to say that boys may be given more opportunities to answer questions, if they are doing well in a course, as they may know the correct answer and that is what the teacher is after.

Student 6 did not feel that there was equality, in the eyes of society, when it came to the abilities of males and females in learning and doing science. She thought that society was closer to accepting the abilities of males and females as being equal than it had been in the past, but we are still not there. She felt that men still held the higher powered jobs and received better pay for their work. She mentioned trends on television showing men as surgeons or scientists and being portrayed as more capable in technical fields than their female counterparts, "TV isn't very helpful, it still shows women in more traditional roles helping people and assisting and supporting men in the job that they are doing. Men are still often shown as the stronger or smart personalities…".

When asked whether she believed that some people were born with a natural ability at science student 6 indicated that she did indeed think that some people were born being better at science and math so it was easier for them to learn and do well in. She was not sure exactly why some people naturally seemed to be better at science. She suggested that they might have been born that way, or perhaps they were encouraged more in that area as children or they just happened to have developed a strong interest in it. She felt that people that did well in science probably liked math and had a strong interest in knowing how and why the things around them worked the way that they did. She also felt

that they were very analytical and curious and liked to experiment and investigate to figure things out on their own, and that they were good at organizing and remembering information.

Student 6 did not feel that teachers treated students that were doing well in their courses much differently than those that were not when it came to the actual course work. She did think that teachers might interact more with these students because of their interest in science and discuss related topics with them because they knew that had an appreciation for it. She also felt that teachers may interact more with these students outside of the classroom too and discuss subjects that were not science related at all.

Student 7

Student 7 indicated that she had an initial interest in science but that her interest faded as she failed to experience success in her science courses, "…some of the stuff is interesting and useful and pertains to our lives but at least half of it doesn't, so I really wasn't interested in some of the topics we had to learn." She also said that she believed that at least half of what she learned was not important to her life so it did not interest her in any way. She did not feel that she was good at science because it was always her lowest grade. She felt that she did her work most of the time but maybe if she was more interested in the topics being taught she might have done slightly better. According to her putting in a fair effort did not seem to help student 7, she felt that "science was just too hard for me or my brain didn't work that way or something".

She felt that boys and girls could both be good at science but that boys seem to have an easier time at it than girls usually. When asked why she responded "because they are just better at it or their minds understand and process those kinds of things better, or

maybe because they are expected to be better at technical and hard things and may be pushed or encouraged more in those areas". Student 7 did not feel that teachers treated their male and female students very differently, she did think though that teachers allow the smarter students to answer more questions or explain things to the class more, and that often those students are the boys in the class.

When asked about society's perceptions about the abilities of males and females in science student 7 felt that we are getting closer a perception of equality between the sexes but that there are still some very strong stereotypes "about what men and women can and should do". She felt that television greatly contributed to the perpetuation of traditional stereotypes. She felt that women were still portrayed in traditional roles often helping people, and in roles where they were required to support men in their jobs. She also said that she felt that men were still shown as the stronger or smarter personalities and that they often had the better jobs and were portrayed as doctors, scientists or the person in charge.

Student 7 believed that some people do well in science because they work very hard while others do well in science with very little effort at all. She felt that some people had a natural ability and that perhaps it lay in how their minds work and how they process things. She thought these people would be good thinkers, organized, and good at memorizing. When it came to problem solving she felt that they could take the problem at hand and break it down and visualize what needed to be done in order to solve the problem. She also thought they would be good at mathematical calculations, doing hands on tasks, and that they enjoy figuring out things for themselves.

She felt at times students that are doing better in a course might get more assistance from the teacher but not always. It was not that teachers are mistreating the students that are not as successful in their course but rather the teacher may be providing extra encouragement to the students that are doing well, so that they may do even better or so that they may continue their studies in science after high school.

Student 8

Student 8 clearly never liked science as long as she can remember though she cannot articulate exactly why she had such a dislike for it. She recalled that science seemed to become very hard when she had to do it all the time. She went on to say that she did not remember doing a lot of science in elementary school so she did not have a strong interest in it when she had to start doing it every day in secondary school. At that point science was boring and difficult to her. She did not feel that she was good at science and to her the marks she earned reflected that. "No I've never liked science. I don't know why exactly I just remember it being hard when we had to do it all the time. I don't think I learned much science when I was in elementary school and so I wasn't very interested in it when I got to high school and had to do it every day. I found it difficult and boring." Student 8 did say that she might have been able to do better in her science courses had she worked harder, if she had had more of an interest in it or if her perception of it wasn't that it was so hard.

Student 8 felt that it may seem boys as a group may do better in some sciences, such as physics, but that both boys and girls are capable of doing well in science. She felt that boys may do better in physics because they might be more interested in that area or because they are expected do better in it than girls by parents and teachers, "I think it is

because they are more interested in that stuff and are expected to do well in it, more than girls are by their parents or teachers, it's kind of like tech classes too." She likened it to more boys participating and being capable in the various technology classes offered in high school.

When asked about how teachers treat their male and female students, student 8 said that she thought perhaps teachers are more interested in the smarter students and may even like them better than those students that are not as successful in their courses. Often those smarter students are the male students and she felt that teachers will ask them the harder questions or have them explain something to the class or take on some kind of leadership role. Aside from being smart she suggested that teachers might treat boys differently because they are more confident than their female counterparts.

Student 8 did not feel that society perceives males and females in science and being completely equal. She felt that men are still shown as smarter and more dominant in school and work roles on television, and even post-secondary course materials. "Traditional roles are still very expected and accepted I think by people in general".

Student 8 felt that some people do understand and learn science easier and better with very little effort. She suggested that the reason for this could be that they can "see it easier" and that their minds focus better on facts, figures, and calculations, things often considered integral in the learning of science. However she also said that some people like science more so they work harder and that is the reason why they can be successful. Regardless of why they did well in science student 8 felt that these people were probably good at mathematics and calculations and memorization. She also thought they should be good at understanding and organizing information and could "see it" so that they

could better understand the problem they were trying to solve. She also felt that they were hard workers, they liked experimenting and that they worked well on their own or with little guidance.

Student 8 did not feel that teachers treated the smarter students better. She thought that they might interact with them more but she suggested that was probably due to the students understanding what they were learning and getting their work done sooner. She also suggested that the smarter students may have in common with the science teacher and may have similar interests, making interactions between them easier. Student 8 also pointed out that teachers may actually spend less time with the students that are doing well in their classes because they need less assistance than those who are not doing as well.

Interview Results as They Relate to the Identified Themes

Interest

Of all the themes that emerged from the interviews about student success in science courses interest was the most common answer, every one of the girls referred to interest as being key in whether or not one is successful in learning science. Interest seemed to be influenced by two main factors for the girls. The first factor was whether or not the girls had been exposed to learning and doing science during their elementary schooling years, and if they had been exposed to science was it a sufficient amount so that they could truly develop an interest in it or have some level of confidence about their abilities in it.

