GIRLS IN SCIENCE:

THE EFFECT ROLE MODELS HAVE ON STUDENT INTEREST

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Dedicated to:

my daughter Safiya Anne

Abstract

The central query of this study is focused around questions about increasing the numbers of girls and women in science. Surveys and focused group interviews were conducted with Grade 8 and 11 girls in two rural southern Alberta high schools to obtain an understanding of the impact they feel role models have on them with respect to an interest in science and the pursuit of a science career. While boys were also surveyed for comparison purposes, the focus of the study was girls' perceptions. Seemingly girls are just as interested in science topics as boys until they get to high school. While boys appear to continue to study science with interest, what prevents many girls from continuing to study topics they previously enjoyed? In elementary school many teachers are female but in high school a majority of science teachers are male. Does the gender of the teacher affect girls' interest in science? Extending this thought beyond the classroom: does the lack of positive visible female role models in science discourage girls' interest in science and science careers? The answers to these questions are complex.

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Chapter 1: Introduction

During my eight years of teaching middle and high school science I never consciously noticed that there may have been a disproportionate number of girls and boys interested in pursuing science as a career. As I reflect back, of the number of students graduating, it seemed that usually an almost equal number of girls and boys decided to major in science at university. I did not realize this was unusual until one of my Masters' classes raised the gender issue. A classmate (male science teacher) and I discussed this issue and his perception had been that very few girls chose to study science in high school as an elective, let alone study it in university. I wondered if girls were subconsciously discouraged from pursuing science because of a lack of female role models in science in high school and university. My research will look at girls' perception of science and try to determine if there is a relation to the gender of their teacher or other role model.

Background

At a young age, girls generally show just as much interest in science as boys but we see a sudden drop off in this interest by high school (Adamuti-Trache & Andres, 2008; Bleeker & Jacobs, 2004; Brownlow, Rogers, & Jacobi, 2000; Dee, 2006; Phillips, Barrow, & Chandrasekhar, 2002; Wood, 2000). Is it because by high school most science teachers are male (Mrazek, 2003; Mrazek & Howes, 2004) and girls have no female role models to look up to? One of my assumptions is that girls need female role models who tackle the science domain with all their feminine ability and knowledge. How can we herald the female scientists in our society to become desirable role models for our girls? Although there are female scientists, they are generally not as well known as their male counterparts such as David Suzuki or Stephen Hawking. The discoveries of the female scientists may be household names, such as Kevlar, but most people are unaware that women invented them. Perhaps the most famous female scientist was Marie Curie, who grew up in Poland and discovered Polonium and Radium. She inspired other Eastern European girls to follow their own interests in science. Do we lack a visible modern Marie Curie in Canadian and American society to inspire our girls with the difference they can make in science and the world?

Bailyn (2008) suggests that the reason Marie Curie and other female scientists were successful is because they were foreigners in the land where they worked. Their foreignness excused them from abiding by the societal norms of that country and permitted them to be successful in an otherwise traditionally male discipline. Subsequently these women were viewed as professionals instead of as women. This meant however that they were also not considered likeable or able to fit into the society in which they lived, a trend some women in science say continues still today (Bailyn, 2008; Hill, Corbett, & St. Rose, 2010). Historically some of the female scientists were eventually able to fit into the societies in which they lived by marrying but most of them did not receive recognition for their own work until after the death of or separation from their husbands. Bailyn (2008) believes that women in science careers are considered a threat to established norms:

> And so it seems as if womanhood and foreignness work together by allowing each one to excuse any transgressions of the other. But the key, it seems to me, in most of these cases, is the use of foreignness to negate womanhood. Gender, thus, is first in the hierarchy of strangeness and a

> female academic is the real transgressor. Foreigners in the academy may be strangers, but they are not strangers in the same way as women. They are not necessarily devalued, nor a threat to an established, seemingly natural social order the way that women are. And this remains true even today, where the wedge is considerably thicker. (p. 296)

Female science students in Fox, Johnson, and Rosser's (2006) study agreed with Bailyn (2008) and expressed that they feel like strangers in their field of study. Likewise the middle school girls in Brickhouse et al.'s (2000) study that showed a genuine interest in science reported being treated differently by their teachers because they were thought to violate societal gender norms; as a result these girls were also less successful with school science.

Society has created stereotypes for girls in science (Belkin, 2008; Brickhouse et al., 2000; Buck, Leslie-Pelecky, & Kirby, 2002; Hill et al., 2010; Whelan, 2001; Wood, 2000). Our North American society sees women that excel in science as less feminine, less-knowledgeable than their male counterparts (Brownlow et al., 2000; Fox et al., 2006; Gilbert, 2001), in some cases even "freaks" (Barnett & Rivers, 2004, p. 150), and much less as desirable role models (Baker & Leary, 2003). Young girls are aware that the cultural stereotypes of science and scientists are negative (Baker & Leary, 2003; Buck, Plano Clark, Leslie-Pelecky, Lu, & Cerda-Lizarraga, 2008; Goodchild, 2004; Ullman, 2010) and girls' beliefs and learning are influenced by these predominantly negative images and assumptions (Bleeker & Jacobs, 2004; Fennema, 2000; Hyde, 2005; Wood, 2000). However, Cleaves (2005) found that, for those students that are truly interested in science, negative opinions held by others about science does not seem to affect them.

When girls had a positive image of scientists or science, Wyer (2003) found that they were significantly more likely to persist in their science studies. Unfortunately though for most girls it is difficult to persevere through the societal stereotypes (Barnett & Rivers, 2004); thus society can significantly influence girls' career decision making, resulting in them following a more traditional career choice (Barnett & Rivers, 2004; Bystydzienski, 2009; Hyde, 2005; Lupart, Cannon, & Telfer, 2004; Warrington & Younger, 2000).

Since science is generally considered a masculine discipline, the stereotype of girls interested in science is that they are less feminine. However Breakwell et al. (2003) found that girls interested in science did not consider themselves to be less feminine; in fact, they found the opposite of the stereotype to be true for both boys and girls. Students that liked science rated themselves higher on feminine and gender neutral traits than on masculine traits. However, girls that did not like science rated other girls who liked science as less feminine (Breakwell et al., 2003) thus upholding the stereotype.

Our society also unfortunately believes that girls are not good at science, technology, engineering, or mathematics (STEM) subjects (Belkin, 2008; Bleeker & Jacobs, 2004; Fox et al., 2006; Warrington & Younger, 2000). Women are generally seen as less competent in science than men, although if a woman's competence has been clearly established, she is considered less likeable (Ceci & Williams, 2007; Hill et al., 2010). "Because both likability and competence are needed for success in the workplace, women in STEM fields can find themselves in a double bind" (Hill et al., 2010, p. xvi). For girls studying science or women working in scientific fields, this lack of respect for their abilities can be frustrating and demoralizing (Ceci & Williams, 2007; Fox et al., 2006; Ivie, Czujko, & Stowe, 2002; Rosser, 2004). Studies in more gender-equal societies, such as Sweden, however show that girls can perform just as well as boys (Guiso, Monte, Sapienza, & Zingales, 2008). Here in North America too girls continue to demonstrate that they achieve just as well in science classes as boys do (Brickhouse, 2001).

> The scientifically-minded female must regularly deal with the obstacle of her assumed inferiority in the areas of reason, rationality, and their application – all the more so if she appears slight of frame, dresses fashionably, and exudes a persona of artistry, creativity, nurturance and humanitarianism. (Mrazek, 2003, p. 63)

We have to overcome this cultural barrier to open the door to science for girls and to enrich the world of science with their creativity and ingenuity (Hill et al., 2010; Mrazek, 2003; Mrazek & Howes, 2004; United Nations Educational, Scientific and Cultural Organization, 2007). Science needs the creative and bright young minds of our women to open new doors and lead to new discoveries. We short-change science, girls, and society by continuing to uphold the gender stereotypes that act as barriers. “It’s not right to waste talent. Diversity also improves the science and maximizes our chances of solving some of our biggest problems” (Mervis, 2000). How many girls are “caught in a paradox”, wanting to pursue their interest in science but hampered by “the cultural feminine ideal” (Baker & Leary, 2003, p. S196)? Can female role models help girls overcome this paradox and encourage them to pursue science careers?

The Gender Gap

After decades of research and efforts to reduce the gender gap, it is worth questioning if a gender gap in science still exists. Blickenstaff (2005) argues that what we have done over the last 20 years to encourage girls to pursue science has not fully worked. Kitts (2009) however is more specific and agrees that while we still need to consider how to encourage students to enter science careers, our efforts in the last two decades have helped to change students' perceptions of science. Kitts (2009) states that students no longer hold stereotypical views of scientists as men in lab coats; that students in general find science interesting; that girls are capable of doing science; and that their parents would be supportive of them pursuing a science career. Unfortunately few other studies seem to agree with Kitts' observations.

The lack of women in science is both a persistent issue, since it is still a problem today, as well as a progressive issue, because the higher in science you go, such as PhD level or senior administration, the fewer women are present (Baker & Leary, 2003; Belkin, 2008; Bettinger & Long, 2005; Blickenstaff, 2005; Burrelli, 2008; Ceci & Williams, 2007; Fox et al., 2006; Haines & Wallace, 2002; Hede, 2009; Heilbronner, 2008; Hill et al., 2010; Ivie & Stowe, 2000; Rosser, 2004; Touchton, 2008; University of Alberta, 2002). Women "who are talented and academically successful drop out of science majors and change careers at a much greater rate than men, even when they are equally or better prepared" (Baker & Leary, 2003, p. S179). Canadian statistics from the 21st century so far show that while progress has been made in some areas, the gap remains sizeable in other areas (McKenzie, 2007). "[G]ender segregation by field is still in full force and shows no signs of abating" (Sonnert, Fox, & Adkins, 2007, p. 1352).

At the doctorate level in science and engineering, men continue to outnumber women four to one (McKenzie, 2007). In Physics especially, women remain underrepresented at all levels comprising only about 21% of both undergraduate and graduate students in the field. In comparison, women represent over 50% of the student population in other disciplines such as humanities (Predoi-Cross, 2008/2009). Even at the primary and secondary levels of education this is noticeable with girls focusing primarily on biology (Baram-Tsabari, Sethi, Bry, & Yarden, 2006). “The boundaries of physics are the most tightly guarded among the sciences, and the gender gaps in physics are among the most pronounced” (Carlone, 2003, p. 32). Statistics Canada (2007) reports that as of 2006 only 22% of professionals in natural sciences, engineering, and mathematics are women, an increase of a mere 2% from 1987; and since women continue to account for a small sector of the student population in these fields, there will probably be little change to this statistic in the near future (Fried & MacCleave, 2009; Statistics Canada, 2007).

Similar situations are visible in the United States and Europe. In the United States, women comprise 50% of the workforce but only 15% of scientists are female (Weinburgh, 2000). While more women are receiving PhDs in science nowadays there still is no equity as far as their career is concerned (Burrelli, 2008; Fox, 2001; United Nations Educational, Scientific and Cultural Organization, 2007). At the end of the 20th century, still fewer than 6% of the highest attainable academic positions were held by women (Fox, 2001).

> To achieve full equality for women depends on more than just numbers... “if all the people at the lower levels are women and there are no women who are making the decisions and who are in the administration, it doesn’t have the same effect”. – Lisa Webb, Queen’s University Ban Righ Centre student advisor (Jemison, 2006)

This trend is also seen in other parts of the world. In Europe, although women represent more than half of the student population, only 11% of top academic science positions are held by women (Dewandre, 2002; European Commission, 2009). While women represent 52% of professionals and technicians, only 32% of scientists and engineers are women. Efforts in Europe to encourage more women to obtain their PhDs have been successful in life sciences and humanities, where women are 41% of PhD holders; however in engineering and physical science, only 25% of PhD holders are women (European Commission, 2009). Women scientists attribute small discriminations along the way that finally end up creating this gender gap (Baker & Leary, 2003; Ceci & Williams, 2007; Dewandre, 2002). Could this lack of women in the higher, more visible science careers be sending a negative message to young girls making career decisions?

Chapter 2: Literature Review

To shed some light on the reasons for this persistent gap, my review of the literature concerning women in science for the past ten years examines several reasons so few girls pursue science. Like a punctured pipeline, science education slowly leaks students along the way; the only problem is that the pipeline leaks more female students than male students (Adams, 2008; Adamuti-Trache & Andres, 2008; Blickenstaff, 2005; Steele, James, & Barnett, 2002; Taylor, Erwin, Ghose, & Perry-Thornton, 2001). "As a result, women's potential and their contribution to the scientific and economic life of a society are not fully realized" (Bandura, Barbaranelli, Caprara, & Pastorelli, 2001, p. 202). Since the gender gap in science has been an issue and a source of research for many years, the literature on the topic is extensive. In this brief review I focused on relatively recent literature dealing with students' perception of science as well as the effect the science teacher or other role model has on students. The literature covers a variety of age groups from elementary school students to working scientists. While some articles define science very specifically as one discipline such as chemistry, physics, or biology, other articles include math and computer science in their definition of science. The literature available is very broad and likewise I am defining science as meaning biology, chemistry, physics, as well as related fields such as engineering. When the term scientist is used, I am referring to someone who has studied these subjects at a post-secondary level and works in these fields or a field that is closely related. Since studies have repeatedly shown that differences are more pronounced by ethnicity than gender, I focused on North American and Western European context in which boys tend to have more early experiences with science than girls (Gilmartin, Li, & Aschbacher, 2006; Warrington &

Younger, 2000; Weinburgh, 2000). Girls are also not a homogeneous group and differences such as family income and ethnicity should be taken into consideration (Baker, 2002; Francis & Skelton, 2005; Warrington & Younger, 2000). While the gender gap in science is an issue to some degree in almost every country and culture (Bystydzienski, 2009; Farmer, 2009; van Langen, Bosker, & Dekkers, 2006), societies in which women are more empowered appear to have almost eliminated the gender gap (Else-Quest, Hyde, & Linn, 2010; Guiso et al., 2008). In the literature, I therefore specifically looked at North American girls' interest in science, with a focus on rural girls and areas that continue to show a lack of female representation in fields such as physics, engineering and fields related to physical science (Adamuti-Trache & Andres, 2008; Belkin, 2008; Bleeker & Jacobs, 2004; Britner, 2008; Carlone, 2003; Dee, 2006; Gilmartin, Denson, Li, Bryant, & Aschbacher, 2007; Halpern et al., 2007/2008; Heilbronner, 2008; Hill et al., 2010; Ivie & Stowe, 2000; Lupart et al., 2004; Phillips et al., 2002; Rosser, 2004; Touchton, 2008; van Langen et al., 2006; Warrington & Younger, 2000).

Science as a Masculine Discipline

Science is largely still considered a masculine discipline (Fox et al., 2006; Hill et al., 2010; Whelan, 2001) based on binary opposites; valuing norms more frequently associated with men, such as rationality, control, logic, over more feminine attributes, such as emotions, or intuition (Blickenstaff, 2005; Brickhouse, 2001; Brickhouse et al., 2000; Fox, 2001; Francis & Skelton, 2005; Gilbert, 2001; Mrazek, 2003; Murphy & Whitelegg, 2006; Whelan, 2001). Students define themselves within these parameters and determine what is of relevance to them. Murphy and Whitelegg (2006) suggest that girls may go so far as to avoid tasks if the content is masculine even though they are fully capable of completing the tasks. The gender domains can therefore create barriers and lead girls to feeling incompetent in certain subjects (Else-Quest et al., 2010; Francis & Skelton, 2005; Hill et al., 2010; Hyde, 2005; Murphy & Whitelegg, 2006).