Students in elementary school are exposed to varying degrees of learning and participating in scientific activities. If the teacher designated to teach science does not have the necessary background knowledge in science then the students may not receive even the required time, which itself is very minimal, because the teacher may not be comfortable enough with their ability to teach the subject. Also if the teacher does not have a science background they may not see the value of learning and doing science as much as a teacher that is more passionate about the subject, and students may spend less or no time on science if that is the teacher's preference. The structure of individual schools, even within the same school, board can be very different. Some schools may place more of an emphasis on certain subjects than compared to others. Also in high school the grade nine populations are composed of students from various elementary schools within that school board. All these aspects can affect the amount of time that students spend learning and doing science during their elementary schooling years. The result is students in grade nine that have a vast array of skills, abilities, and understandings in learning and doing science.

If one is exposed to little or no science at all during their elementary school experience it seems this has the potential to impact upon their perceptions about, and abilities in, science when they are required to study and participate in it on a regular basis. The students may not have constructed their own system of learning and understanding science. When they are required to do it on a daily basis, upon entering secondary school, it may become overwhelming for them to have to gain so much knowledge and to be able to demonstrate skills regularly that they may not have had the chance to practice or even develop before. Problem solving and investigative techniques

can seem quite daunting if one is not familiar with using them and working outside of the more traditional learning structure than they likely experienced during elementary school.

This trend is easily observed in any grade nine science class, it is certainly one that I have seen in my own classroom, year after year. With students coming from different schools the scientific knowledge, skills, and abilities demonstrated within each year's grade nine cohort varies greatly. So some students start with a disadvantage compared to the rest of their peers from the very first day. It is therefore very easy to understand why some students dislike science and have no interest in it. If students are not allowed to develop an interest in learning and doing science, and they are not given the opportunity to investigate and be curious about science in the world around them in their own way (when they are young and often naturally curious), when we make them do it and every single day at that, it most certainly will not be an enjoyable experience. If they do not enjoy learning science or even hate it, as some students often proclaim, then the students' ability to be successful in science can be greatly hampered.

Importance

The second factor that the girls related to being interested in science was whether or not the science they were being taught had any importance to their lives, presently and in the future. In their interviews three of the girls said that they did not enjoy science and were not interested in it because many of the topics they were learning were simply not interesting to them. If one is not interested in something then it is understandable that we may not exert a strong effort or any effort at all, if it fails to hold our interest. Some people may put in a minimal effort because they have to, for example, because they need to get the credit in order to graduate. Others however may fail to be motivated enough

even by that, required completion on their part, to put in the necessary effort. There will always be students that have acquired a credit because they have been helped along a little by the teacher, because we are aware that they may not otherwise be successful if left to their own methods.

These girls felt that not only was it boring to learn but also that it had no relevance to their present lives, since they could not see it being useful to them in any way they could not relate to it or draw any connections from it to their daily lives. I have noticed that many of our students do not go on to study science, some only take it because it is required of them to have to science credits in order to graduate, if they have no future school or work plans that include science then a lot of what they are being asked to learn is going to be useless to them both in the present and in the future. If one sees no value in what they are learning they may lack the motivation to put in the necessary effort so that they may increase their knowledge and understanding in that area, and perhaps be more successful.

All of the girls indicated that interest was in some way related to one's ability to succeed in learning science. To fully understand what they mean we need to be able to understand the idea of success that they have constructed for themselves, and their perceptions of how one can achieve this success. In general these girls see two avenues that can allow one to be successful in learning science. The first of these is simple, they feel that one's work ethic can greatly impact the level of success that one can achieve when learning science. I believe it is fair to say that usually there is a strong correlation between one's effort and how well one performs on any given task.

All of the girls indicated that they put some effort into their learning during their science courses, nobody said that they didn't try at all. Some put in a minimal effort while others exerted a great deal of effort, some experienced minimal success (simply earning a passing grade in the course) while others received higher marks (but that were not in line with their idea of being successful). However it was the general consensus that if they had been more interested in what they were being taught that they may have put in more of an effort into their school work. Most of them felt that if they had actually liked the material they were learning that they might have been more driven and would have been more willing to work harder, not one suggested that they had put in their maximum effort.

The reasoning of the girls does make sense, for most of us if we are interested in something and enjoy it then we are more likely to put in a greater effort into being good at it, not just for the sole purpose of getting a better mark but because we actually want to learn more about it and gain a better understanding. Besides accrediting work ethic as being connected to how well one does in science, interestingly the girls also felt that the scenario at the exact opposite end of the spectrum could predict one's potential to being successful in learning science. The girls also seemed to believe that some people have an innate ability when it comes to science, that they are naturally good at it and this is why they are successful at it (or more successful than others).

When asked directly whether they believed that some people possessed a natural ability when it came to learning and understanding science only about half of the girls answered yes to the question. As a sub-group they articulated that they believed that some people were naturally better at science because they were possibly born that way,

they were able to learn and understand concepts easier and better than everyone else in general because their minds functioned in such a way that allowed them that ability. A couple girls also suggested that perhaps these individuals may have been born with a predisposition that allowed them to excel at science, but that they acquired an interest in science and enjoyed it and that this was nurtured or encouraged in them, and that (along with their predisposition for science) allowed them to be successful in learning and doing science.

Most of the girls believed that it was one's interest, and the work ethic that stemmed from that interest, that best predicted one's ability to be successful in their science courses. Interestingly, when asked in general about success in science courses, most of the girls articulated to some degree that they felt that there did exist a natural ability in some people to do well at science. Some of these girls had answered in the opposite manner when they were asked directly if they believed that people could have a natural ability to do well in science, but then in other questions around success they indicated that such an innate ability might be possible. It is not clear why they changed their minds, but I do think that it may have to do with their desire to disagree with clearly decisive statements that leave no room for interpretation.

Gender

The issue of gender and the girls' perception on how gender related to success in science was one that I was keen to gain a better understanding of. When asked about gender and success the girls were ambivalent, they said one thing when asked directly about their personal beliefs but then many of them indicated that opposite sentiment when asked questions that were more indirectly related. The question I posed was

whether or not they believed that males and females had equal abilities in science and in their potential to be successful at it. All of the girls said that they felt that both males and females could be good at science at that the gender had no bearing on predicting one's success.

I cannot explain their ambivalence but I suspect it may be due to an immediate and strong negative response to my question, which is that when asked if males are better than females at science, being girls they would naturally be against a sweeping statement that did not favour girls. To explain their indirect inclination to believe that males are better at science than females, I came to the conclusion that it may have to do with their personal learning experiences and the experiences of those close to them compared to what they see happening in general with the larger classroom population.

When asked about society's perceptions of the ability of men and women to participate in science related education programs or jobs all 8 of the girls gave the same response. They felt that society had progressed in its thinking and ideas and the way it perceived the contribution of men and women in more technical fields, such as science and engineering related jobs. However they all felt that society still had some way to go to get to a point where it viewed the contribution of men and women in these areas as equal. When asked what they had formed this opinion on they all spoke of the media, more specifically and in every case, they referred to television.

When asked about television they all had the same response. They said that they commonly saw women in portrayals of positions that involved helping and taking care of people, and in roles where they were acting in a supportive manner to men that were in positions of authority.

They felt that the men were most often portrayed as the people being in charge and doing the technical jobs. They made the decisions and were the leaders, they were often the surgeons or the head scientist or the person in the highest administrative roles in hospitals or larger corporations. If the girls feel they are unsuccessful at science and perceive their own female friends or even other females in the class in the same manner, and if they see the boys in general being more successful in what they are learning, they may be more inclined to feel that perhaps boys may be better at science. They may not be in a position to know, in any detail the personal experiences of the boys in their class that are not doing well. Of the students that are doing well, male and female, the boys may simply express their knowledge better. The boys just might be more confident and louder and more likely to participate in discussions or activities that allow them to be the attention of the class.

Self-Efficacy

Whether the girls felt that people could have a natural ability or not in their potential to be successful at science, the group in general had a similar understanding of what they believe to be the characteristics, skills, and abilities that people that are successful at science might possess.

As certain topics of science overlap with mathematics it is no surprise that the girls felt that people that do well in science both enjoy math and are good at it. They also felt that being able to memorize and recall things easily was a necessary skill for those that excelled at science.

Problem solving skills was a common answer among the members of the group, they felt that one had to be good at solving problems to be good at science. Their

perception of problem solving went beyond that however, they also felt that one had to not only be good at tackling problems but that they enjoyed it and they enjoyed being given the opportunity to solve a question and construct their own understanding. They believed that people that were good at science liked investigating and doing hands on activities, and that they were good at working with minimal guidance or instruction. They felt that what set these people apart and allowed them to excel in this area is because they could visualize the problem or task at hand and they could see it and break it down into the smaller pieces necessary to start resolving it.

Teacher

This was another area that I was very keen on gaining the students' perceptions. Across the group the girls felt that teachers do not treat students that are doing well in their class any differently, in an academic respect, than they treat students that are not doing as well. They felt that all students usually are treated fairly and receive the attention and help that they need regardless of their level of success in the course.

Approximately half of the group's members did however comment the nature of the interactions that take place between students and teachers. In academically related interactions, or interactions that were directly involved with course work, the teachers gave their help wherever it was needed. However when it came to interactions that were not directly related to the course work and one's success in the course, the sub-group of girls indicated that they felt that teacher's interacted more with the students that were doing well in their course.

The girls felt that the amount of time spent interacting as well as the nature of the interactions between students and the teacher was different, and was related to whether or

not one was doing well in that course. It was suggested that teachers may have more in depth science interactions with the students that are doing well in their course compared to those that are not, the reasoning for this was simple and makes sense. They felt that those students and the teacher might have more in common, like an appreciation of science, so they had more to talk about. It was suggested that if someone is doing well and they seemed to enjoy science that the teacher might discuss more science related things, extensions to the course, with that student to further encourage their interest, to introduce them to potential areas of study or work for their future. They also felt that it only made sense that if someone understood what was being taught in the course and they were doing well that they just might finish their work sooner than others, allowing them free time with which they may interact with the teacher, in this case on a more personal or social level.

Difficulty

Difficulty, as a theme, did not prove to be significant. A majority of the girls, regardless of which group they belonged to, expressed a belief that science was a difficult subject to learn and be successful at, as compared to other subject areas that they studied. The girls in the group that had chosen to cease their studies in science, expressed this belief more as a group, than the girls who had chosen science as an elective area of study. It had been my expectation that what the girls express might show a correlation between their perceptions of how difficult science was and their interest in it, so if they perceived learning science to be a difficult task then that might affect how they gauged their interest

in the subject. However, in some instances, even the girls that expressed an interest in science still often perceived it as being a difficult subject.

In the both groups of girls, when asked whether they felt that only "smart" people do well in science, approximately half of each group disagreed with the statement. This indicates that they may feel that one does not have to be limited by their intelligence and previous success, but that learning science and being successful is a skill that one can improve their ability at. The girls not studying science had more than half of the group expressing the belief that learning science is confusing, while in the girls studying science there was no general consensus within the group.

Difficulty as an influence on the girls' decisions whether or not to continue their studies in science, was hard to assess. One's definition and assessment of what is "difficult" is very personal and subjective, it varies greatly from person to person based on their knowledge, skills, and experiences. Difficulty in a particular subject area will be influenced by one's previous success or (lack of) in that subject, this can be closely tied to self-efficacy as one's perception of their ability to achieve success in that subject area may influence how difficult they perceive it to be. Also, people may assess something as being difficult initially when presented with a novel idea. An unfamiliar concept or idea at first may seem difficult or confusing, but upon closer inspection and after the application of time and effort to familiarize one's self with the topic at hand, the concept or idea may not appear to be as difficult or confusing as it was initially perceived.

Chapter 6 – Conclusion

Problem Revisited

The purpose of this research was to examine girls' perceptions of the school related factors that had an impact on whether or not girls chose to continue or cease their studies in science, once it was no longer a compulsory credit. It was my perception that overall, once science becomes an elective course in secondary school that more boys continue on with their studies in science while more girls choose to cease their studies in science. I also held the belief that if girls did choose to study senior science that they were more inclined to take biology, while boys were more likely to take chemistry or physics. It was my aim to gain a better understanding of this situation, and if my perceptions were true, then what were the causes for these differences in the paths of study between boys and girls.

Context of Study

The study comprised of two stages, a survey for all participants and an interview for selected participants. All girls in the grade 12 year at a Southwestern Ontario secondary school were given the opportunity to fill out a survey on their school experiences and their feelings as they pertained to learning science. The entire group of girls completed a survey in which they were asked to evaluate twenty statements using a five point Lickert scale. The twenty statements were organized into six themes, as identified from the literature review, based on their similarities; the six themes were importance, interest, teacher, difficulty, gender, and self-efficacy.

Importance was expressed as whether or not the girls felt that science and scientific knowledge were useful and essential in their own lives and in the world in general. Interest included whether or not the girls felt in engaged in the science they were learning and whether or not they enjoyed learning science and had fun doing it. The role of the teacher involved the impact that previous science teachers had on the choices that the girls made pertaining to their course selection, as well as how the girls felt their teachers perceived their abilities at being successful in learning science. Difficulty was addressed in order to determine whether or not girls chose to study or avoid science courses because of a perception that those courses are challenging to learn and be successful at. Gender was a factor of great interest to me, I was curious to discover whether or not the girls felt that the ability to learn science and be successful at it was related to one's gender. Self-efficacy was investigated because I was interested in knowing whether or not the girls felt that some individuals have a natural ability at learning and being successful in science, and whether they themselves identified with being a part of that group.