In order to be successful in a science career, girls believe they have to adopt masculine attributes (Mrazek, 2003; Mrazek & Howes, 2004); if they do not adopt these attributes, they tend to have a lower science self-efficacy (Bandura et al., 2001). This means then that women who are involved in science must either be seen as supporting the male authority or as being a “substitute” man (Gilbert, 2001, p. 298). Teenage girls’ who want to be attractive to boys (Barnett & Rivers, 2004) will therefore focus on more “feminine roles that often exclude science” (Brickhouse et al., 2000, p. 441). In conversation with me recently, a 19 year old male agricultural student commented on two female students in his class. He felt they did not belong in his class because, in his words, they were incapable of doing a good job in agriculture. He continued by noting that these girls were not really girls anyway, rather more like “she-men”, and the only purpose they served was for comic relief in class. When I asked him what his teacher’s response is to these girls being mocked and treated poorly, he responded that his teacher led by example and made the most fun of them. It is shocking that women in an educated, modern, Western society still have to deal with this kind of attitude because they are interested in science.

As seen from the previous example, men’s view of women in science can be influential to girls’ perceiving science as a profession they are not welcome in. Women are “threatened by negative gender stereotypes that allege they are not as capable as men”

(Steele et al., 2002, p. 49). Stake (2003) found in her research that boys had negative attitudes about female scientist. The boys and girls that she researched were all science-oriented students and thus the boys with the negative attitude towards women in science represented the girls' potential future co-workers. While boys and girls both agreed that women could make significant contributions to science, the boys did not think that more women were needed in science.

> The boys' ratings suggest that, although most know that there have been exceptional woman in science, the majority are not concerned about women's low participation rates and might not have a welcoming attitude toward girls who choose to participate in science. The boys who failed to agree with this item may convey this attitude, in a subtle or overt manner, in their interactions with girls in their science classes. According to stereotype threat theory, such discouragements affect girls' performance, especially on highly challenging science tests and activities, and may lead girls to decide against a career in which they believe they are not welcome. (Stake, 2003, p. 678)

Interestingly the few boys that had exceptionally high science self-efficacy did not feel threatened by the presence of women in science and were more open to increasing female participation in science. Thus the boys that doubted their own science abilities had more negative attitudes toward women in science. "Male attitudes under threat are likely to be negative and unsupportive of advances in women's science participation as long as women are generally marginalized in science and the successful woman scientist is seen as the exception" (Stake, 2003, p. 680). In a study with middle school girls, Huguet and Regner (2007) noticed that stereotype threat significantly impacted girls' performance but that a positive role model can decrease the effect of the stereotype threat. But without role models "[t]he very powerful influence of stereotype threat means that male bias may be a significant deterrent to girls' and women's science performance and willingness to choose and persevere in science fields" (Stake, 2003, p. 669).

From a female perspective, according to Baker and Leary (2003), being a woman in science means emphasizing relationships and therefore "doing science in a related and connected way" as opposed to "the norms of science that emphasize hierarchy, distance, and objectivity" (p. S178). Thus Gilbert (2001) suggests that in order to include more women in science, we should teach science not with the goal to prepare new scientists but to increase overall science literacy; it should be taught not as a series of facts but rather as a series of stories which should be read for both the actual meaning and the underlying meaning, or what Gilbert describes as the audiences interpretation of the story from their own viewpoint. While the actual meaning of the story is literal, verifiable and masculine, the underlying meaning depends on the moment, involves emotions, and is associated with the feminine. This approach to science teaching will however, she argues, allow girls to participate in science as women, instead of "substitute" men (Gilbert, 2001, p. 298).

> Rather than relying on a notion of objectivity that is opposite of subjectivity, and splits mind and body, as well as nature/culture, male/female, we need an objectivity that is understood as part of the natural and social worlds and therefore also accountable to them. (Brickhouse, 2001, p. 285)

Encouraging more women to study science started as an equal rights movement with programs designed to change women to fit into science (Baker, 2002; Gilbert, 2001).

Later programs were altered to change how science is presented to women, rather than trying to change women (Brickhouse, 2001; Gilbert, 2001). However, Gilbert (2001) argues that it still does not address the “deeply gendered nature of scientific knowledge” (p. 292). Until we define science other than through binary opposites, she claims that:

> woman and scientist are mutually exclusive categories. The implication of this for actual women is that, while there are no formal procedures excluding them from participation in science, there are considerable conceptual and psychological barriers to being a woman and a scientist simultaneously. (Gilbert, 2001, p. 294)

Whelan (2001) too agrees that trying to eliminate the gender gap is not going to work unless we redefine science because the bias is part of our current science definition. Based on that statement, science is not so much an unbiased interpretation of the world around us but rather facts and principles that represent one particular group’s interpretation (Brickhouse, 2001; Whelan, 2001):

> Science works not because it is true to the world but because the world is tinkered with to make science work… Scientific facts must be consistently applied in order to work; they do not work in just any reality, but only in a particularly constituted one. (Whelan, 2001, p. 544)

Whelan (2001) suggests that the reason women are especially missing from the “hard sciences” like physics is because “their connections to the social world are less immediately obvious” and “soft sciences” have more “obvious political implications” of interest to women (p. 549). She also notes that “Physics is the apex of natural sciences” and that women in other areas of science or "soft science" are seen as "relatively unskilled labourers doing inconsequential namby-pamby work" (Whelan, 2001, p. 549).

Interestingly Haines and Wallace (2002) found that women who did not consider science to be a masculine discipline were still less likely to pursue science degrees; they therefore argue that traditional gender roles do not affect girls' decision to study science. On the other hand Baker and Leary (2003) describe it as girls interested in science being "caught in a paradox. They are struggling with establishing and standing up for who they are and the cultural feminine ideal" (p. S196). Therefore while girls may do just as well as boys in science classes, they continue to think of science as a boys subject (Ullman, 2010).

Gender differences. Some suggest that one argument for why fewer women pursue science is that biological differences exist between men and women, and that on average men are better suited for science (Summers, 2005). Spelke (2005) claims that review of the research shows that there is no significant biological difference that makes men better suited for science than women and that the gender gap can be attributed more to societal issues than biological factors. Although there is no overall IQ difference between men and women, some claim that men have better spatial abilities than women (Brownlow et al., 2000; Carpenter, 2007/2008; Ceci & Williams, 2007; Fennema, 2000; Halpern, Benbow et al., 2007; Heilbronner, 2008; Kimura, 2004). Guiso et al. (2008) found that although a gender-equal society eliminated the gender gap in math between boys and girls, girls still performed more poorly in geometry than in arithmetic. However training and experience can improve women's spatial abilities as was shown in a study by University of Toronto psychologist Ian Spence in which he used video gaming to improve women’s spatial abilities even five months later (Carpenter, 2007/2008). Spatial visualization is important in science, but Blickenstaff (2005) argues that the ability difference between men and women is not significant enough to account for the gender gap. While men may be better at spatial tasks, women tend to be better at verbal tasks (Ceci & Williams, 2007; Kimura, 2004). After all scientific ability is complex and includes more skills than just spatial visualization, such as verbal communication skills, memory, quantitative data analysis, and more (Ceci & Williams, 2007; Ginorio, Fournier, & Frevert, 2004; Halpern et al., 2007/2008; Halpern, Benbow et al., 2007).

Nonetheless, some studies show that there seems to be some distinct differences in the male and female brains (Ceci & Williams, 2007; Halpern et al., 2007/2008; Halpern, Benbow et al., 2007; Kimura, 2004). “Imaging studies assessing brain function support the notion that females perform better on tasks such as language processing that call on more symmetric activation of brain hemispheres, whereas males excel in tasks requiring activation of the visual cortex” (Halpern et al., 2007/2008, p. 49). Studies found that an increase for example in the male hormone testosterone will improve visuospatial abilities (typical male skill) and decrease verbal skills (typical female skill) (Ceci & Williams, 2007; Halpern et al., 2007/2008; Kimura, 2004). However, since “the brain reflects learning and other experiences, it is possible that sex differences in the brain are influenced by the differences in life experiences that are typical for women and men” (Halpern et al., 2007/2008, p. 49). So too Kimura (2004) argues that there are fewer gender differences now because men and women tend to have more similar life experiences than previous generations. She also notes that while there is a relationship between life-experiences and cognitive abilities, it is not necessarily causal (Kimura, 2004). Regardless, the purpose of schools and science in schools should be to train individuals and improve them in all the skills used in science, regardless of gender (Ceci & Williams, 2007; Else-Quest et al., 2010; Halpern, Aronson et al., 2007; Halpern et al., 2007/2008; Heilbronner, 2008; Hill et al., 2010).

Hyde (2005) in contrast postulates the gender similarities hypothesis, noting that males and females are more alike than they are different; most psychological gender differences are too small to be significant. Gender differences also vary with age and culture; such that social contexts have a significant influence on gender differences. Therefore stereotypes we have about men and women can significantly influence not only for example, the girl wanting to study science but also teachers and parents (Hill et al., 2010; Hyde, 2005). “Implicit bias is common, even among individuals who actively reject these stereotypes. This bias not only affects individuals’ attitudes toward others but may also influence girls’ and women’s likelihood of cultivating their own interest in math and science” (Hill et al., 2010, p. xvi). Phillips et al. (2002) note that gender differences in science are already noticeable at a young age; and yet this is when the “foundation for a [science] career is laid” (Hill et al., 2010, p. xv). In pre-school, children already learn what gender-specific activities are appropriate for them; boys focus on structure and mechanism and girls focus on colour and smell (Murphy & Whitelegg 2006).

Historically too topics such as mechanics were excluded from girls’ science education because it was not considered to be important to them. As Murphy and Whitelegg (2006) point out this type of “exclusion can lead to cultural beliefs about competence” (p. 288). Baram-Tsabari et al. (2006) also “found significant differences between girls’ and boys’ interests, with girls generally preferring biological topics. The two genders kept to their stereotypic fields of interest" (p. 1050). Usually girls' find science and math less useful than boys (Eccles, 1994; Fennema, 2000).

Others argue that the reason fewer girls study science is because boys have better attitudes and more positive experiences with science than girls (Britner & Pajares, 2006; Heilbronner, 2008; Lupart et al., 2004; Weinburgh, 2000). Tenenbaum (2009) however found that young girls were more positive about science in conversations with their mothers than boys were. In the end it appears that most students find school science uninteresting, thinking it does not apply to their lives and is only useful for training the stereotypical research scientist (Cleaves, 2005; Halpern, Aronson et al., 2007; Li, 2008).

> [I]n order to understand learning in science, we need to know much more than whether students have acquired particular scientific understandings. We need to know how students engage in science and how this is related to who they are and who they want to be. (Brickhouse, 2001, p. 286)

Attitudes to science overall are less positive with each grade level (Fredricks & Eccles, 2002), by Grade 8 they seem to be negative (Weinburgh, 2000), and interest in science career decrease with higher grade levels (Fredricks & Eccles, 2002; Jacobs, Finken, Griffin, & Wright, 1998; Tenenbaum, 2009). Murphy and Beggs (2003) claim that the "erosion of children's interest in school science occurs between the ages of 9 and 14" (p. 109). Weinburgh (2000) too found that by 3rd grade 50% of students are no longer interested in science regardless of gender. Wood (2000) also agrees that girls lose interest in science in Grades 3 and 4; furthermore girls are allowed to lose interest "without any objections from parents or teachers" (para. 6). And Mueller (2004) states that in Grades 4-8 girls are subtly or obviously discouraged from pursuing a career in science. Yet Taylor et al. (2001) note that students decide to become scientists between fourth and sixth grade. Baram-Tsabari et al. (2006) found that girls in the US, UK, Canada, Australia and New Zealand contributed more questions, both self-directed or school related, to an ask-a-scientist website. However the number of American girls dropped significantly when they entered high school. The female physicists in Ivie et al.'s (2002) study stated that they became interested in physics before or during secondary school. Regardless of the age at which an interest in science starts, it is apparent that by the end of high school most girls have lost interest and some will have been discouraged from pursuing a science career. Again, some researchers argue that the difference in attitude is not large enough to account for the gender gap we see at the higher levels of science (Baker & Leary, 2003; Blickenstaff, 2005).

Baker and Leary (2003) found that girls in Grade 2, 5, 8, and 11 in their study had a positive attitude towards science and it was only reduced by negative experiences with teachers, choice of topic, or instructional format. Positive previous experiences with science, including experiments, are influential to girls' interest in science and deciding to pursue science careers (Jacobs et al., 1998; Phillips et al., 2002). Generally the younger the student and the higher their science marks, the more interested they are in a science career (Jacobs et al., 1998). Realizing that interest in science decreases with grade level, they comment "that the experience [students have with school science] is not positive because preference for careers in sciences tend to decline with grade level" (Jacobs et al., 1998, p. 697). Gilmartin et al. (2006) however point out that even if there is an interest in a science class, it does not automatically translate into a science.

While girls in general may be more positive than boys about learning for its own sake (Baram-Tsabari et al., 2006; Britner & Pajares, 2006; Lupart et al., 2004; Warrington & Younger, 2000), in science girls feel they have to work harder than boys in order to achieve (Heilbronner, 2008; Lupart et al., 2004; Warrington & Younger, 2000). However the girls in Lupart et al.'s (2004) study that felt this way disagreed much more strongly than boys with the statement "men are better than women at science" (p. 37). Interestingly Grade 7 girls disagreed with the statement more than Grade 10 girls (Lupart et al., 2004). While girls seem to be more positive about gender equality (Owen et al., 2007; Wyer, 2003), they also seem to think that "gender differences in attitudes toward women in science may have increased" (Owen et al., 2007, p. 1472).

Dweck (2007) conducted several studies with students from elementary school through university to determine why we see a gender gap in math and science courses. She noted that when girls are confronted with a difficult problem, they tend to lose heart, whereas boys seem to be energized by it. The higher the IQ of a girl was, the worse she tended to deal with difficulties. Dweck (2007) however went deeper and discovered that how girls think about their intellectual abilities determines how they react to challenges. If a girl thought of her intellectual ability as an innate gift, then a difficult problem tended to demoralize her and call into question her actual ability. "If you have to struggle, then you must not have the gift. If your initial grades are poor, you must not have the gift" (Dweck, 2007, p. 52). These girls, who believed their intellectual ability is a gift, were also more influenced by stereotypes. "After all, stereotypes are stories about gifts – about who has them and who doesn't" (Dweck, 2007, p. 52). Those girls with the gift mentality in male-dominated fields then quickly lost heart and discontinued studying the subject opting instead for a field more stereotypically female. In contrast, girls that thought intellectual ability is developed saw difficult problems as a challenge to fix. "'Maybe my group hasn't had the background, experience, and encouragement in the past, but with the right effort, strategies, and teaching, we should be able to make headway'" (Dweck, 2007, p. 53). These girls did considerably better so that a gender gap was barely noticeable and they continued to enjoy learning. Dweck (2007) noted that how teachers teach lessons can convey to students the innate ability versus growing ability mentality. Through several experiments, girls who had received the message that learning is a process requiring effort, performed significantly better and were more engaged in their learning than the girls who thought they either did or did not have the gift (Dweck, 2007; Halpern, Aronson et al., 2007). Because of this Dweck (2007) comments that praising girls for their work is not in their best interest as it sends the message that their ability is a gift and if those girls encounter difficulties, they will question their abilities and most likely feel demoralized. However girls' ability to do science does not necessarily correlate to an interest in science (Carlone, 2003; Ceci & Williams, 2007; Kitts, 2009; Phillips et al., 2002). "Students feel they *can* do science; they simply do not *want* to do science" (Kitts, 2009, p. 163).