Based on the survey responses (responses indicating negative experiences in learning science or negative feelings and ideas towards the subject of science), 8 girls were chosen for the interview phase of the study. Responses for each interview question were compared, looking for common themes or reasons as to why the girls made the decisions (about continuing their studies in science) that they did and why they held the beliefs about learning science that they did.

Summary of Interview Findings

From the surveys and interviews completed I had expected to come up with a set of factors related to their science schooling experience that influenced the girls' decisions on whether or not they chose to continue their studies in science. I did establish a list of factors but found that they were not strongly related to the girls' learning experiences in their previous science courses. Even more, of the themes established only three of the six proved to actually be statistically significant enough to have an impact on the decisions that the girls made on whether or not to further study science as an elective course.

I expected that all the themes that I had identified from the literature would prove to be significant factors on impacting the decisions that the girls made about studying science. Of those themes, **importance**, **interest**, and **self-efficacy** were found to be statistically significant factors that were influential in the course selections that the girls made pertaining to science. The themes **teacher**, **gender,** and **difficulty** were shown to not be significantly important factors that influenced whether or not the girls continued their studies in science.

It is interesting to note one aspect that came out of the interviews. Aside from the importance that the girls placed on science, their interest in the subject, and their beliefs on how successful they themselves could be in science, influential people in the girls' lives tried to play a role in the decisions the girls made on whether or not they should continue their studies in science. Just as previous science teachers did not have a substantial impact on the girls' decisions, guidance counsellors, parents, and even older siblings who did try to influence the girls' decisions to study more science were also not very effective in most cases.

When asked about the ultimate decision as to whether to study science or not, all 8 of the girls said it had been their decision and the final choice had been left up to them, however 5 of the 8 girls did have some familial influence in that at least one person in their immediate family had the preference that they continue studying science. Of the girls that had some input from influential people in their lives, most of them chose not to take the advice of their family members:

> No. I chose my courses myself, no one helped me. My mom wanted me to take more science but I wasn't good at it. Mostly it was my decision what course I took. ***Student 1***

> I have three older brothers and sisters and all but one of them are in science so they all told me I had to take science. I took biology, but for the French credit (student is enrolled in a French immersion program) not for the biology, science is not my kind of thing but it's theirs so I've dealt with that kind of influence. They wanted me to take more science because they're really interested in it, they really tried to get me to like it. ***Student 3***

> Mostly it was my choice. My parents would have liked me to take more science, my older brother did and is now doing that at university, but I'm not as good at it as he was. They tried to make me but I didn't like it much and wasn't good at it so they gave up on that. ***Student 7***

> It was my decision what courses I took. My dad wanted me to take math and science courses but I'm not a fan of those. I'm not interested in them and I don't do well in them. ***Student 8***

Regardless of what influence various people tried to have, the girls for the most part based their decisions to cease or continue their studies in science, on their own beliefs and experiences. It seems that most families tried to have some input, even if the girls did not listen, though 3 of the 8 girls identified no one who tried to sway their choices towards studying science. Student 6 was not interested in study science and she felt as if her mother understood and supported that decision, "It was my decision what I wanted to take. My mom didn't mind that I didn't want to do more science because she never liked it either and understands it's hard."

Guidance counsellors played opposite roles in the cases of two of the girls, which is to be expected, if they are giving the best advice based on the girls' interests and abilities. Student 6 who was not interested in science and had not been particularly successful in previous science courses was advised by her counsellor against any further studies in the area, "My counsellor suggested that I focus my attention on courses that I could do well in and that I had an interest in, that was not science, so they never really tried to tell me to take those." Student 2 was advised by her counsellor to take more science courses, but based her decision to not take them on other things, however later she had to take all the sciences (biology, chemistry, and physics) as she changed her post-

secondary plans and required the senior science courses in order to be admitted into her new programs of choice.

> I talked to my guidance counsellor about it a lot when choosing my grade 11 courses and he thought it was a good idea (to continue taking science courses) too. If I had an older friend or an older sibling that took the courses and that person found it difficult, since I'm not really strong in science, that would affect my decision. I went back and changed my mind when I changed my plan for what I wanted to do after high school so I had to take more sciences. I had to take all the sciences for my new choices, but I ended up dropping physics because I didn't think it was going to be an easy course for me, the math and the calculations. ***Student 8***

It is interesting to see the role that the guidance counsellors played in the girls' decisions, and it seems that a guidance counsellor may have more of an impact on the decisions that the girls make. Perhaps students are more open to taking the advice of their guidance counsellors than their family members because they may feel that a counsellor is in a better position to help them make that decision. Guidance counsellors do not have the same personal biases that parents may have when it comes to what their kids study, as well they may be more in tune to the trends in the workplace and post-secondary education requirements and opportunities. Regardless of what influence was imparted to the girls, it is clear that they were the ones that made the ultimate decision on what to

study, and those decisions were based more on their beliefs, experiences, and desires than the influence of the people around them.

Discussion of Significant Themes (Importance, Interest, and Self-Efficacy)

Interest

Interest was the theme that had the greatest division between the two groups of girls, when asked to evaluate the statement **The science being taught in the classroom is interesting**, the two groups of girls disagreed. As a group, the girls not choosing science did not find science interesting while approximately half the girls choosing science did (see Table 4.6). For the statement **I find science interesting**, there was disagreement between the two groups of girls. The girls not choosing science had their responses spread across all level of the rating scale while the majority of the girls choosing science agreed that they found science interesting (see Table 4.7). For the final statement pertaining to interest, **I enjoyed learning science**, there again was disagreement between the two groups of girls. The girls not choosing to study more science had their responses spread across all levels of the scale, with no real consensus, while the girls choosing to further study science had over half of the group agreeing with the statement (see Table 4.8).

Some of the girls suggested that they were not interested in science because many of the topics that they were required to learn about they found boring and therefore could not see the potential connections to their lives, so they did not see the value in continuing their studies in that area. Other students never had an interest in science so it is easy to understand why they did not ever consider studying science as an elective course, but not

all of them were able to articulate why they did not like science while others could. Student 4 expressed having no interest in science, but she can explain her feelings, "Because my teacher in elementary school was bad and really boring, and we didn't really do much science. When I got to high school it was too late." Student 3 also never liked science but cannot explain why that is:

> I strongly dislike science. I'm not sure what happened and why I didn't like it, I've never liked it. I remember in public school and grade nine and ten, I never really enjoyed science class and I was never really interested in it.