Women also make decisions different from men; they base success and identity more on relationships than professional or academic success (Baker & Leary, 2003; Ceci & Williams, 2007; Dentith, 2008). Girls mostly choose science careers because of a desire to help people, animals or the planet (Ceci & Williams, 2007; Kniveton, 2004; Li, 2008; Lupart et al., 2004; Tan & Barton, 2008; Weinburgh, 2000; Whelan, 2001) and subsequently have difficulty establishing a connection with physical science or lab based professions (Baker & Leary, 2003; Brickhouse et al., 2000; Ceci & Williams, 2007; Goodchild, 2004; Murphy & Whitelegg, 2006). Unfortunately few students seem to know someone personally who works in science; “[t]his apparent lack of role models is significant” because mentoring can assist students in forming their identity (Kitts, 2009, p. 161). “The few instances in which the girls chose a physical science career were all based on having experienced that science with a loved one” (Baker & Leary, 2003, p. S189). The organization Women in Engineering at Rochester Institute of Technology (WE@RIT) attempts to help girls establish a connection between physical science and helping others. They conduct programs with girls in grades six through eight allowing them to build structures or learn about topics such as solar energy with a hands-on approach. Following participation in the program, girls were able to articulate how they could use an engineering career to help others (Bailey, Anderson, DeBartolo, Lam, & Mozrall, 2008). Repeatedly girls in studies have stated that relevance of the material learned is important to them; they have to be able to make a connection with it to their everyday lives (Baker & Leary, 2003; Bloor, Krenitsky, & Wellenstein, 2007; Heilbronner, 2008; Jacobs et al., 1998; Murphy & Whitelegg, 2006; University of Alberta, 2000).

The various societal influences on women studying science are significant (Wyer, 2003). Women tend to be much less committed to pursuing a science degree than men and in part their commitment is significantly related to the images they have of who a scientist is and what a scientist does, as well as gender equality in science. Those that have a positive image of scientists tend to be much more persistent (Wyer, 2003). Persistence is important for women scientists to be successful (Adamuti-Trache &

Andres, 2008; Rosser, 2004) and women scientist state that they have to be determined to pursue their interest in science (Ivie et al., 2002).

For girls in middle and high school, their emotional reasoning can dictate what they believe, making it difficult for them to distinguish between facts and feelings. If they feel something to be true, then in their mind it is true (Pipher, 1994). This type of reasoning makes girls very susceptible to outside influences and a teacher or other role model can have a significant impact on the girl at this age (Britner & Pajares, 2006; Pipher, 1994). "[A]dolescence represents a critical juncture in which one first begins to negotiate the intersection of one's own self, beliefs, values, worth, and potential in a particular society and culture" (Seaton, 2007, p. 2). Girls' perception of their success in past science experiences thus dictates their self-efficacy and science anxiety which in turn influence their continued interest in the subject (Britner & Pajares, 2006). Britner and Pajares (2006) note that middle school science teachers especially have the opportunity to provide girls with a positive learning environment that prepares them for the more inquiry-oriented science teaching of high school classes. Is it that when girls are teenagers most of their science teachers are male that is a factor in causing them to lose interest in science? What happens to those girls that in elementary school wanted to be doctors, veterinarians, astronauts, pilots, or engineers? What causes girls to lose those dreams? Pipher (1994) suggests that "Girls can't say why they ditch their dreams, they just 'mysteriously' lose interest" (p. 63).

Pedagogic dynamics. How we teach science can therefore be another crucial factor. Blickenstaff (2005) states that ninety percent of students who leave science cite the lack of quality teaching as their reason. This is corroborated by Brickhouse et al.

(2000) who found that girls with a genuine interest in science lost their interest in science within the span of one year due predominantly to instructional format and subsequently dropped to the lowest science class possible. Another study found that a new science teacher "had changed girls' perceptions enormously: they described how they had stopped hating physics, and for the first time they had begun to understand some of the basic concepts" (Warrington & Younger, 2000, p. 497) including wanting to continue studying physics at higher levels.

Students' difficulties in science are frequently the result of insufficient explanations by teachers (Murphy & Beggs, 2003). If the teacher is unable to explain or answer questions well, it can create an atmosphere of uncertainty in the classroom. "Creating a safe, nurturing environment provides a framework for empowerment" (Taylor et al., 2001, p. 76). Although the girls in Brickhouse et al.'s (2000) study were all interested in science and considered themselves good at science, none of them asked a science related question in class. Perhaps girls feel embarrassed or ridiculed for asking questions in class. For this issue Baram-Tsabari et al. (2006) found that online learning can provide a safe environment for students that is especially "attractive" for girls (p. 1065).

Girls also show a preference for group work (Fennema, 2000; Taylor et al., 2001) and hands-on activities, desiring the relationship aspect and making connections to life outside of the classroom (Baker & Leary, 2003; Bloor et al., 2007; Brickhouse et al., 2000; Ginorio et al., 2004; Heilbronner, 2008; Lupart et al., 2004; McCarthy, 2009; Murphy & Whitelegg, 2006; Tan & Barton, 2008; Warrington & Younger, 2000; Whelan, 2001; Wood, 2000). However, working in mixed groups may be difficult for some girls because as one study found, boys “just messed around, made sexist comments and made fun of those who worked” and “would frequently not listen to, or devalue, the girls’ contributions” (Warrington & Younger, 2000, p. 501). Girls in Warrington and Younger’s (2000) study were frustrated because the entire class was banned from conducting experiments due to boys’ misbehaviour. They were also frustrated that boys’ misbehaviour took away the teachers’ time to teach and that they boys were so disruptive to the girls’ learning (Warrington & Younger, 2000).

Connecting what is learned in science class to the outside world is important to girls. The girls in Buck’s (2002) study verbalized that they wanted to connect what they learn in the classroom to their world. One girl specifically said:

> So that’s why in science, and like science, is probably one of the most important classes you’re going to take. Because it kind of tells you about the world around you... This is telling you how things work, and why things happen for a reason. (Buck, 2002, p. 38)

Although it seems to be important for girls choosing to study science if they liked the subject and how successful they had previously been in the subject, how useful they perceive the subject to be is even more important (Ceci & Williams, 2007; Murphy & Whitelegg, 2006).

The topic choice covered in science class is also important to girls’ interest in the subject. Girls seem to be more successful when a topic is covered in depth but many science courses give just a broad overview (Blickenstaff, 2005). Students stated that they felt rushed through the science curriculum and there was no time to absorb the material or just appreciate it (Buck, 2002; Osborne & Collins, 2001). Buck’s (2002) research of 51 girls showed that being able to choose what is studied in science is appreciated by girls. Students have opinions on what they want to learn and a genuine interest in a topic will increase student motivation; this has been especially noticed for girls in science (Baram-Tsabari et al., 2006). Generally though instead of learning science out of curiosity and using investigations to discover answers, it seems to be disconnected from the students' lives and taught as a series of facts and laws (Brickhouse et al., 2000; Li, 2008; Mueller, 2004; Weinburgh, 2000). Kaufman, Ewing, Montgomery, Self and Hyle, in their book *From Girls in Their Element to Women in Science: Rethinking Socialization Through Memory Work*, described that their "personal science" was separated from who they were individually when they entered school (Mueller, 2004).

What can be done then to improve girls' experience with science education? According to Brickhouse (2001), feminist pedagogy involves co-operative learning, inquiry-based learning, and a curriculum of care. Britner and Pajares (2006) feel the transition from textbook to inquiry-based science teaching needs to be given attention:

> Middle school science teachers are in a unique position to scaffold children's science development as they move from the textbook-based science instruction common in many elementary classrooms to laboratory-based science classes found in high school. Engaging students in authentic inquiry-oriented science investigations during middle school will provide mastery experience necessary to the development of strong science self-efficacy beliefs. (Britner & Pajares, 2006, p. 494)

Britner and Pajares (2001) posit that because girls tend to have higher self-efficacy than boys in language arts, perhaps that is why at the middle school level girls are reporting higher science self-efficacy than boys.

Girls can see the value in science overall but they also want to feel included in their science curriculum. Girls in middle and high school are not the only ones feeling excluded; in university too, many women reported that they feel isolated and intimidated in the science environment (Blickenstaff, 2005; Pain, 2002; Rosser, 2004). In order to feel included, studies suggest girls need to be able to make those connections from science class to their world and relate ideas (Buck, 2002; Murphy & Whitelegg, 2006; Taylor et al., 2001). The current science curriculum, however, places an emphasis on content; it is facts and answers that are either right or wrong (Carlone, 2003; Osborne & Collins, 2001) and does not factor in girls' desire to belong.

Self-efficacy. Several studies contend that the gender gap in science begins in high school and by the end of high school, girls find science difficult instead of interesting and helpful (Brownlow et al., 2000; Cleaves, 2005; Warrington & Younger, 2000). Perhaps it is in part because when girls become teenagers they lose not only their interest in science but also their confidence (Bleeker & Jacobs, 2004; Mueller, 2004; Taylor et al., 2001; Warrington & Younger, 2000). Girls may start describing themselves as "dumb" in science and math subjects (Wood, 2000) and doubt their own abilities in science even if their performance indicates otherwise (Cleaves, 2005). Bandura (1997) states that even though individuals may be successful at a task, if it is perceived to be a difficult task it may nonetheless lower their self-efficacy. Particularly math is thought to be a limiting factor for girls' pursuing science (Bandura et al., 2001; Farmer, 2009), especially calculus (Bystydzienski, 2009). Because girls may doubt their mathematical abilities, they tend to opt for more traditional gender occupations (Bandura et al., 2001). Bystydzienski (2009) found that those students that do well in math tend to want to achieve higher and pursue occupations such as science.

However even though girls may be capable in science, they may still not be interested in it as a career choice (Ceci & Williams, 2007). Carlone (2003) noticed that although girls were successful in physics and felt confident in their abilities, they did not see themselves as scientists but rather as good students; they enrolled in physics because it looks good on their transcript, not because they were interest in it. Dentith (2008) also found that girls take traditionally male-dominated classes to increase their chances of getting into a good university. Even though the girls' in Dentith's (2008) study were taking science courses, they all expressed low self-confidence and thought boys were better than them.

Several studies found that girls receiving encouragement has a significant effect on their decision to pursue a science degree (Britner & Pajares, 2006; Haines & Wallace, 2002; Heilbronner, 2008; Hill et al., 2010; Ivie et al., 2002; Taylor et al., 2001; Wood, 2000). However generally only stellar girls or model students are encouraged to pursue science (Francis & Skelton, 2005; Warrington & Younger, 2000). This means that girls who may not be model students but have a genuine interest in science, will most likely not be encouraged or recommended to take higher level science courses (Brickhouse, 2001; Brickhouse et al., 2000; Ginorio et al., 2004; Warrington & Younger, 2000). Ginorio et al. (2004) specifically targeted non-A students in their study. Although they were not A-level students, half of the rural girls that participated in their program pursued science studies past high school (Ginorio et al., 2004).

How prepared girls feel through their high school science and math courses seems to have a bigger impact on career choices than gender roles (Britner & Pajares, 2006; Haines & Wallace, 2002). Unfortunately there seems to be a steady decrease in interest in science over the grades as science becomes more abstract and complex (Murphy & Whitelegg, 2006; Warrington & Younger, 2000). As noted above, a decline in girls' interest in the subject is linked to their belief that they are not competent in science. Girls with a strong self-efficacy are more likely to study science (Bleeker & Jacobs, 2004; Britner & Pajares, 2001; Campbell & Skoog, 2004; Eccles, 1994; Scott & Mallinckrodt, 2005; Stake, 2003). If students think they are good in a subject, they are more likely to think they will be good at a career involving that subject (Bandura et al., 2001).

Students who believe they can be successful in science, are more likely to take more science class, put in an effort, and persevere through obstacles (Britner & Pajares, 2001, 2006; Tan & Barton, 2008). While some girls' science self-efficacy may be the same as that of boys, Britner and Pajares (2006) found that girls tend to report higher science anxiety. Pointing out that gender difference exist in science classrooms can for example increase girls' anxiety about the subject (Fennema, 2000). Brownlow et al. (2000) suggest that the difference to individuals pursuing a science career is more influenced by their science anxiety than their gender. Although they also report that there is no significant gender difference for high science anxiety; instead students that were perfectionists tended to have higher anxiety and avoided science classes because they generally did not guarantee success (Brownlow et al., 2000). Other studies also have shown that girls on average do not like to take risks as boys do (Tan & Barton, 2008; Warrington & Younger, 2000) and may therefore avoid science classes that do not guarantee success.

Although average grades for girls' in science are often equal to that of boys, girls tend not to believe in their own abilities and think they must work extra hard to achieve in this masculine subject (Guiso et al., 2008; Heilbronner, 2008; Hill et al., 2010; Warrington & Younger, 2000). In contrast Baker and Leary (2003) found that "girls expressed confidence in their ability to do science and were not afraid of the challenge of the work or of making mistakes" (p. S183). Nevertheless even if female students felt confident in their abilities, they often still "feel outnumbered and even intimidated in class" (Fox et al., 2006, p. 69); and there is a relation between achievement and a sense of belonging for girls (Murphy & Whitelegg, 2006; Taylor et al., 2001).

Britner (2008) found that girls' science self-efficacy varied with the type of science studied. Using Bandura's theory, she looked at which of the four sources of self-efficacy had the greatest influence. The four sources are: 1. mastery experience or previous success in the subject, 2. vicarious experience or evaluating the ability to do well in an area based on watching someone else; this would be a self-efficacy source that role models can influence, 3. social persuasion or the opinions and support of others, and 4. physiological states or the emotions experienced while performing the task (Bandura, 1997).

In Earth and Environmental Science classes, girls' performed better than boys and had a stronger self-efficacy. This self-efficacy was based predominately on mastery experience – previous success. In Life Science girls continued to earn higher grades but they did not have a higher self-efficacy than boys; instead they showed higher science anxiety. Interestingly, mastery experience seemed to have little influence on girls' self-efficacy in life science but social persuasion – opinions of others - did have a strong effect. Britner (2008) speculates that this may be due to life science being a popular science for women to study and work in. She found no difference in grades or self-efficacy in Physical Science, but girls reported high anxiety and of Bandura's four self-efficacy sources, their emotional state had the strongest influence on self-efficacy. Consistently, self-efficacy mirrored students' grades, and mastery experience seemed to have the greatest influence on self-efficacy. Science self-efficacy determined what classes students choose, how much effort they put into it, if they were willing to persevere, and in the end if they would be successful (Britner, 2008). "Children's perceived efficacy rather than their actual academic achievement is the key determinant of their perceived occupational self-efficacy and preferred choice of worklife. Analyses of gender differences reveal that perceived occupational self-efficacy predicts traditionality of career choice" (Bandura et al., 2001, p. 187).