For many of the girls the effort they put into learning science often correlated to their level of interest, for some it was the deterrent that kept them from further studying science and for others it was the reason why they perhaps were not as successful as they could have been. Student 8 had not experienced much success with science in the past and used that experience to make decisions about her future, "My counsellor suggest that I focus my attention on courses that I could do well in and that I had an interest in, that was not science so they never really tried to tell me to take those." Student 3 appreciates that because she was not very interested in science she did not have the drive to put in the extra effort and time that may have helped her be more successful in science, "Not at all, because I was never really interested so I never really had that extra push to go and do extra studying and extra research and everything so I never really achieved success in science." Student 5 actually expressed an enjoyment of learning science but at a very

superficial level, the basic topics and ideas, but she was not at all interested in putting in the necessary effort in order to gain a comprehensive understanding of the principles behind the ideas:

> I enjoyed them but I didn't like doing the work. The concept, to learn was interesting, but after that actually doing the work or figuring it out, I didn't want to do that. It was interesting to learn but I didn't want to put in the time.

Importance

Importance was a theme that the two groups of girls, in general, agreed upon. When asked about the statement **Science is an important aspect in our lives and the world**, the groups of girls were in agreement. In the girls not choosing to study science more than half agreed with the statement, while the majority of the girls choosing to study science agreed with the statement (see Table 4.1). When asked to rate **Understanding science can make life easier**, there was disagreement between the two groups of girls. In the girls not choosing science less than half of the girls agreed with the statement, while the majority of the girls choosing science agreed with the statement (see Table 4.2). There was a general consensus between the two groups of girls towards the statement **Everyone should have some understanding of the science around them**. The majority of both groups of girls were in agreement with the statement (see Table 4.3). When asked if **The science being taught in the classroom is useful**, there was disagreement between the two groups of girls. In the girls not choosing further science

studies less than half of the girls agreed with the statement, while in the girls choosing to study science over half of the girls agreed with the statement (see Table 4.4). In the last statement addressing importance, **I find science useful**, there was a general agreement between the two groups of girls. In the girls not choosing science over half of the girls agreed with the statement, while in the girls choosing science the majority of the girls were in agreement with the statement.

It is understandable that students who clearly do not see themselves working or studying in a specific area or field in their post-secondary future may choose not to study that subject area in secondary school. It makes sense to focus one's attention and effort on the things that will be important and useful in one's future, as well as on things that are of interest. Of the girls that did not choose to continue studying science, there was a general consensus that the topics studied in the mandatory grade nine and ten science courses were not only uninteresting but also that they lacked significance to the daily lives and futures of the girls. Student 6 expressed this feeling, "Some of the time, they were interesting some of the stuff we learned but some was really boring too. Some of the topics we learned were not interesting and were not useful to my life and I'd never need to know them." Student 7 expressed a similar viewpoint, making the point that for her interest, success, and usefulness (of the subject) in one's life are all linked:

> At first I was interested in science but since I wasn't doing so well in those courses my interest kind of went away I guess. Also some of the stuff is interesting and useful and pertains to our lives but at least half of it doesn't, so I really wasn't interested in some of the topics we had to learn.

Self-efficacy

Self-efficacy was the third theme that was found to be significant, in the two statements that addressed this theme the girls agreed for one of them but disagreed for the other. When asked to evaluate the statement **Some people are just not good at science**, there was a consensus between the two groups of girls. In the girls not choosing science the majority of the girls agreed with the statement, while in the girls choosing science over half of the girls agreed with the statement (see Table 4.19). When asked about their own abilities in science, **I am not a science person**, there was disagreement between the two groups of girls. The girls not choosing science generally agreed with the statement with a majority of the girls agreeing, while in the girls choosing science only a minority of the girls agreed with the statement (see Table 4.20).

The girls that did not continue their studies in science were more likely to feel that people may possess some natural ability that makes them better suited to learning and being successful at science. Student 6 clearly expressed this belief that some people are just good at science (or mathematics):

> Yes I think that some people have some more natural abilities in science or math and so it is easier for them to learn and do well in. I'm not sure why they are, maybe they were born that way or maybe they were encouraged more in those areas when they were younger or had more of an interest in it.

Student 7 shares a similar sentiment when it comes to some people possessing a natural ability in science, but she also appreciates that with hard work that others that may not possess this natural ability (or so much of it) can be successful as well:

> Yes I think so. Some people do well in science because they work really hard but others do well in science with not a lot of effort. They just seem to understand science better, it must be something in how they think or how their minds work.

It is interesting that both of the girls clearly feel that some people can possess a natural ability in science, but they do not have any clear understanding or explanation of why this is, with both of them giving different possible reasons.

Girls and boys are placed in the same learning environments, albeit they may get very different experiences from that environment. Research shows that in mandated tests in some states in the USA, girls and boys are performing at the same level in science and mathematics during their elementary and secondary schooling years (Hyde & Mertz, 2009). However, when they make decisions about their careers girls do not stay on the same path as boys, choosing less often to pursue careers in science and mathematics (Huebner, 2009).

During adolescence girls become interested in boys and being attractive to boys and can take on more feminine roles that often exclude science (Brickhouse et al., 2000). It is at this point that many girls may come to the belief that boys do not like smart, aggressive or competitive girls. It is very possible that girls who are very capable in

science and mathematics may mask their abilities in order that they may not look too smart in those areas, potentially making them more attractive to boys. These girls often fail to investigate, and therefore ignore, their abilities fully in the areas of science while they still possess them, these same girls become women who cannot and do not engage in science (Britner, 2008).

Discussion of Non-significant Themes (Teacher, Difficulty, Gender)

Teacher

Surprisingly the teacher, as an influence on the girls' choice to cease or continue their studies in science, was not found to be a significant factor. While the majority of the girls agreed with the statement **A good teacher can make learning science more fun** (see Table 4.10), when given the statement **If I had different teachers I may have enjoyed learning science more** only a minority of the girls agreed with that statement (see Table 4.13). When asked to address **My teachers had an impact on my no longer choosing to study science**, most of the girls disagreed with the statement (see Table 4.9). Similarly, when it was phrased in a different manner and the girls were presented with the statement **If I had different teachers I may have continued my study of science**, most of the girls again disagreed with the statement (see Table 4.11).

Overall, for the previous statements discussed, there was a general consensus across the girls in both groups (those choosing to continue studying science and those that did not). So even though the teacher may have an effect on the learning environment and how much girls may or may not enjoy learning science, in the end it seems that the girls' experiences with their teachers had little or no impact on their decisions to further study science. These findings are not in agreement with some of the literature reviewed, where

it was found that the teacher's treatment of girls in the science classroom can affect the chance at being successful.

The literature examined suggests that teachers may call on girls less frequently and when they do, they ask girls lower level questions (Brickhouse et al., 2000; Martin & Newcomer, 2002)). Student 6's interview response indicates that even though she does not feel that overall teachers treat boys and girls differently in the science classroom, students do still pick up on certain trends in the classroom:

> In some science classes though if boys are really smart and understand what we are learning then the teacher might let them answer more questions because they know that they are going to be right. We are all taught the same material and if boys or girls need more help teachers are usually willing to provide it.

When the girls were asked about whether they felt that teachers treated the "smarter" and more successful students differently than those who were not as successful, the general consensus was that teachers did not necessarily treat successful students better in terms of teaching and learning course material but that they might interact with them more (on a personal level) and the girls seemed to have constructed their own understanding of why that was:

> Sometimes. But not that much differently. They may ask smarter students more questions because they know they will have the answer or they may

discuss something with them more because the students might be more interested than the ones that aren't doing so well. Sometimes they talk to them more because the smarter students will ask more questions than the students that aren't doing well or that don't care about science or don't like it. ***Student 2***

Mostly I think that teachers treat male and female students the same, sometimes a little different though. Sometimes they ask boys more questions in class and talk to them more, and some will ask the smarter kinds (sometimes boys) to answer more questions than the kids that aren't doing well. ***Student 1***

Not really I don't think. Most teachers are fair. They may interact with some students that do well more than others but maybe that is because they understand what they are learning and they get their work done sooner, so they have time to be more social. Also the smarter students probably have similar interests as the teachers, that is why they like science. ***Student 8***

Not usually or most of the time. They may interact more with students that have a greater interest in science than those who do not because they know they enjoy it. Teaching the course material though, they tend to treat everyone about the same and are willing to help. But I think they may like

> the smarter students more because they talk to them more outside of the classroom and talk to them more about even things that aren't science related. ***Student 6***

In trying to determine what causes women to not pursue careers in science and technology, it was found that the educational system and process was indeed a factor influencing the career choices that girls made (Sander, 2005). Teachers were also found to give boys more praise and more criticism (Drudy & Chathain, 2002), and they tended to follow up more with the responses from boys (Martin & Newcomer, 2002).

From their differential treatment and experiences, girls adopt different ideas towards science and have much different participation levels than their male counterparts. Biases between female students and teachers (both male and female) in their classroom interactions as well as in scientific investigations do exist (She, 1999; Kahle & Meece, 1994; Martin & Newcomer, 2002), indicating that the practice is so ingrained in us that teachers are not aware that they are doing it. When it came to seeking help from teachers, at times teachers would help the girls by completing the tasks for them whereas with the boys, they would explain the underlying concepts to the boys and expect the boys to complete the task themselves (Sadker & Sadker, 1994).

The last statement concerning the teacher as an influence was the only time that the two groups of girls disagreed (in the discussion around the theme of the teacher). When asked to evaluate the statement **In past science courses, the teachers thought I was a capable student,** there was approximately an equal number of the girls in the group that did not choose to continue studying science disagreeing with the statement as

those agreeing, while a majority of the girls in the group that did choose to continue studying science agreed with the statement (see Table 4.12).

It is interesting that in the girls who did not continue their studies in science there was no group consensus, approximately an equal number of girls felt that their teachers did not see them as being capable in science as compared to those that felt that their teachers did perceive them as being capable. In the girls that did continue studying science, as a group the majority felt that their teachers did see them as capable at achieving success in science. In the discussion surrounding the role of the teacher, this is the point where the two groups of girls disagreed.

Though both groups of girls felt that a good teacher can make learning science more fun they did not necessarily accredit having different teachers with themselves enjoying learning science more, so though they see and appreciate the potential in different teachers and teaching styles, they do not believe that they would have had a different learning experience had they had different science teachers.

Therefore the role of the teacher is not a very influential one when it comes to the choices that the girls went on to make, regardless of their survey responses. This lack of teacher impact (on the girls' decisions) is further emphasized by the fact that both groups were in agreement, their teachers did not have an impact on their decision to no longer study science and that having different teachers also would not have caused them to continue studying science. Can it be assumed then that these girls came into secondary school with experiences and beliefs about studying science, that then drove them to make the decisions that they about future studies in science?

The findings suggest that only that the secondary school science teachers did not have a significant impact upon the girls' decisions about studying science, but we cannot assume that all previous teachers that taught them science did not have an influence. In this study I did not address the influence the elementary teachers may have had on the girls' learning and ideas about science. Recall Student 4's comment on why she was not interested in science and ceased her studies in it, "Because my teacher in elementary school was bad and really boring, and we didn't really do much science. When I got to high school it was too late."

The role and impact of the girls' previous elementary science teachers was outside the scope of this study and would be far too difficult to gauge, as a high school population is comprised of students from many different elementary feeder schools, as well as students from outside the feeder schools, and even students outside of that specific school board, which would give a very large number of teachers teaching elementary science (some of whom do not have a science background). Interestingly, it was found that in Hawaii girls are equally engaged in the use of scientific equipment as the boys (Greenfield, 1997), in a school district where students participate in hands on scientific experiments in elementary school and therefore develop and interest and proficiency for doing science at a young age.

The theme of difficulty was also not found to be statistically significant in the girls' decisions about studying science. I was also surprised by this finding, as I assumed that not only interest but also the perceived difficulty of a subject (and therefore the perceived effort necessary in order to achieve success) would be key in choices that students make about the courses that they choose to enroll in.

Across both groups of girls there was a general consensus that **Science is a hard subject** in which to succeed, in comparison to other subject areas (see Table 4.14). When asked to address **Science is a confusing subject**, there was disagreement between the two groups. In the girls that chose not to study science, over half the girls agreed with the statement while in the girls that chose to study science, there was no real consensus with a split occurring across the five levels of the scale and with approximately half the girls neither truly agreeing or disagreeing (see Table 4.16). When asked to rate **Only smart people do well in science**, approximately half of each group of the girls disagreed with the statement with the other half being spread across the remaining levels of the scale (see Table 4.15).

Difficulty of science, in terms of learning it, is really hard to truly assess on its own. Similar to interest in science being related often with one's effort in science or one's perception of its applicability to real life, difficulty can be linked to one's level of interest and also to perception to one's self-efficacy. Difficulty is hard to measure as everyone's idea of what difficult means is different. I also believe that sometimes people can confuse difficulty with being uncomfortable or being exposed to something new, just because there is something unfamiliar and one may feel uneasy at first with what they are being presented (novel ideas) with, that does not mean that it is difficult and perhaps a little time and effort invested would remove some of the discomfort or apprehension. Student 8 expresses this very well:

> No I've never liked science. I don't know why exactly I just remember it being hard when we had to do it all the time. I don't think I learned much

> science when I was in elementary school and so I wasn't very interested in it when I got to high school and had to do it every day. I found it difficult and boring.