Rural Girls

Tradition also seems to be important in most rural communities. However despite large rural populations, little research has been conducted on rural students and their interests (Beeson & Strange, 2000; Bloor et al., 2007; Hardré, Sullivan, & Crowson, 2009; Harmon, 2001; Harmon et al., 2003; Henderson, 2001). Rural populations are unique (Bloor et al., 2007; Harmon et al., 2003; Henderson, 2001; Howley & Harmon, 2000) and can differ significantly from urban and sub-urban populations in several ways: for example, they tend to have a lower socioeconomic status (Beeson & Strange, 2000;

Berns, Century, Hiles, Minner, & Moore, 2003; Hardré et al., 2009; Harmon, 2001; Howley & Harmon, 2000); rural students are more likely to terminate their education prematurely (Hardré et al., 2009); community is very influential (Beeson & Strange, 2000; Berns et al., 2003; Ginorio, Huston, Frevert, & Seibel, 2002; Hardré et al., 2009; Harmon et al., 2003; Henderson, 2001; Howley & Harmon, 2000; Jacobs et al., 1998) and in turn the school is very important to the rural community, bringing it together (Berns et al., 2003; Harmon, 2001; Harmon et al., 2003; Henderson, 2001; Howley & Harmon, 2000). "Rural youth (compared to non-rural) often experience greater conflict between educational goals and their family connections" (Hardré et al., 2009, p. 2) which can result in avoiding continuing their education (Ginorio et al., 2002; Hardré et al., 2009). However some studies found that rural schools tend to perform very well (Harmon, 2001; Howley & Harmon, 2000; Yang & Fetsch, 2007) and have significant parent involvement as compared to urban schools (Harmon, 2001). "[S]mall schools are more productive and effective than larger schools" (Howley & Harmon, 2000, p. 1). Part of this is because it is difficult for students to hide in a small class and they are more likely to participate (Howley & Harmon, 2000).

Teachers in rural schools tend to be very influential by supporting students, encouraging them, and acting as role models. But teacher staffing and retention is also a significant issue in rural schools: in some rural areas in North America teachers receive a lower salary and in other areas as well may be asked to teach subjects outside their expertise area (Beeson & Strange, 2000; Berns et al., 2003; Harmon, 2001; Henderson, 2001; Howley & Harmon, 2000). In rural schools, lack of quality science education also may be due in part to the lack of quality resources (Harmon, Henderson, & Royster, 2003). Hardré et al. (2009) found that while teachers are very influential on rural students, peers have very little influence and in general rural students seem not to base their choices as much on what others' think. Interestingly rural students' beliefs of their self-worth and academic abilities are generally significantly higher than that of their urban counterparts (Yang & Fetsch, 2007). "At least in terms of children's feelings of self-worth and academic competence, rural communities may still be safe harbors" (Yang & Fetsch, 2007, p. 6). Jacobs et al. (1998) however note that for girls peer approval is very instrumental in pursuing their science interest since rural areas often hold a more traditional view of women and rural girls desire to share their science experience with their friends. But Harmon et al. (2003) remind too that rural areas can differ significantly. It is important to determine what the community's attitude is toward science and if girls' are traditionally expected to avoid math and science courses (Harmon et al., 2003). For example, Ginorio et al. (2002) found that some science teachers in their study "openly stated that girls' first priority should be to become wives and mothers" (p. 316).

Ginorio et al. (2004) studied a program focused on permitting underrepresented girls – rural minorities - to learn the scientific process with a community self-selected inquiry in order to increase their interest in science. They selected girls who were non-A students who would probably have been overlooked by most other programs. With the support of teachers, parents, and the community, girls designed studies of interest to them based in their locale. The program was so effective that 50% of the girls continued on to pursue science studies past high school. One girl in their study noted:

> If it were not for the program, I would be working at McDonald's and maybe not even attending school. Now I'm going to be the first member of my family to graduate from high school, and I'm going to college. (Ginorio et al., 2004, p. 82)

Unfortunately most rural schools have limited opportunities for students (Berns et al., 2003; Harmon, 2001) and following their education, the number of science jobs in rural areas are limited (Berns et al., 2003). Berns et al. (2003) point out that while "parents in rural communities want the best for their children, many have limited views of the connections between science and their rural lifestyles" (p. 8). They note that:

> Educators, parents, and the community often view science with low status. The lack of economic opportunity in rural areas has exacerbated the situation by making it even more difficult for residents to understand the relevance of science. (Berns et al., 2003, p. 12)

Rural communities believe that their children will have to leave in order to pursue science careers (Berns et al., 2003). One of the characteristics about rural populations is that they tend to want to hang on to their way of life, stay close to home and those they love; they have a very strong sense of community (Howley & Harmon, 2000). On the other hand, "youth who desire to stay in a rural place are usually labelled with low aspirations, persons who obviously are not considered among the 'best and brightest'" (Harmon, 2001, p. 5).

But rural population adds diversity to our larger society (Howley & Harmon, 2000); just like encouraging girls to pursue science adds diversity in STEM careers. Henderson (2001) agrees that how science is perceived in the community is very influential on science education in rural schools; unfortunately, most communities do not seem to see the value in science education. He also notes that gender differences in science education seem to be more pronounced in rural areas (Henderson, 2001). Van Langen et al. (2006) in contrast found that there is less of a gap between girls achievement in general in comparison to boys in rural schools than in urban schools.

Because rural girls are more limited in access to other resources for support and help, the interactions that teachers have with them daily is very important. However, if the teachers do not see the girls' needs, then those needs will most likely go unmet because rural girls are reticent to ask for help. "For adolescent girls growing up in rural communities—who may face inadequate social and capital resources, restricted opportunities for social connections, and limited adult role models—connections with teachers play a central role in girls' self-understanding" (Seaton, 2007, p. 1). Yet the girls in Seaton's (2007) study repeatedly stated that they did not consider their teachers to be supportive adults and would not seek them out for help or advice. This may be in part because in rural communities there is no privacy and asking for help may carry with it a negative stigma for the girls; especially since rural communities tend to value self-reliance and independence. Furthermore teachers also held gendered expectations of their students; "the gendered expectation that 'good girls' should be silent, passive, and in control of strong feelings left the girls feeling disempowered to act, particularly in the face of boys' harassment" (Seaton, 2007, pp. 9-10). Teachers in Seaton's (2007) study felt that they had a connection with the "good" girls in the school but the girls reported not feeling respected or connected to the teachers. The girls verbalized that because teachers were not defending them (usually by disciplining others for something done to the girls), they felt that they were not worth being defended. Teachers in rural schools also appear to form opinions about girls before they are even in their classroom, based on rumours or prior knowledge of the family; it prevents them from getting to know the girls for who they really were (Seaton, 2007). More than anything all the girls in Seaton's (2007) study stated that they wanted to be known by their teachers, "not only for who they are, but also for the potential they hold" and for "the person she hoped to become" (p. 11).

Visualization

While girls may enjoy science another disconnect seems to be that they cannot necessarily make the association and see themselves becoming scientists (Baker & Leary, 2003; Blickenstaff, 2005; Bloor et al., 2007; Buck et al., 2008; Campbell & Skoog, 2004; Carlone, 2003; Ginorio et al., 2004; Goodchild, 2004; Lupart et al., 2004; Taylor et al., 2001; Wyer, 2003). "[S]tudents do not see scientists as people they could grow up to be" (Cleaves, 2005, p. 484). Girls need to be able to make a connection between their science classes and a career yet this is difficult for many girls (Goodchild, 2004; University of Alberta, 2000). Since girls cannot see themselves in this profession, the trend is then for them to opt out of science courses if given the choice. Most girls have difficulty visualizing themselves as scientist because they are unclear what a scientist is or what a scientist does (Baker & Leary, 2003; Blickenstaff, 2005; Brickhouse, 2001; Buck et al., 2008; Carlone, 2003; Ginorio et al., 2002; Li, 2008; Ullman, 2010).

In some cases girls are unsure if what they want to do is considered science (Baker & Leary, 2003). Some researchers contend that focusing on research scientists is too far removed from students' realities and difficult to relate to (Brickhouse, 2001;

Brickhouse et al., 2000; Cleaves, 2005). Carlone (2003) also points out that how science is taught in schools is generally not a way for students to get a good idea of what a scientist does; it is following instructions and memorizing facts, rather than exploring and being creative. Instead other professions that use science, such as horticulturalist, should be included in science curriculums and introduced to students (Brickhouse et al., 2000). Alternatively girls may use science class to develop identities such as "environmentalist... or smart health-care consumer" (Brickhouse 2001, p. 289); girls and students in general should be taught to use science to be better citizens in the local and global community (Brickhouse, 2001; Mrazek & Howes, 2004).

Carlone (2003) found that girls felt scientists are geniuses and they cannot see themselves being geniuses. Zirkel (2002) also agrees that students will only pursue a career or goal that they can visualize and points out the part role models can play in the visualization. "Race- and gender- matched role models provide clear and concrete images through which young people can begin to develop a deeper sense of having a place of value within the structure of the larger culture in which they live" (Zirkel, 2002, p. 372). Buck et al. (2008) in their study found that girls' have difficulty choosing scientists as role models because they have a stereotypical, negative image of scientists. Girls cannot visualize themselves becoming geeky scientists with glasses and a lab coat and no personal life. This image of scientists prevents them from being able to identify with them:

> The main reason the girls' originally could not picture a scientist as a role model was (1) role models are persons with whom they have a deep personal

> connection and (2) scientists are "geeky looking" people that are too mean or too smart to be connected to them. (Buck et al., 2008, p. 698)

The girls in Buck et al.'s (2008) study participated in a program which allowed them to interact with female scientists regularly. A few months after interacting with these scientists, girls had changed their view of scientists and were able to relate to them and see them as role models. The girls could see that "scientists are normal people, but know science" (Buck et al., 2008, p. 698). Phillips et al. (2002) included female scientists as role models in their study of Grade 10-12 students. While exposure to a science career increased girls' interest based on hands-on activities, the interactions with the scientists seemed to decrease girls' interest. However they also found that the most recent experiences have the greatest impact on girls' career choices (Phillips et al., 2002). While exposing girls who are interested in science to female scientists may not increase girls' science self-efficacy (Stake, 2003), Wyer (2003) contends that girls who have positive images of scientists are significantly more likely to persist in studying science.

Future prospects. In the 21st century there is still no equality in the workforce for men and women (Barnett & Rivers, 2004; MacDonald, 2000; United Nations Educational, Scientific and Cultural Organization, 2007; Warrington & Younger, 2000; Whelan, 2001; Wiley-Blackwell, 2009). Statistics show that women continue to earn about 1/3 less than men; although the pay difference is less in science disciplines than in other areas. "For every dollar earned by a male doctorate holder, female doctorates earned 77 cents. In contrast, a female in the general labour force earned 71 cents for every dollar earned by a male" (McKenzie, 2007, p. 3). Strangely, in Canada, women with a PhD in agriculture or biological sciences earn less than those with a Masters degree (DeBroucker, Bordt, Read, Harris, & Zhang, 2001). Women also feel that they are less likely than their male counterparts to get a job or be promoted (Adams, 2008; Ceci & Williams, 2007; Rosser, 2004; Sonnert et al., 2007; United Nations Educational, Scientific and Cultural Organization, 2007). Women believe that industry will hire men before women because companies think women will leave to have children (Adams, 2008; Halpern et al., 2007/2008; Kniveton, 2004) and some companies appear to not even interview women (University of Alberta, 2000). "Instead of denying gender discrimination, workers acknowledge it can happen but construct it as singular events that happened in the past, placing the onus on women to overcome such obstacles" (Wiley-Blackwell, 2009, p. 4). Interestingly, Predoi-Cross (2008/2009) points to another gap: that between working mothers and women with no children; she states that the pay gap is larger between mothers and women with no children than between men and women. Statistics from the National Science Foundation show that "[f]amily characteristics, specifically marital status and the presence of children in the home, were found to be related to women's chances for earning tenure and for holding either an associate or full professor rank" (Burrelli, 2008, p. 7).

Science is seen as a medium of power because its findings can have consequences for both the present and the future (Ceci & Williams, 2007; Fox, 2001). Information in science is often seen as authoritative knowledge (Carlone, 2003; Fox, 2001; Fox et al., 2006). Since the information that science produces is so powerful there is a lot of political interest in it (Fox, 2001) and politics can easily spill over into the actual science arena (Ceci & Williams, 2007). "Science and engineering careers thus play an increasingly pivotal role in the overall workforce, and the size as well as the composition of the science and engineering workforce are focal concerns for the government, business, and the media" (Sonnert et al., 2007, pp. 1333-1334). Whelan (2001) calls science "politics by other means" (p. 558). While women have been present and involved in science all along, they have not been in such visible roles as most of the male scientists. Their inventions have also not necessarily been as highly rewarded as those of their male counterparts (Fox, 2001; Rosser, 2004; Whelan, 2001), they may be promoted slower than their male counterparts (Baker & Leary, 2003; United Nations Educational, Scientific and Cultural Organization, 2007; Urquhart, 2000), and have greater difficulty getting jobs than their male counterparts (Hede, 2009; University of Alberta, 2000). Blickenstaff (2005) asks why women would pursue a field in which their efforts are constantly devalued.

Therefore when seen from a historical view, deciding to study science and pursue a career in it requires a lot of commitment and determination for girls (Murphy & Whitelegg, 2006; Rosser, 2004). "Women have to outperform men in order to obtain equivalent recognition" (Dewandre, 2002, p. 278). Even high school girls in Dentith's (2008) study expressed this sentiment that they have to work harder than boys to receive recognition. They felt they had to achieve more than the boys in order to get into male-dominated classes. "They have to prove their worth by doing more, working harder and more purposefully for recognition" (Dentith, 2008, p. 159). These girls also felt that boys had an inherent right to certain classes while the girls had to earn it; thus they ended up feeling the need to compete with other girls to take these classes. "These young women defended their need to compete with one another for the finite number of spaces allocated to them in these male-dominated classrooms" (Dentith, 2008, p. 161). Why would girls enter a field in which their talents are not appreciated when they could enter another area where they receive the recognition they deserve?

Women in science careers leave the profession at about twice the rate that men do (Belkin, 2008; Wyer, 2003), mostly between the ages of 35-40. Most women again attribute it to the work culture in which women encounter:

> sexual harassment (63 percent of women say they experienced harassment on the job); and dismissive attitudes of male colleagues (53 percent said in order to succeed in their careers they had to "act like a man"); and a lack of mentors (51 percent of engineers say they lack one); and hours that suit men with wives at home but not working mothers (41 percent of technology workers says they need to be available "24/7"). (Belkin, 2008)

The scientific workplace tends to remain decidedly "macho" (Belkin, 2008, para. 6; Rosser, 2004; Whelan, 2001). A female computer programmer created for herself a male online identity. For her male online persona she received important job-related information from her male colleagues that she did not receive to her alternate female account (Belkin, 2008). Women in STEM undergraduate programs report more discrimination than those in any other subjects; discrimination both at the individual and at the female gender in general (Steele et al., 2002). These same women that reported discrimination in Steele et al.'s (2002) study also stated that they intend to leave the science programs they were enrolled in.

Work-family balance. Lupart et al. (2004) point out that girls have to choose from "multiple adult life-roles" (p. 26). Thus another reason why women feel less confident in succeeding in a science career is because of the pressures to raise a family

(Adams, 2008; Brickhouse, 2001; Bystydzienski, 2009; Ceci & Williams, 2007; Eccles, 1994; Farmer, 2009; Hede, 2009; Ivie et al., 2002; Kniveton, 2004; MacDonald, 2000). Baker and Leary (2003) note that while in school few girls think about balancing a career and a family however students in MacDonald's (2000) study did wonder about the difficulties involved in balancing both. Both boys and girls in Lupart et al.'s (2004) study agreed that women can have both a family and a career; but "the males are more traditional in their responses than the females" (p. 41). Grade 10 girls in Lupart et al.'s (2004) study were more likely to believe that it is difficult for women to have a family and career than Grade 7 girls. Several studies confirm girls' belief that it is difficult for women scientist to have both a career and family (Blickenstaff, 2005; Brownlow et al., 2000; Ceci & Williams, 2007; Rosser, 2004). The idea that women are the primary caregivers to their children can be a significant obstacle to pursuing a career in science. Some researchers contend that girls who believe that women can have both, a career and a family, are more likely to pursue a science degree (Baker & Leary, 2003; Campbell & Skoog, 2004; Haines & Wallace, 2002; Kniveton, 2004).