So while both groups of girls agree that science is hard (and therefore requires a lot of effort) to be successful at science, since the girls did not agree on science being a confusing subject to learn, then there must be (according to the girls) other factors that the girls attribute to making science a challenging subject to achieve success in. In support of that, when asked if only smart people do well in science, a fair portion of both groups of girls disagreed, again reinforcing that (in their belief) it isn't just one's ability to learn science that determines success but that there must be other factors that come into play.

Gender, though technically found to be statistically not significant on the girls' decisions about learning science, came close to being significant. When asked about the statement **Most girls are not good at science**, there was a very strong consensus between the two groups of girls, with the majority of both groups disagreeing with the statement (see Table 4.17). And when asked to evaluate the statement **Boys are naturally better at science**, again there was a very strong consensus between the two groups of girls, with the majority of both groups disagreeing with that statement as well (see Table 4.18). Clearly the girls did not feel that one's gender had any effect on one's ability to achieve success in science:

> I think that boys and girls can both do well in science. It has to do with the person and their interests and how much work they are willing to do. So boys and girls can be equally good at science. ***Student 1***

> It's not that they (boys) are naturally smarter, some people are better at it (science), if they enjoyed the subject then they excel at it, some people just understand it. If they enjoy it they would try harder... ***Student 2***

> I don't think so, X (another student) is a genius at science and she's a girl, so I think that there is an equal balance there. It's not a matter of being better at it because they're guys. ***Student 3***

If girls do not see gender as an issue to one's success in being successful at science then what is responsible for the discrepancies? In standardized tests in the USA the differences in achievement between girls and boys was insignificant (Hyde & Mertz, 2009). However, having similar levels of achievement as their male counterparts in elementary and secondary school did not follow girls into their careers, they were not choosing careers in mathematics and science as much as they boys were (Huebner, 2009). Since recent research has all but dismissed the idea that an innate ability between the sexes exists when it comes to learning mathematics and science (Huebner, 2009), it may be that historical practices in the traditional instruction of science may create and support a bias that excludes girls (Carlone, 2001; Eisenhart & Finkel, 1998).

Girls tend to work well in groups and in a more cooperative manner than boys (Hammerich et al., 2000), studies have shown that girls enjoy learning science in social settings where they can interact with others as opposed to doing tasks where they work independently such a reading, writing, or taking notes (Baker & Leary, 2006). At the same time, working in small groups does not necessarily alleviate all concerns, girls still may be restricted in their ability and the opportunities for them to participate. When working in smaller groups, stronger (often the more aggressive male students) students may take on a leadership role and lead the activity, leaving the girls to play a supporting role such as a scribe (Brickhouse et al., 2000).

These social roles and gender cues do not only exist in the classroom, but follow the girls from their personal lives and experiences outside of school. A number of writers suggest that girls are at a disadvantage in science before they even begin school, because they are given toys like dolls (and tea sets and make up) as opposed to blocks and other creative toys. Perhaps it is not done consciously but it seems that parents and society encourage and support the nurturing side of girls at a young age, much more than they encourage and support their curiosity and a desire to investigate and create, while boys are encouraged to be independent, assertive, and in charge. In a study of computer and video games it was found that only 17% of games have female characters and of these games, 50% of the women do not participate actively but instead are props having high pitched voices, tended to faint, and were highly sexualized (Children now, 2001). Even in their own homes, girls are less likely to help their fathers while they fix things around the house while boys are given more opportunities to do that. Research shows also that girls

are not given chemistry sets or microscopes by their parents as often as boys, and girls are not taken camping as much (Baker & Leary, 2003).

In schools we are not helping to make the situation any easier. One might expect that resources used in the science classroom, resources that we expect girls to consult and refer to in order to complete the required work or for clarification on topics they might find confusing or difficult, would be free of gender biases but that is not the case. New resources still possess messages or images that may have an impact on the abilities and perceptions of the students using them (Whitely, 1996; Elgar, 2004). Both Whitley (1996) and Elgar (2004) identified science textbooks, from Jamaica and Brunei, with strong male biases and gender stereotypes. Interestingly though, it was found that students in Brunei generally had the perception of gender equity in their classroom environments while American students had a perception of gender inequality (Guzzetti & Williams, 1996). Girls from affluent schools in the Southwestern states seemed to be especially aware of gender biases and inequitable classroom situations in their textbooks and other resources (Guzzetti & Williams, 1996).

Implications of Findings

The purpose of my research was to determine the factors that affected young girls and their desire or lack of, to further pursue their studies in science. I was interested in learning what factors influenced their decisions so that we, at the high school level, could take the necessary steps to either further encourage their interests in science or to counteract the factors that have caused them to choose to cease their studies in science.

From the findings of my research I have come up with the following recommendations on what can be done at the school level to counteract the ideas that some young girls have about science and learning science:

1. Encourage and support elementary school science programs so that girls can gain more exposure to science at an earlier age, as well as addressing teaching methods so that they may better engage young girls (relate to their interests) and illustrate the importance of understanding science in everyday life.

2. Address how teaching and learning occurs in secondary school science classrooms (acknowledging socio-cultural obstacles), providing girls with more opportunity to participate in and enjoy learning science. Tailoring teaching methods so that they appeal more to girls (and their interests) and engages them better allowing them to use their strengths, and illustrating the usefulness and applicability of science to everyday lives and careers/professions.

3. Provide the opportunity for young girls to see and appreciate more female role models in the areas of science and technology, so that they may better relate to who they are learning from and to see parallels between themselves and those successful women.

4. Provide more support for elementary science teachers (who may not be a science specialist or even have a science degree), so that they have more support and access to the necessary resources in order to become more

knowledgeable in their understanding of science and to feel more comfortable in their abilities to teach of science.

Based on my findings from the survey, and more importantly from what the girls who were interviewed expressed, I believe that exposing girls to learning and doing more science at an earlier age would help to increase their interest greatly. In their interviews many of the girls reported not learning a lot of science during their elementary schooling years, and doing even less in the way of actual scientific investigation or experimentation. As a result, doing science every day in secondary school can be overwhelming and the girls may lack confidence in their abilities, which may make them feel uncomfortable and more likely to avoid science when it becomes an elective subject.

If science was not their subject of study some elementary teachers may not feel entirely comfortable in teaching science even though they have been given the task of doing so. As a result their students may get little or no exposure to learning science and even less opportunity to participate in the fun and meaningful investigations that can make learning science interesting. From my own discussions with my colleagues I have come to understand that some elementary schools are not even properly equipped with the necessary equipment to provide students with the valuable learning opportunities that scientific experimentation can provide. If they have a familiarity with learning and doing science then they may not be quite so unsure when something new comes along that they haven't seen before.