Hill et al. (2010) found that, primarily due to the work climate, women in science fields tend to be more dissatisfied with their jobs than men and will leave the profession earlier. Perhaps the low number of women in science sends a message to girls that it is not an attractive profession for them. Some girls seek out female role models that have been successful at having a family and a science career (Gilmartin et al., 2007; Rosser, 2004) but the low number of visible women in science can make this difficult. It would be beneficial to help girls "envisage their future prospects" in science (Goodchild, 2004, p. 114). While a science career requires significant time commitment, women are less likely to make such a commitment because they also need to balance a family with their career (Ceci & Williams, 2007).

Role models

A final factor why so few girls pursue science may be the lack of female role models in science (Belkin, 2008; Bloor et al., 2007; Fried & MacCleave, 2009; Halpern, Aronson et al., 2007; Rosser, 2004; Taylor et al., 2001; Ullman, 2010). "Because women are disinclined to choose careers in scientific and technical fields traditionally dominated by men, such occupations lack female role models to inspire and encourage women to enter these career paths" (Bandura et al., 2001, p. 202). Yet studies have shown that role models can have a positive influence; for example, women in a University of Alberta study acknowledged that role models were influential to them: “Participants frequently spoke of family members (parents in particular), friends, and people in the discipline/field as important influences” (University of Alberta, 2000, p. 4). In another study in Alberta, MacDonald (2000) noted that Operation Minerva, a job-shadowing program for junior high girls with female scientists in Calgary, increased the number of girls interested in science and subsequently pursuing science courses and careers to over 80% of participating girls. “[G]irls will perform at the same level as their male classmates when they are encouraged to succeed, are given the necessary educational tools, and have visible female role models” (Else-Quest et al., 2010, p. 125). Wood (2000) too found that girls’ participation increased substantially by exposing girls’ to female role models and permitting them to have a brief start in a nurturing, all-female environment. Middle and high school girls seem to especially benefit from same-sex role models in science (Gilmartin et al., 2007).

There are two popular role-model theories: one requires a personal, specific role model; the other purports that the mere presence of women sends a message to girls (Gilmartin et al., 2007; Sonnert et al., 2007).

> [F]emale role models may be especially beneficial for women for a variety of reasons: Outstanding women can function as inspirational examples of success...They demonstrate that it is possible to overcome traditional gender barriers... [They] may undermine traditional gender stereotypes about women, thus reducing the damaging potential of stereotype threat effects. (Lockwood, 2006, p. 44)

In a Canadian study of post-secondary students, while female students claimed to identify more with female professors, in the end the gender of the mentor did not seem to have an effect on the students' choice to pursue science as career (Fried & MacCleave, 2009). Downing et al. (2005) separated potential role models, which they term guides, into three categories: mentors, sponsors, and role models. They found that while over 90% of female science majors had a guide at some point, mentors were the most influential followed by role models. Guides during college were also more important to these students than guides they had before college. While most of the guides were female, it is the male guides that were most influential. Their explanation for this is that:

> if women science students see mostly men as leaders in their fields of study, they may be more awed and thus more influenced by male guides than by female guides. Alternately, it may be that men have greater access to power and benefits than do women in science, so that they can bring more

> opportunities to their students (women or men) than can women guides. (Downing et al., 2005, p. 424)

However they acknowledge that having studied only upper level college students, there may well be girls in middle and high school that lack the guides they need to encourage them to pursue science in college (Downing et al., 2005). The female scientists in Rosser’s (2004) study also referred to mentors and role models, predominantly male guides, who had been influential. But Reis and Graham (2005) point out that even interested and informed high school girls can act as mentors to middle school girls interested in science careers.

Studies show that girls need to be able to make a connection to individuals in order for them to serve as role models (Bloor et al., 2007; Buck et al., 2008). It is therefore not surprising that girls frequently cite family members as role models. Unless the stereotypical images of scientists are challenged, girls may have difficulty making a connection with scientists. In a University of Calgary study, Li (2008) used video conferencing with female role models to successfully increase girls’ interest in science by making the sessions relevant to the girls’ lives, boosting their science self-efficacy, and providing them with more information about careers involving science and math. Girls in Buck et al.’s (2008) study however did not consider scientists in videos or books to be role model material because they were not able to establish a personal connection with those scientists. Likewise scientists that were considered by girls as too perfect were not role model material because girls’ did not feel they could live up to that image. According to Buck et al. (2008) “an ideal science role model is someone who has a good personality, expertise in science, and is able to make personal connections" (p. 699). Bandura (1986) adds that role models should also be interesting and attractive to the girls.

In a University of Toronto study female students stated they were more influenced by female role models regardless of whether they were interested in traditional or non-traditional female careers. These female students stated specifically choosing female role models because of their accomplishments or overcoming gender barriers (Lockwood, 2006). Female students in other studies as well expressed a desire for more female science teachers (Fox et al., 2006). For example, female scientists in Rosser's (2004) study admitted that they choose educational institution based on the number of female faculty members in their discipline and note the importance of women in upper level science to attract more girls. Due to the lack of women in many non-traditional female careers, women in these fields are more likely to have males as role models (Gates, 2002). But gender specific role models can be especially influential because students can identify better with someone who shares their background, especially for women in a "traditionally male-dominated profession" (Gilmartin et al., 2007, p. 984).

> It is important to remember that modeling is more successful when the observers perceive similarities between themselves and the models. This may be particularly important to young women and minority students who may not often see themselves reflected in the faces of those who do science. (Britner & Pajares, 2006, p. 495)

Zirkel (2002) too found that students who had race and gender specific role models achieved higher, were more invested in their own future, and enjoyed their achievements more than students that had no role models or did not have race and gender specific role models. She argues that matched role models can show students what is possible for them as members of a specific social group as well as provide them with information that non-matched role models cannot show them--for example, how women can balance a career and family. It is, according to her, the opposite effect of discrimination which reduces achievement and goals. She also notes however that the profession of the role model does not necessarily need to match the interest of the student in order for them to be a successful match. Instead “goals and academic performance can be enhanced by the sense of opportunity afforded by seeing others like you in desirable social positions” (Zirkel, 2002, p. 372). Karunanayake and Nauta (2004) reiterate Zirkel’s findings that students tend to pick role model most similar to themselves, in part because those role models may be able to provide information about how to navigate career paths, including dealing with stereotyping and discrimination. Citing Bandura’s Social Learning Theory, they remind that “people learn from watching others” (Karunanayake & Nauta, 2004, p. 226). Similarly Kitts (2009) states that role models can be influential for a student in forming their identity. “[M]ost human behaviour is learned by observation through modeling. By observing others, one forms rules of behaviour, and on future occasions this coded information serves as a guide for action” (Bandura, 1986, p. 47).

Teachers. Regardless of gender dichotomies and future prospects, in the end one of the barriers that is identified for girls choosing to study science was the interactions they had with their teachers (Baker & Leary, 2003; Bloor et al., 2007; Brownlow et al., 2000; Dee, 2006; Dentith, 2008; Ivie et al., 2002; Murphy & Whitelegg, 2006; Wood, 2000). For girls choosing to study science, the teacher is very important – the teacher’s ability to teach, the support provided by the teacher, and the teacher’s approachability

(Dentith, 2008; Le Mare & Sohbat, 2002; Rosser, 2004). For most students, teachers' ability to teach is more important than the teachers' gender (Francis et al., 2008). Yet girls in Warrington and Younger's (2000) study specifically said that "they were put off physics and chemistry because there were no female teachers in those subjects" (p. 498).

Dee (2006) proposes that there are two teacher gender theories. The gender of the teacher determines how the teacher will interact with the students; or the teacher is a gender-specific role-model (Dee, 2006). Several studies of middle school students show that the gender of the teacher does not have a significant impact on the students (Carrington, Tymms, & Merrell, 2008); instead that the quality of teaching is much more influential than the teacher's gender (Carrington, Tymms, & Merrell, 2005; Martin & Marsh, 2005). Carrington et al. (2005, 2008) noticed though that "women teachers seem to bring out the best in both" girls and boys (Carrington et al., 2008, p. 321). And girls tend to state that they have better relationships with their female teachers (Martin & Marsh, 2005). Elstad and Turmo (2009) found the same to be true in their study of high school students in the relatively egalitarian society of Norway. While they note that girls seemed to connect better with female teachers and felt female teachers created a better classroom environment, they reported that none of their findings were statistically significant (Elstad & Turmo, 2009).

Still Weinburgh (2000) states: "Gender is a significant predictor on student attitudes toward the teacher and enjoyment of science" (p. 9). In a study with high school students, male students rated their female science teachers, regardless of discipline, significantly lower than male science teachers; female students only rated female physics teachers lower than male physics teachers (Potvin, Hazari, Tai, & Sadler, 2009). These poor ratings did not correspond to different pedagogic dynamics or different performance level of students; and both genders of teachers prepared both genders of students equally well for post-secondary level science. Potvin et al. (2009) therefore suggests that students have a physics gender bias even towards their female teachers. Gilmartin et al. (2007) concede that:

> Little is known about the representation of women in high school science contexts, and how this might affect girls' and boys' persistence through the science pipeline over time. Relatedly, very few studies consider how female science teachers in high school act as role models for their students, and/or introduce new and different forms of science that deviate from dominant images. (p. 981)

At the post-secondary level studies show that there seems to be a connection between the number of women in the faculty and number of women receiving degrees in that science discipline (Bettinger & Long, 2005; Sonnert et al., 2007). Bettinger and Long (2005), however, point out that results from their study are mixed. They looked at the gender of the instructor in initial courses taken by students since the initial course can influence the students' interest and success in the subject. Comparing how many subsequent courses the students' took in that subject and if they majored in it, Bettinger and Long (2005) found that female instructors in biology seemed to decrease girls' interest but in math and geology having a female instructor increased interest. It was difficult to determine the effect of female faculty in engineering, physics and computer science since there are so few women instructors in those fields. They also found that male faculty members significantly increased male students' likelihood of pursuing education courses and therefore conclude that same gender instructors may increase student interest after all (Bettinger & Long, 2005).

An interesting study conducted by Schmid (2010) showed that girls in Grade 1 and 2 who did not have math anxiety at the beginning of the year, exhibited math anxiety by the end of the year if they had a female teacher who showed math anxiety. Those girls in turn then grow up believing they lacked math skills and avoided higher math and science classes (Schmid, 2010). Dee's (2006) study showed that the gender of the teacher also has a significant impact on the students' performance--both positive when taught by same sex and negative when taught by opposite sex. "Simply put, girls have better educational outcomes when taught by women and boys are better off when taught by men" (Dee, 2006, p. 71).

> Furthermore, when taught by a man, girls were more likely to report that they did not look forward to a subject, that it was not useful for their future, or that they were afraid to ask questions. This dynamic is strongest in science, where student reports indicate that female science teachers are far more effective in promoting girls' engagement with this field of study. (Dee, 2006, p. 73)

Dee (2006) believes that one reason the gender makes such a big difference is because "the opinions of teachers about their students-- and of students about their teachers--is shaped in part by gender characteristics."(p. 73) The girls in Brickhouse et al.'s (2000) study were all successful in science while taught by a female teacher; however, those that did not conform to behavioural gender norms, quickly lost interest the following year with a male teacher.

In contrast a University of Calgary study conducted with engineering students showed that male and female students with mentors were less likely to plan on having a full-time engineering career as compared to students that did not have mentors. Wallace and Haines (2004) found that mentors, male mentors more so than female mentors, helped female students feel like they belong in the engineering department and that they would receive help if they needed it. Mentoring however did not affect students' self-efficacy in engineering or physics despite students with mentors being more satisfied with their engineering education. Female mentors however did increase students' math self-efficacy and for female students they provided role-modeling that it is possible to balance a career and family (Wallace & Haines, 2004).

Similarly participants in a University of Alberta study stated they trusted teachers who encouraged them to pursue science careers (University of Alberta, 2000). Teachers can help students identify their strengths and weaknesses and encourage them to pursue certain courses of study (Brickhouse et al., 2000; Carlone, 2003; Heilbronner, 2008; Kniveton, 2004; Warrington & Younger, 2000; Wood, 2000). A young lady I met a few years ago liked science and wanted to pursue a science career all through her schooling until she was in Grade 11. That year she got along well with her English teacher but not with her Science teacher, both female teachers. By Grade 12 she decided to study English instead of Science. Fortunately after her first year of university, she remembered how much she enjoyed science and switched majors. One teacher can make a difference.

> I still remember my ninth grade teacher coming up to me after I had gotten an A on a science test and saying, "I didn't think someone like you would do well on that test!" recalls Danica McKellar, 25, who as a teenager played the

> girl-next-door Winnie Cooper on the popular television series *The Wonder Years*. (Mervis, 2000)

One would hope that memories like this one are few and far between, but my experience from personal conversations with girls and women is that incidences like this occur far too often. Murphy and Whitelegg (2006) note that over half the teachers in their study believe girls find physics more difficult than boys which can in turn influence girls' beliefs about their ability in physics even if "performance outcomes did not support these beliefs" (p. 288).

A significant number of girls early on think of their teachers as role models (Carrington et al., 2007). Girls in general tend to be more positive than boys about teachers and are more likely to want to please their teacher (Lupart et al., 2004; Warrington & Younger, 2000; Weinburgh, 2000). Lupart et al. (2004) also found that younger girls (Grade 7) want more approval from their teacher than older girls (Grade 10). While some studies show that the gender of the teacher does not affect students (Brownlow et al., 2000), other studies note that both boys and girls feel more comfortable around female teachers (Gilmartin et al., 2007); believing female teachers to be more approachable (Le Mare & Sohbat, 2002) and less strict, increasing students' self confidence and trust but not affecting their achievement or career goals (Gilmartin et al., 2007).

After the home, schools are the "next important socialization context" (Lupart et al., 2004, p. 30) for children. Teachers can not only be role models but can also directly or indirectly affect students (Gilmartin et al., 2007). "By eighth grade the teacher had assumed an important role in the science classroom. Attitudes toward science were often dependent on whether the teacher made the subject fun or boring" (Baker & Leary, 2003, p. S182). Students' attitudes to science frequently seem to be related to their attitude to their science teacher. One way that teachers influence students is by taking them and their ideas seriously and allowing them to investigate, increasing students' self-efficacy (Brickhouse et al., 2000; Heilbronner, 2008; Phillips et al., 2002; Tan & Barton, 2008; Warrington & Younger, 2000). This way teachers can also help students lower their science anxiety and feel more successful in their science activities (Britner & Pajares, 2006; Tan & Barton, 2008). Brownlow et al. (2000) confirmed that those students who had effective teachers also tended to have lower science anxiety. Similarly LeMare et al. (2002) note that teachers who are seen as unapproachable and make it difficult for students to ask questions evoke strong negative feelings: "Discouraging interactions were seen to evoke negative affect such as fear, embarrassment, frustration, anger, and feeling 'put down'" (p. 251).

Several studies found that science teachers are frequently viewed as unapproachable and appear to give boys more attention than girls (Blickenstaff, 2005; Brickhouse et al., 2000; Dentith, 2008; Warrington & Younger, 2000). Teachers who give boys more attention than girls can function as a turn-off for girls' interest in science (Francis & Skelton, 2005; Warrington & Younger, 2000; Wood, 2000). Some studies contend that teachers interact more with boys because they receive more pressure from the boys (Dentith, 2008; Fennema, 2000; Warrington & Younger, 2000) but Fennema (2000) claims it is not enough to cause the gender gap. Nevertheless, Warrington and Younger (2000) found that it annoys girls when boys are given the majority of the teacher's attention. "Fiona explained that, in her science class, it seems like her teacher paid no attention to her: ‘I had my hand raised for like 20 minutes, and he just ignored me. Just talking to all the boys and everything’” (Seaton, 2007, p. 9). In some cases girls believed that their science teachers spent more time dealing with boys because the boys understood the subject better (Le Mare & Sohbat, 2002) and “that the teacher seemed easily frustrated with the girls and was irritated by their questions” (Warrington & Younger, 2000, p. 498).

The difference in participation appears to increase with age. With girls receiving the message that boys’ participation is more important they naturally want to move to an environment where they are more valued (Blickenstaff, 2005; Dentith, 2008; Warrington & Younger, 2000). The teachers in Buck’s (2002) study were all volunteers who wanted to give girls a voice in science; yet they interpreted the girls desire for learning to be “fun” and “interesting” as being “immature” (Buck, 2002, p. 45). A 1992 Eccles and Jussium study showed that teachers’ opinions of how a student would perform dictated the student’s actual performance later that year (Halpern et al., 2007/2008; Jussim & Eccles, 1992). The powerful influence of teachers’ opinions and stereotypes has been documented in other studies as well (Carlone, 2003; Warrington & Younger, 2000). These studies “suggest that stereotypes of science as masculine may prejudice educators against girls from the start” (Halpern et al., 2007/2008, p. 50). Girls have also expressed that they feel uncomfortable in classes where their male teacher demonstrates sexist behaviours such as flirting with girls (Francis & Skelton, 2001; McCarthy, 2009), not taking them seriously, or conversely joking with boys and excluding girls from the boys club (Warrington & Younger, 2000). While boys are praised for their work, girls are praised for their looks (Blickenstaff, 2005; Brickhouse et al., 2000; Dentith, 2008). Dee

(2006) confirms that teachers “offer praise and remediation in response to comments by boys but mere acknowledgement to comments by girls” (p. 70) thus subtly communicating different expectations.

Studies confirm that teachers appear to have higher expectations of boys in science and subsequently treat boys better and encourage them more (Dentith, 2008; Murphy & Whitelegg, 2006; Warrington & Younger, 2000). Unfortunately in one study, being made aware of the unequal treatment given did not change teacher practices (Murphy & Whitelegg, 2006). Sadly some teachers continue to hold a sexist attitude and have low expectations for women in science (Blickenstaff, 2005; Dentith, 2008; Murphy & Whitelegg, 2006; Warrington & Younger, 2000). For teachers who think girls’ achievement in science is based more on effort than ability, it can affect how they interact with girls (Brownlow et al., 2000; Dentith, 2008; Warrington & Younger, 2000). Brickhouse et al. (2000) also noted that teachers responded positively to the girls who followed acceptable gender behaviour and negatively to the girls that acted a bit like boys. In the end how they were treated by teachers discouraged some girls from studying science (Brownlow et al., 2000; Murphy & Whitelegg, 2006; Warrington & Younger, 2000).

Another aspect to consider is that some girls do not consider their science teachers to be scientists or even do “real” science (Baker & Leary, 2003; Gilmartin et al., 2007; Kitts, 2009). Therefore they also do not consider them to be role models for what a scientist is and would not approach their teacher for information or advice about a science career (Baker & Leary, 2003). From the teachers’ perspective, Bloor et al. (2007) point out that most teachers do not feel that they are knowledgeable enough to adequately represent what a STEM career looks like. However students appear more likely to feel that their male science teachers do more “real” science than female science teachers (Baker & Leary, 2003; Gilmartin et al., 2007). For the girls in Carlone’s (2003) study one teacher was a scientist, extremely smart, knowledgeable, always had an answer; although he was a good teacher, in the end he was not someone that the girls’ could identify with and choose as a role model. They did not believe themselves to be able to be that smart (Carlone, 2003).

Parents. Parents have a significant influence on girls’ career choices. Parental influence tends to be stronger than that of teachers; not only do parents act as an example but they are a source of support as well (Bystydzienski, 2009; Farmer, 2009; Kniveton, 2004; Rosser, 2004). Girls with a strong self-efficacy are more likely to study science and their self-efficacy is in turn related to their parental bonds. A secure home environment with growing autonomy allows girls to build up their self confidence in their science abilities. Yet for girls, parents have been found to be the single strongest negative influence because they may give girls different treatment, fewer opportunities to experience science outside of school and have different expectations for girls (Baker & Leary, 2003; Ceci & Williams, 2007). Crowley et al. (2001) conducted a study with very young children and parents interacting at science exhibits. They noticed that while boys and girls showed about the same interest in the exhibits, parents were three times more likely to explain the science concepts to their boys than to their girls; this was more pronounced for fathers than mothers (Crowley et al., 2001). In another study parents selected high school courses for their children; these parents consistently selected more science courses for boys and more language arts courses for girls (Tenenbaum, 2009).

Bleeker and Jacobs (2004) note that “adolescents form their self-perceptions on the basis of more than just their own performance. Gender-differentiated messages from parents and other sources may account, in part, for their non-data-based beliefs” (p. 107). According to Jodl et al. (2001) parents have a direct influence on what their children think about academics and their potential. Thus when parents hold gender stereotyped beliefs about which subjects their children will be successful in, it also significantly influences the child’s own beliefs about her abilities in that subject (Eccles, Jacobs, & Harold, 1990; Fredricks & Eccles, 2002) more than even her grades in that subject (Frome & Eccles, 1998). Halpern et al. (2007/2008) point out that how parents and teachers respond to children also influences the children’s views of themselves and their abilities. Parents tend to make more discouraging remarks to girls in general than to boys (Tenenbaum, 2009). For example, even though there were no differences in the boys’ and girls’ self-efficacy, interest, or grades in science, parents in Tenenbaum and Leaper’s (2003) study treated their daughters as less able to understand and less interested in science.

Several studies corroborate that parents have a significant influence on girls’ career choices (Gates, 2002; Ivie et al., 2002; Scott & Mallinckrodt, 2005; Wood, 2000), especially fathers (Gates, 2002). While some studies point to the influence of the fathers and other studies to the influence of mothers, Kniveton (2004) differentiates parental influence by birth order; the oldest child is most influenced by the father while the youngest is most influenced by the mother. Younger children are also influenced more by older siblings than by parents (Kniveton, 2004). However Jodl et al. (2001) state that by Grade 7 parents may not be significantly influencing the child’s career choice anymore, but they are still influencing the child's academic beliefs. Instead by Grade 7 other sources such as peers become more influential on a child's career choice (Jodl et al., 2001).

Some studies state that fathers have a more significant impact than mothers because fathers are seen as career role models (Scott & Mallinckrodt, 2005). However, as Bloor et al. (2007) point out: if parents are not working in STEM careers, it is difficult for them to be STEM role models. Female scientists Kaufman, Ewing, Montgomery, Self, and Hyle reflected on their journeys to becoming women in science and discovered that they too viewed their fathers as their main connection to science (Mueller, 2004). In Tenenbaum's (2009) study it was also fathers who were found to speak more discouragingly toward girls than mothers did, and fathers dumbed down their explanations of science concepts to girls as compared to boys (Tenenbaum & Leaper, 2003).

However mothers can have a strong influence on girls' science beliefs as well (Bleeker & Jacobs, 2004; Tenenbaum & Leaper, 2003). Gender stereotypes held by mothers influenced their belief whether their child would be successful in science (Jacobs & Eccles, 1992); the mother's belief of her child's success in science (Bleeker & Jacobs, 2004) and interest in science (Tenenbaum & Leaper, 2003) in turn effected the child's self-efficacy (Bleeker & Jacobs, 2004; Tenenbaum & Leaper, 2003), interest (Tenenbaum & Leaper, 2003) and later on career choice (Bleeker & Jacobs, 2004). Mothers talked science more with boys even at an early age which in turn was found to predict the child's science literacy by Grade 6 (Tenenbaum, Snow, Roach, & Kurland, 2005). While mothers' beliefs did not have the same effect for boys, girls were up to four times less likely to enter a science career in which women remain underrepresented if their mother believed they would not be successful in a science career. Mothers of Grade 7 boys tended to believe that their child would be successful in science more so than mothers of Grade 7 girls (Bleeker & Jacobs, 2004). Jacobs et al.'s (1998) study of rural girls showed that the mother's belief of science as a beneficial career choice for women and the mother's belief in her daughter's ability in science is crucial to rural girls choosing to pursue a science career. Jacobs et al (1998) found this is especially true in rural areas where more narrow, traditional gender roles are held for women and girls need to know that their interest in science is acceptable. According to Jacobs et al. (1998), for rural girls, their mothers' beliefs are the single most influential factor.

A family's socioeconomic status likewise can have a significant influence on a child's education and career choice (Bandura et al., 2001). The socioeconomic status is linked to the parent's belief that they can affect their child's education; hence, the "higher the family's socioeconomic status, the stronger the parents' beliefs in their efficacy to promote their children's academic development and the higher the educational aspirations they have for them" (Bandura et al., 2001, p. 197). In a ten year longitudinal study in British Columbia, Adamuti-Trache and Andres (2008) found that students with university educated parents were significantly more likely to study science in high school; while students from non-university educated parents were more likely to opt out of taking science courses. Thus girls from rural areas may be less likely to study science in high school and consequently in university and therefore less likely to pursue a science career.

Media. Rarely are women portrayed as scientists in the media or textbooks (Barnett & Rivers, 2004; Blickenstaff, 2005), but media is a significant source of models for today's youth which can affect their self-efficacy through vicarious experiences (Bandura, 1997). Baker and Leary (2003) found that media had a big impact on girls' view of scientists. "If you grow up seeing only male engineers, pilots, and truck drivers, then of course you accept the 'fact' that only men have the ability to do such jobs" (Barnett & Rivers, 2004, p. 166). Most TV shows, for example, star men as the scientists--Mr. Wizard, Bill Nye, Mythbusters, The Big Bang Theory--to name just a few. A popular current show, the main characters in the Big Bang Theory are four male physicists, with one female physicist, Lesley, periodically in various episodes of the show. While she is "portrayed as strong, confident, smart" she is "also unfeminine and unstylish"; not a positive female role model since she acts like a man (R. Morrison, personal communication, January 20, 2010). One other female physicist makes an appearance on the show that lasts less than one minute; while she also appears confident and smart, unlike Lesley, she is well-dressed and feminine. However it only takes 40 seconds for one of the main male characters to sexually harass her (Holland, 2010). Referring to another show, a girl in Baker and Leary's (2003) study was asked if she thought she could be Mr. Wizard someday to which she poignantly replied no, because she is a girl.

Unfortunately female scientists portrayed in the media are rarely shown as knowledgeable experts; rather, they are usually the assistant to a man who is the expert. According to Brownlow et al. (2000) this negative attitude about women in science contributes to girls' science anxiety which in turn results in them less likely to pursue a science career. However, when media does portray a positive female science role model, it can have a significant impact on girls (Baker & Leary, 2003), including encouraging their interest in science and motivating them to pursue a science career.

> In general, this group of girls is not getting a clear message from society at large as to who scientists are and what it is that scientists do. They received mixed messages from the media, where scientists were often portrayed as strange-looking males doing bizarre things in laboratories. However, when the girls did encounter positive messages these were very influential. (Baker & Leary, 2003, p. S193)

Other. The image of science portrayed by media is also fostered in our schools through underlying bias in textbooks and curriculum design. Science textbooks for example have significantly more pictures of men than of women doing science (Wood, 2000). Apart from media and printed material, peers also can be influential on girls' beliefs and interests. Generally science receives a high academic status and those students that can do science are considered to be intelligent (Osborne & Collins, 2001) which may not be a desirable quality to most girls in middle or high school. Around middle school girls will often start to downplay their intelligence for fear of being "isolated". "It is within these critical years that girls' identities become lost within the dominant structure" (Buck, 2002, p. 30). The need to be a member of a group and belong is important for girls' identity and social interactions (Breakwell et al., 2003). A girl may feel that if she achieves in science she is less feminine (Blickenstaff, 2005) and less capable of belonging to a desirable group. Breakwell et al. (2003) called it the "black-sheep effect" (p. 437) which in their study revealed itself as girls who did not like science discriminating against girls who did like science. Likewise Jacobs et al. (1998) found that in rural areas where traditional views of women's roles are held, a girl that is interested and capable of pursuing a science career may not do so if she is not supported by her peers and community. Not only was the support important but rural girls expressed a desire to share their science experiences with their peers as important (Jacobs et al., 1998). So for these girls it was important to not only be a part of a community but also to share their learning within that community.

> Learning is happening all the time – whenever a person engages in activity in the world. Learning is unavoidable. It is what is required in the process of becoming a person. Learning is not merely a matter of acquiring knowledge, it is matter of deciding what kind of person you are and want to be and engaging in those activities that make one a part of the relevant communities. (Brickhouse, 2001, p. 286)

Girls recognize the importance that science can have in their lives, but the complexity of the conditions: the pedagogic dynamics, external influences, a need for acceptance, and others, can make science seem like a strange and uninviting community to girls. We teach facts and formulas instead of allowing them to learn science with connectivity and creativity. How can they feel accepted in science if the majority of individuals they see are men? "Modeling supplemented with guided mastery experiences provides an especially effective vehicle for building resilient self-efficacy" (Bandura, et al., 2001, p. 202). This research study investigated what factors, specifically if the lack of positive visible female role models discourages rural girls from pursuing careers in science. It is just one part of the "leaky pipeline", but perhaps it is important enough to encourage change.

Chapter 3: Methods

This study set out to determine the effect role models have on girls' interest in science and the research was therefore focused on Grade 8 and Grade 11 girls because repeatedly studies have shown that these years are important in interest and career formation: during these years teenagers start to form their own values and make their own decisions (Lupart et al., 2004); they carefully observe those around them to determine what is possible for them to do (Zirkel, 2002) and narrow down possible career paths (Phillips et al., 2002); they form a view of themselves – what group and who they want to be identified with (Brickhouse et al., 2000). "Adolescence is a time when critical decisions are made about which identities to adopt and which domains are worth investing in" (Zirkel, 2002, p. 374). In their study of rural girls' interest in science careers, Jacobs et al. (1998) note that decisions to pursue a science career are almost always made by high school, very rarely are new science recruits added to the pipeline after high school. Furthermore Zirkel (2002), in her study with 12-14 year olds, found that role models are crucial at this stage. Role models can help with questions such as: How can they fit science into their identity? Do they even "want to understand the world scientifically" (Brickhouse et al., 2000, p. 443)?