Students get to high school and are expected to learn and do science for seventy-five minutes a day, every day of the week, for five months. If a student has had little experience learning science, making them do it for so long a period or much more

frequently than they are used to can seem very overwhelming. If they are overwhelmed and feel like they are already behind from the very beginning then they may be more likely to write off science completely because it already seems too challenging for them.

Based on the interviewee responses, focusing more on the interests of girls can also help to keep them interested in science longer. Many of the girls in their interviews indicated that much of the science they were made to learn was not important to them or their lives and they could not see how they would ever use it. Indeed a lot of the science curriculum may not be readily applicable to the lives of many students and even less so that they have to intention ever to do anything scientifically inclined or related, instead the focus seems to be to introduce bits and pieces of science so that we introduce various topics and subject areas to those who may actually consider going on to learn or work in science.

We need to better tap into girls interests so that we may present the science that they have to learn in such a way that it appeals more to them and their lives and so that it is more relevant to their interests and needs. We need to be able to make science more of a subject that they relate to. We can do this by allowing them to see how they themselves can do science or may need it in some aspect of their own lives or how some future aspect could use science. We can also achieve this goal by exposing them more to the usefulness of science in people's lives in general or how much the world relies on scientific knowledge and discovery.

Many of the girls indicated that the media still often presents women in supporting roles when it comes to STEM roles, providing more and better role models for young women hopefully it provides them with more of an appreciation of the impact that

women have had on science and technology. Also they can see people in front of them, women that they can relate to and may have more in common with than many of the usual male scientists that they are used to hearing about. We need to break down any stereotypes that young women have of scientists and what doing science is all about.

As some elementary "science" teachers may not even have a degree in science, providing them with the necessary resources and support so that they may feel better prepared and more confident in their abilities, is beneficial both to the teachers and their students. If these teachers themselves have a higher self-efficacy when it comes to their knowledge and skills in science, they may be more willing (and able) to expose their students to learning and doing more science, which may allow students to develop more confidence in their abilities and also possibly spark their interest in science the more they are exposed to it.

Future Research

One finding that surprised me was the lack of influence that the classroom teachers had on the girls' choices to continue their studies in science. Both groups of girls expressed that even if they had had different science teachers that would not have an impact on their choosing to study more science once it became an elective subject, suggesting that them having potentially different learning experiences in the classroom would not have been the basis for their choices. When phrased differently, to ask whether the teachers they did have had an impact on them no longer choosing to study science, both groups of girls disagreed quite strongly with the statement. Again, this indicates that it was not the girls' learning experiences in the classroom that affected their decisions when it came to making decisions about their future studies in science.

If the learning experiences of the girls in their secondary school science classes and the effect of their teachers, do not have a significant impact on the decisions that the girls made, then it might be important to determine (if possible) what ideas and influences did impact the girls' decisions. A similar study to this one, done at the elementary school level, might reveal some valuable information. It might prove valuable to do a similar study before students start studying science regularly, to ascertain what their perceptions and beliefs towards science and their own abilities are. A follow up to that research might be to do a similar study in the upper elementary years to see how the students' perceptions and beliefs towards science and their own abilities may have changed, to determine whether their science classroom experiences have any impact on their beliefs and perceptions.

Previous research has indicated that in elementary school, Canadian students are performing above international averages in standardized math and science tests given in grades 4 and 8 (Statistics Canada, 2001). This same study found that even though students are still performing above international averages, their performance in both math and science dropped between grades 4 and 8, with the most marked decline being in science. Research needs to be done so that educators can gain a better understanding of why students are losing interest in math and science between grades 4 and 8, causing their performance to decrease during those years. This research can also help to determine what steps need to be takes to reverse this trend, so that students do not lose an interest in science and math (so that they may continue to pursue these subjects, and be successful), and especially to help determine why young women (despite their abilities in

science and math) move away from studying science in their secondary and post-secondary years.

Final Thoughts

At the start of my research I anticipated that I would find a common set of themes, related to the girls' experiences in the science classroom environment that impacted upon their decision. I have come to the conclusion that this is a much more complex issue than I had first anticipated, there are many factors that influence girls as to whether they should continue their studies in science once it becomes an elective course, and many of those factors do not have anything to do with their experiences in the science classroom.

Every girl has a different experience when it comes to her understanding of and appreciation for science, her previous learning experiences, her attitude and beliefs, and the way that she perceives and accepts cues from society, the media, and people in her own life. Some girls may have a natural inclination towards being interested in science, they may have family or friends or other influential people in their lives that impart onto them support and appreciation for science.

We must acknowledge that each girl has different life and learning experiences and that their backgrounds will include varying degrees of exposure to science in school and the world, different levels of experience in participating in science related activities, and different perceptions of their abilities in science. The task then becomes to level the playing field in such a way, that regardless of their past experiences, science educators may be able to have an opportunity to still get secondary schools girls interested in

science and possibly even to “hook” them to develop more than just a basic interest and understanding.

In secondary school students come from various “feeder” schools within the school district. Girls are entering secondary school science programs from different elementary schools (where science learning may or may not have been actively promoted) and coming from different classroom teachers (each of whom have their own strengths and weaknesses, and may or may not have had post-secondary education in science). Add onto this whatever messages about science (learning, importance, difficulty, gender, self-efficacy) girls may specifically relate to and pick up from society and the media, and whatever messages about science (same as above) they may be getting from parents, siblings, or other influential people. It is no wonder that girls possess such varying degrees knowledge, interest, self-efficacy, and ability when it comes to learning and doing science.

For some girls we need to make science a subject that they can better relate to, by allowing them to see the usefulness of science in their lives and the world around them, and by presenting the science in ways that are related to their interests and strengths. We also need to provide them with more role models (science teachers, female professionals working in science fields, women working in science related jobs but not necessarily in a scientific field) that allow them to appreciate that women can (and do) great things in science, and that they do not have to trade away their personality, interests, and traditional gender traits and abilities (being feminine, “pretty”, understanding, nurturing…) in order to be successful in science. Also, we (educators, parents) need to come up with ways in which to combat the still persistent stereotypes of women in the

media (in supporting roles as assistants as opposed to being the lead researcher or doctor or engineer), so that girls can see themselves in similar roles and aim to achieve them.

A lot of work has been done on gender and learning, more so related to reading and writing. Some research has been done in the area of science achievement and gender, but a lot more still needs to be accomplished. If boys and girls are experiencing similar levels of achievement in science during elementary school, then what is happening at the secondary and post-secondary school levels that is separating the genders in achievement? Achievement levels are not the same overall between genders, and certainly girls tend to shy away from the physical sciences more than their males counterparts, both at the secondary and post-secondary school levels. This is a concern because some brilliant minds that are capable of brilliant things may never be able to realize their full potential, simply because they did not get the support and encouragement that they needed when they needed it.

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