There have been several different approaches to studying girls' interest in science. For example, Lupart et al. (2004) repeated Eccles' decision making model study with a large population of Grade 7 and 10 students in Canada since there is little Canadian research literature about this. Owen et al. (2007) retested the WiSS in a school in Texas and determined that the questions could be condensed into two categories of equality and sexism. These questions included statements such as: "Women can be as good in science careers as men can. Women can make important scientific discoveries. A woman with a science career will have an unhappy life. A woman's basic responsibility is raising children." (Owen et al., 2007, p. 1471) and others. Gilmartin et al. (2007) administered surveys to Grade 10 girls and boys in southern California and also asked some girls to respond to certain questions as if they were a boy.

Procedure

Likewise this study used a survey, however focusing on Grade 8 and 11 girls and also asking boys their opinions and responses. Survey data was entered into an Excel spreadsheet for data analysis. Baker and Leary (2003) used focus group interviews in their study to provide context and similarly, in this study the survey was followed up with selective small group interviews of the Grade 8 and 11 girls to obtain a deeper understanding of how the lack of positive, visible female role models in science affects girls' decisions to pursue science. Of the girls surveyed, 19 were selected for interviews if they previously volunteered to be interviewed by signing their names at the end of the survey. Although 20 girls had initially volunteered, one girl was not selected for interviews because her father is the science teacher and her presence in the interviews could have influenced the other girls. The girls were divided into groups based on their response to survey Question 41: "Science is interesting". Five of the 19 girls selected for interviews indicated on their survey that they did not find science interesting, with the remaining 14 rating the statement "Science is interesting" as either "Agree" or "Strongly Agree". This resulted in six groups of girls that volunteered to be interviewed: two Grade 8 groups with girls interested in science (7 of 9 Grade 8 girls, consisting of Donna, Emma, Gina, Holly, Jenny, Karla, and Cindy), one Grade 8 group not interested in science (2 of 9 Grade 8 girls, consisting of Linda and Marie), two Grade 11 groups with girls interested in science (7 of 10 Grade 11 girls, consisting of Cathy, Alicia, Beth, Sara, Ruth, Tanya, and Anna), and one Grade 11 group not interested in science (3 of 10 Grade 11 girls, consisting of Steph, Yvonne, and Katie). The largest group contained five girls and the smallest group was two girls. The interviews lasted about one hour and were transcribed and coded for recurring themes.

Instruments

The 52 question survey (Appendix A) took about ten minutes to complete and asked about career choices, views of science, science class, people who work in the sciences, gender differences, role models, self-efficacy, and stereotypes. Very few of the questions allowed for open-ended responses and most were based on a four point Likert type scale. All questions forced an answer from the respondents with options such as “none” or “I don’t know” where applicable. The survey was piloted in one of the schools with some Grade 8 and Grade 11 girls and boys of the previous academic term. The responses from the boys were used as a comparison to the girls’ responses to verify a gender difference as opposed to a potential school culture or teacher specific phenomenon.

The interview questions were designed to complement the survey questions while also allowing for deeper exploration of various topics related to girls’ interest in science and effect of role models. Refer to Appendix B for the question template used as guidance during the interviews.

Participants

This study focused in part on Grade 8 girls based on Baker and Leary's (2003) study which found Grade 8 girls to have the strongest gender and science stereotypes. Baker and Leary (2003) also found that "[b]y eighth grade the teacher had assumed an important role in the science classroom. Attitudes toward science were often dependent on whether the teacher made the subject fun or boring" (p. S182). Likewise Dee (2006) notes that most of the gender studies between students and teachers have been conducted at the post-secondary level instead of dealing with adolescents who tend to be more sensitive about gender issues and therefore focused his study on Grade 8 students as well. Furthermore, Weinburgh (2000) points out that students' attitudes shift from being positive to being negative in Grade 8. Seaton (2007) also noted that Grade 8 girls in rural contexts are looking for support and guidance as they frame identities and future possibilities for their lives.

Grade 11 girls were also included in this study because they are thinking more about career choices and post-secondary studies but still have some secondary education to complete. Wyer (2003) notes that career choices are easily influenced by societal factors and that "degree aspirations may be the one that most reflects decisions in the making" (p. 10). Furthermore Baker and Leary (2003) found in their study that Grade 11 girls appear to believe that boys are better at science. Yet at the same time Grade 11 girls seem to recognize that considering science to be a male discipline is a stereotype (Baker & Leary, 2003).

The girls and boys are students in two rural high schools in southern Alberta, a school culture which based on data from Alberta Education (2010) seems to represent about 25% of schools in Alberta. As Harmon et al. (2003) note, there is a "lack of research on, and understanding of, the teaching and learning of science and mathematics in poor, rural school environments" (p. 53). Both schools are within about an hour driving distance of larger urban centers that provide opportunities for the students to participate in extracurricular activities such as science camps. The students also have access to universities and technical colleges in these urban areas that offer various disciplines of science education. In 2008, both towns in which the schools are located had a population under 2,000 and an average family income of approximately $50,000 (AlbertaFirst.com, 2008). The schools' grades range from 7-12 and in 2009/2010 had a student population of 175-217 students (Alberta Education, 2010). Typically, according to other studies, most rural schools have a population of less than 400 students in Grades 9-12 (Harmon, 2001; Howley & Harmon, 2000) and so these two schools fall well within the student population definition.

Methods of Analysis

Interviews were transcribed and coded for recurring themes. Tallies were used to determine which themes recurred in the different interview groups. All girls' names were replaced with pseudonyms and are in no way linked to their actual identities.

The majority of the survey questions were based on a 4 point Likert-type scale however for analysis it was changed to a 9 point scale as some students marked in between two options. On the 9 point scale 1 indicated strong negative opinions toward science and 9 indicated strong positive opinions toward science. The following questions were reversed to have a higher number indicating a more positive association to science: 14, 22, 27, 36, 38, 42, 43, and 44. The coding of any survey questions is described below when the question is discussed in greater detail. Questions 2, 3, 7b, and 31 were open ended questions and Questions 15, 26, and 28 asked students to provide details to their previous answer. Other coding included “Yes”=2, “No”=1 for Question 7a, “Female”=2, “Male”=1 for Questions 4b, 7c, 9, 12, 29, and 30. Questions 10 and 11 provided students with a list of dichotomous traits; it was therefore analyzed on a 3-point scale where 1 represents the negative trait, 2 is neutral, and 3 is the positive trait. Question 39 was analyzed with a count of names recognized as scientists, non-scientists and gender differentiated; maximum possible count for each category was ten. In retrospect not all of the survey questions elucidate the hypothesis and are therefore not included in the following discussion; however measures of central tendency for the omitted questions can be found in Appendix C. Of the total 144 surveys, 5 surveys were discarded as the student did not indicate gender. The remaining 139 surveys were used for the following survey data analysis unless otherwise noted. Student participation was broken down by 20 Grade 8 girls, 34 Grade 8 boys, 46 Grade 11 girls, and 39 Grade 11 boys. The terms “Grade 8” and “Grade 11” refer to both boys and girls together unless specified (e.g., “Grade 8 girls”). Also unless otherwise indicated, all students’ survey responses are presented. As explained by each of the applicable questions below, some analysis was only conducted on specific groups of students.

Measures of central tendency and in some cases frequency were calculated for the survey responses. Median is also included because it is not as influenced by extreme data and may therefore present a better measure of central tendency for smaller groups (Gonick & Smith, 1993); while the median does not provide any more informative data for all questions, it does so for some questions and is included to reduce the effect of outliers in the data. No inference should be drawn from this data as it is exploratory and descriptive in nature. Also the sampling of participants was a convenience sample for exploratory purposes and not a random sample; as such statistical significance is not examined. Nevertheless patterns and trends observed could serve as a starting point for more in depth research with rural Alberta students' interest in science.

The survey data was used in part to select interview participants and also to confirm themes that emerged from the interviews. The interviews provided the rich, in-depth perspective from girls desired to obtain a better understanding of their interest and perception of science and women in science. Therefore the survey data is presented in association with the interview data. Again the purpose of this study was exploratory and permitted determining how girls in rural southern Alberta might compare with girls studied in other research projects.

Chapter 4: Results

The mixed-methods approach resulted in both qualitative and quantitative data. The data below is therefore also presented in a blended approach to provide more coherence for the themes discussed. As the interviews were the focus of this study, themes from the interviews are presented framed by related survey data. This permits focused reading of the themes supported by both interview and survey data instead of the more traditional approach of separating qualitative and quantitative data which in this case would disrupt the continuity.

Based on the context provided by the girls in the interviews, role models are broadly defined as individuals with a positive impact on the girls in that field of study, encouraging their interests and possibilities in it. Generally the phrases “women in science” or “women with science careers” were used, however in a few instances the term “scientists” was used in order to get the girls’ impression of non-traditional female science roles. However, as indicated in the introduction, when “scientist” is used in the analysis and discussion of the data it includes the broader range of an individual who has studied science at the post-secondary level and works in a field related to those studies. Any deviations from previously provided definitions are noted as applicable in the discussion following its occurrence.

Ten of the 14 girls surveyed stated wanting to pursue a science career; of which 12 were in their opinions traditionally female science careers; the two non-traditional science careers were doctor and forensic scientist. Only one of the 19 girls stated that she was undecided and the remaining eight girls stated they were pursuing traditional female non-science careers such as accountant, psychologist, or teacher. Four of the six groups interviewed spent a considerable amount of the interview time voicing their frustration with their current lack of quality science education. Throughout these interviews their frustrations kept resurfacing and it was evident that most of the girls wanted better science instruction regardless of whether they found science interesting or not.

The themes discussed below emerged from the interviews and were tallied across the groups; Appendix D contains the themes and tallies from the interviews. In the results below each theme is supported by samples of conversation from the interview transcripts, edited for conversational items such as uhms, like, yeah, etc.... as well as repetitions and fragments for ease of reading; all names for the girls are pseudonyms and do not relate to their actual identity. If applicable, interview excerpts are related to data from the surveys; Appendix E displays survey question numbers as related to the interview themes.

Theme 1: Science as a Masculine Discipline

As seen in the conversation excerpts below, while girls felt they are capable of doing science and contributing to science, most of them feel that men still have the "upper hand" in science careers. They spoke of men being experts, more likely to be hired, and a "macho image".

Women are just as capable to do science as men. Of the girls interviewed in this study, sixteen vocalized that women are just as good at science as men and some of them felt that women are better. They also spoke about girls in their classes doing better in science than boys but attributed it to girls working harder, paying attention, and being interested in school which they repeatedly noted boys were not. Some of the girls acknowledged that the ability to do science or an interest in science is dependent on the individual rather than gender.

> [Sara]: ... I think the guys probably get more recognition even though the girls may be just as good or better.
>
> [Alicia]: I think it really does depend on the individual not the gender.
>
> [Marie]: I think women can do whatever boys think that they do because when you see people doing construction you sometimes see women doing that as well, you see women being scientists, you see women doing rig moves, you see women doing everything and I think that if a woman wants to be a scientist they can do that. I think some of the smartest people in the world right now as we know it, the scientists, some of them are actually women that have found out things that some boy scientist would never find out.

The survey data confirms what the girls stated in the interviews. Grade 8 girls were least likely to believe that boys are better at science than girls and Grade 11 boys were more likely to agree that boys are better at science than girls (Table 1, Figure 1). Lupart et al. (2004) made a similar observation in their study and it also corresponds to Kitts (2009) study that perceptions have changed and people believe girls are capable of doing science.

Table 1

Descriptive Statistics for Question 42

	Q42: Boys are better at science than girls (reversed)				
	Gr. 8 Girls	Gr. 8 Boys	Gr. 11 Girls	Gr. 11 Boys	Total
Mean	6.75	6.65	6.52	5.79	6.38
Median	6.00	6.00	6.00	6.00	6.00
Std. dev	1.07	1.07	0.98	1.66	1.28
n	20	34	46	38	138

Note. Responses to Question 42 are reversed, thus a high number indicates stronger disagreement with the statement.

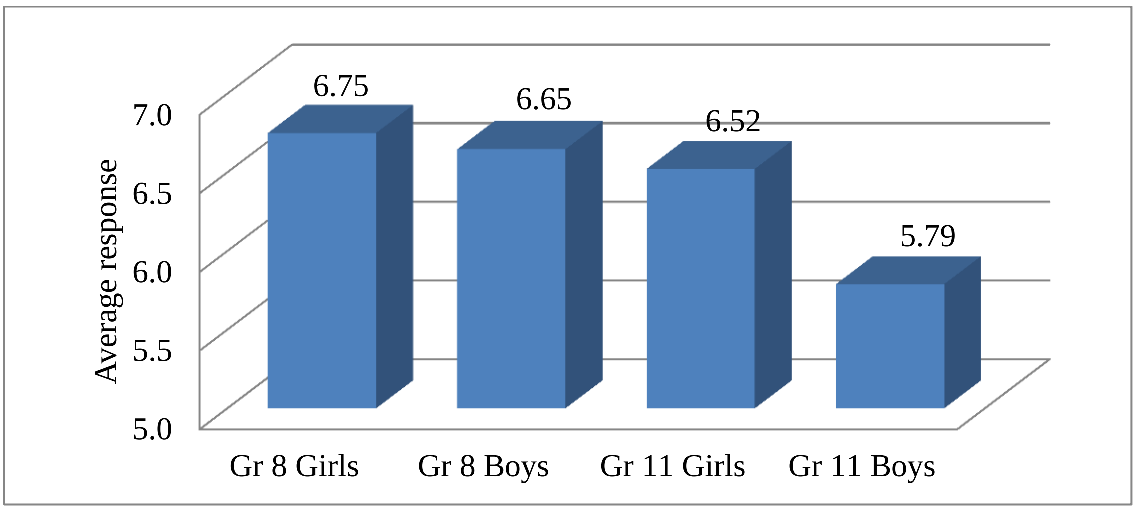

Figure 1. Average responses to Question 42 (reversed): Boys are better at science than girls.

Men more likely to be successful. About half of the girls interviewed felt that men were more likely to be hired or would be more successful in a science career. Some of them extended this thought to other “big” careers, a concept that resurfaced when they spoke about men being the experts or main person and women being assistants.

> [Katie]: I think just in general women don’t get hired as much for corporations and stuff like that

> [Cathy]: ...you might not think they're (women in science) as good for some reason, you might stereotype them that they'll not succeed as much as a guy would
>
> [Cathy]: they might be like - the woman might be better, that they'll be like well in the long run I think a guy might be able to handle it better than a girl so that maybe they'll just choose because of that
> [Alicia]: And it does make a difference if it's men or women choosing what's going on too right
> [Beth]: if it's a woman they're more likely like lets
> [Alicia]: hire other women
> [Alicia]: but if it's a man he might not be as happy to do that
> [Alicia]: until women get into the job it might be difficult cause if more men keep getting hired than they might just keep
> [Beth]: hiring more men 'cause they know that the men are working out
> [Alicia]: more men, more men, more men. So until you get more women in there it might be harder to get it more evened out

Table 2 and Figure 2 show that based on average survey responses, Grade 8 students agreed less with Question 38: I think that men are more likely to be hired than women for science careers. But Grade 11 girls, who are thinking more about career choices, on average agreed the most with the statement and Grade 8 girls agreed more with the statement than Grade 8 boys.

Table 2

Descriptive Statistics for Question 38

	Q38: I think that men are more likely to be hired than women for science careers (reversed)				
	Gr. 8 Girls	Gr. 8 Boys	Gr. 11 Girls	Gr. 11 Boys	Total
Mean	5.53	5.94	4.91	5.28	5.35
Median	6.00	6.00	6.00	6.00	6.00
Std. dev	1.71	1.37	1.24	1.49	1.45
n	19	33	46	39	137

Note. Responses to Question 38 are reversed, thus a high number indicates stronger disagreement with the statement.

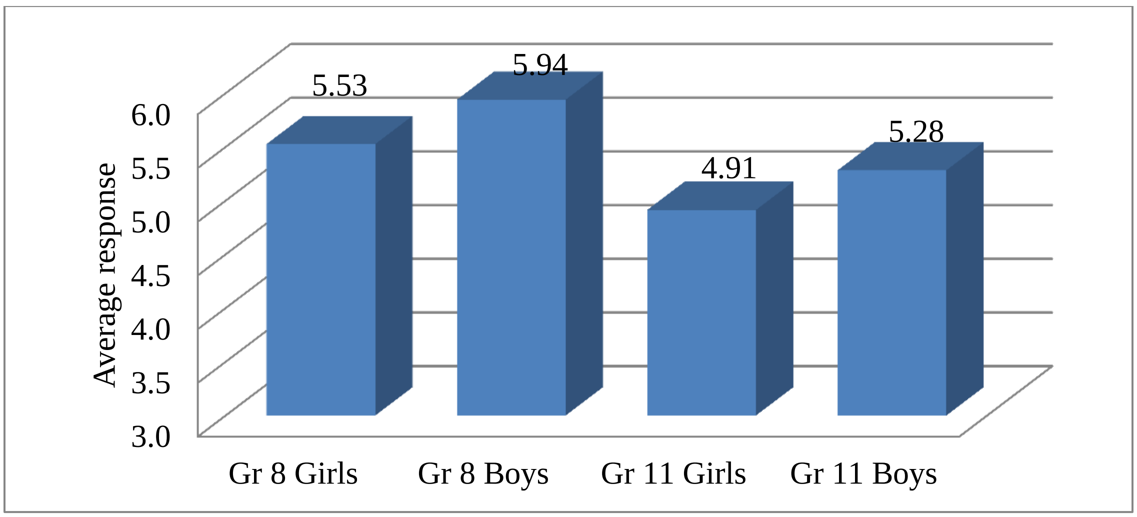

Figure 2. Average responses to Question 38 (reversed): I think that men are more likely to be hired than women for science careers.

Macho image. Half of the girls too spoke about a “macho” mentality the boys exuded which made girls feel that boys think they are smarter and better at most tasks. This was not an idea that was addressed in the surveys and only surfaced through the interviews. But if these girls feel that science continues to be dominated by men, this “macho image” could add to girls believing science is not a community they would enjoy belonging to or welcoming to women.

> [Steph]: guys always have the final say kind of thing
>
> [Beth]: I think it’s the subconscious thing that men are still viewed more better at things than women
> [Alicia]: particularly by other men
>
> [Emma]: guys think they’re way better than girls at some things that they do
> [Donna]: they think that they have everything like they’re better, they’re smarter, they’re faster
> [Jenny]: the best
> [Emma]: they have a macho motto
> [Donna]: macho man
> [Jenny]: yeah, they think that they’re just the toughest and they know everything and can do everything when it’s not always that way

Women’s work less recognized. Several of the girls in the interviews noted that women’s work seems to be less recognized than that of men. Three of the girls initiated a reference to the list of scientists’ names I had provided on the survey, commenting that they knew several if not most of the men but nearly none of the women.

> [Sara]: I just don’t think the recognition is the same. ‘Cause I know when we were doing the [survey] I was like - yeah girls get recognized just the same. Then when I was going through looking at all the scientists I barely, I only knew one of the girls but I knew like all the guys and so I think the guys probably get more recognition even though the girls may be just as good or better
>
> [Linda]: ... I just don’t think they get as much acknowledgement as a guy would because when you hear about laws and principles that your teachers teach you, I don’t think I’ve ever heard of a woman who has a principle like that. And I’m sure there are, I’m sure there’s tons, it just seems like they don’t get as much popularity as like Albert Einstein or Isaac Newton.

The surveys indicated that both Grade 8 and Grade 11 girls were less likely to agree with Question 37: I think that in science, women receive the same recognition that men do.

Grade 11 girls agreed least with the statement as shown in Table 3 and Figure 3. Figure 3 also shows the median because for Grade 11 girls the response appears to be even more negative when accounting for outliers.

Table 3

Descriptive Statistics for Question 37

	Q37: I think that in science, women receive the same recognition that men do				
	Gr. 8 Girls	Gr. 8 Boys	Gr. 11 Girls	Gr. 11 Boys	Total
Mean	5.70	6.00	4.87	5.59	5.46
Median	6.00	6.00	4.00	6.00	6.00
Std. dev	1.75	1.32	1.38	1.31	1.46
n	20	33	46	39	138

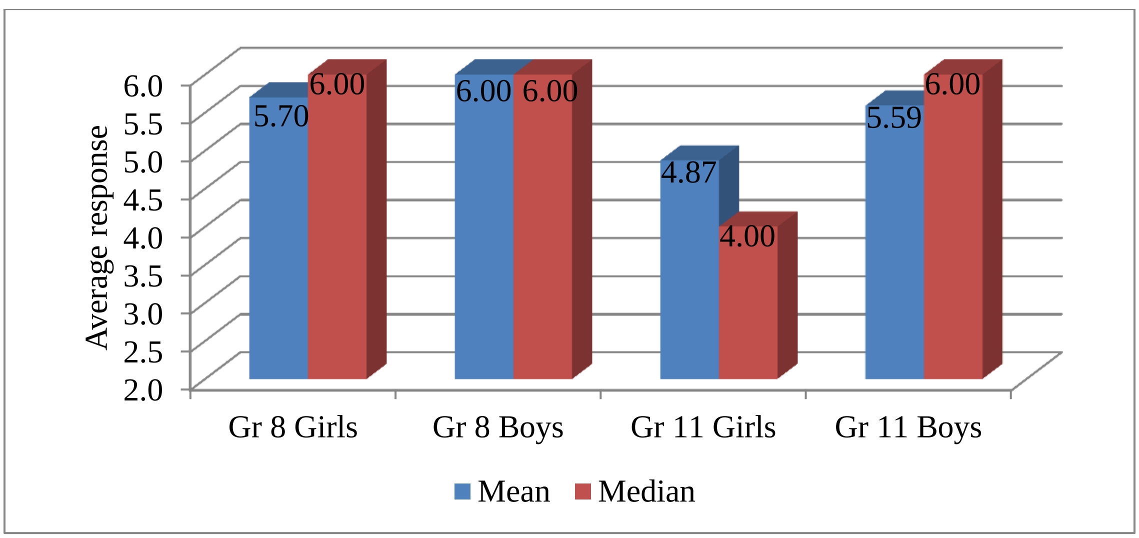

Figure 3. Average responses to Question 37: I think that in science, women receive the same recongition that men do.

Women's rights recent. Over half of the girls noted that part of the issue may stem from women's rights being a recent phenomenon. In their opinions, women taking jobs instead of being homemakers is still a young concept.

[Katie]: just ‘cause traditionally women are supposed to be in the home
[Yvonne]: I was gonna say, woman go have babies and their busy
[Katie]: so it’s kinda a recent thing that girls actually go and get actual jobs and things

[Alicia]: in the past [women] didn’t have the opportunity to do anything but it’s evening out definitely

[Beth]: I just don’t think we’ve reached that level in society yet to have them all viewed as equals since women’s rights are still pretty new
[Alicia]: Well, men have had a few hundred years before we did

[Marie]: I think the society that we have today, women are given a better chance of how they can change their future but I don’t think that they’re given much, they’re not given as much as I, that some people would like to see

Brain differences – guys natural ability, girls have to work hard. In the interviews a few of the others girls spoke about biological differences in the brain that could account for the lack of women in science careers. As indicated in the literature review, while some studies state that there are biological differences between male and female brains (Ceci & Williams, 2007; Halpern et al., 2007/2008; Halpern, Benbow et al., 2007; Kimura, 2004), the ability to do science is not inherently male and skills needed in science can be acquired through education and training (Ceci & Williams, 2007; Halpern, Aronson et al., 2007; Heilbronner, 2008; Hill et al., 2010). In the interviews no clear consensus was found with some girls believing boys and girls have the same natural ability to do science and other girls believing that boys have a better natural ability to do science than girls. Even girls themselves seemed unsure about the topic and varied their approach to it within the span of the interview.

[Steph]: some of them (boys)
[Yvonne]: have the natural ability to just do it, like it’s in their head easier

> [Sara]: [boys] might be smarter, more able to learn and make better ideas and stuff than girls can

A few groups spoke about boys they knew who in their opinions could do very well on science tests without having to study. Girls on the other hand, in their minds, did not have the ability to test well in science without studying. This was however not supported by survey data were girls indicated on average that they did not think boys are better at science than girls (Table 1, Figure 1).

> [Tanya]: sometimes they can just test without studying and they get good marks

A few girls however also acknowledged that education can improve their abilities in science, which according to some studies should be the purpose of science education (Ceci and Williams, 2007; Halpern, Aronson et al., 2007; Heilbronner, 2008; Hill et al., 2010).

> [Steph]: well it's also to get you ready for problems that happen when you're out of school so you have the skill set to figure things out
> [Yvonne]: yeah grows your brain

Linda made several references to her own as well as others' brains "being scientifically trained":

> [Linda]: well my friend A my best friend, she was so interested in science the first year Mr. B had taught her she just clicked it but this year it's just like what are you talking about and her grades just sunk and now she just gave it all up because she's been getting bad teachers and her brain's just not scientifically trained
> [Linda]: so many of those great scientists were males and so you think about it and they're probably just thinking - well this guy made this big discovery so maybe if we can get another guy - and they're just thinking - well maybe it's just how the guys mind works

Girls have to work hard to succeed in science. There was a lot of agreement among the girls that they have to work hard to succeed in science which is corroborated by several other studies (Guiso et al., 2008; Heilbronner, 2008; Lupart et al., 2004; Warrington & Younger, 2000). Speaking from their own experience, most of the Grade 11 girls talked about studying on a daily basis for their science courses. They also spoke about girls working harder in their classes than boys because in their opinions boys were either able to succeed without studying or they just seemed to not care about doing well.

> [Steph]: the girls in our class definitely work harder than the guys do
>
> [Sara]: it depends what it is but I think in some aspects girls are gonna always have to work a bit harder to be up there and if you wanted to be a scientist or something or research you're gonna always have to work a little bit harder to be up there

Based on the survey data shown in Figure 4 and Table 4 all the students found science difficult (Question 44) which corresponds to findings from other studies (Brownlow et al., 2000; Cleaves, 2005; Warrington & Younger, 2000) with Grade 11 girls being the group that felt it was more difficult and Grade 8 girls being the group that felt it was less difficult. Although other research states that boys have a better attitude and are more positive about science than girls (Britner & Pajares, 2006; Heilbronner, 2008; Lupart et al., 2004; Weinburgh, 2000), students in this study disagreed with this concept (Question 43); Grade 8 girls disagreed most and Grade 11 boys disagreed least. All students felt they were okay at science (Question 45) with Grade 8 girls being slightly more positive than any of the other groups.

Table 4

Descriptive Statistics for Questions 43-45

Grade & gender	Descriptive statistic	Q43: Boys have a better attitude and are more positive about science than girls (reversed)	Q44: Science is difficult (reversed)	Q45: I am good at science
Gr. 8 Girls	Mean	6.90	4.60	5.35
	Median	6.50	4.50	6.00
	Std dev	1.07	1.23	1.42
	n	20	20	20
Gr. 8 Boys	Mean	6.48	4.41	5.21
	Median	6.00	4.00	6.00
	Std dev	1.50	1.83	1.70
	n	33	34	34
Gr. 11 Girls	Mean	6.39	3.89	5.22
	Median	6.00	4.00	6.00
	Std dev	1.00	1.55	1.47
	n	46	46	46
Gr. 11 Boys	Mean	5.95	4.21	5.21
	Median	6.00	4.00	6.00
	Std dev	1.37	1.64	1.56
	n	37	39	39
Totals	Mean	6.37	4.21	5.23
	Median	6.00	4.00	6.00
	Std dev	1.28	1.61	1.53
	n	136	139	139

Note. Responses the Questions 43 and 44 are reversed, thus a high number indicates stronger disagreement with the statement.

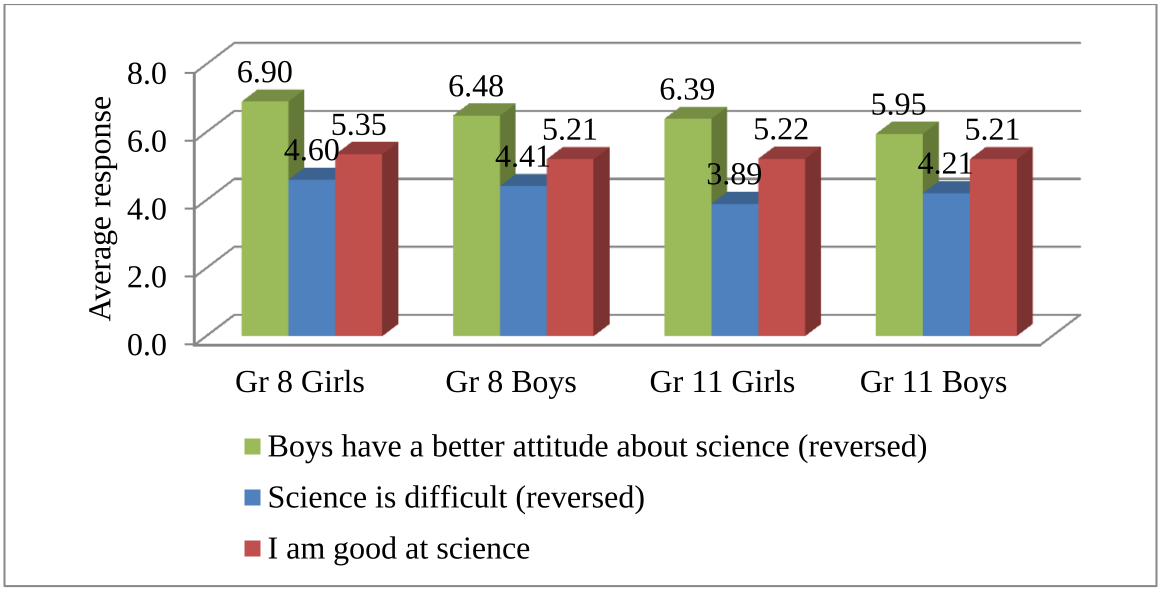

Figure 4. Average responses to Questions 43-45.

Theme 2: Stereotypes of Women in Science

Typical jobs – nursing, vet...less typical doctor. Most of the girls stated that science careers for women include nurse and veterinarian; however several of them felt that doctor is not a common female science occupation. One group spoke specifically about engineering not being a science career that seemed inviting to women.

> [Yvonne]: ...when I think engineer I don’t really think women
>
> [Cathy]: well, when you think about women you think of jobs that they’ll have, it’s like a teacher or librarian, you don’t really
> [Beth]: or a nurse
> [Alicia]: homemaker
> [Cathy]: yeah, you never really think of the big things and when you think of a guy they can be pretty much
> [Alicia]: doctor, lawyer
> [Cathy]: yeah, all that big stuff
>
> [Sara]: I think too, in our heads, it seems more common to have the males be the doctors but there’s still a lot of really good female - like if I was, I don’t think I’m smart enough to be a doctor or anything, if I was I would love to be a doctor

Table 5 displays the science related careers that girls included on the surveys as one of their top three career choices they are considering pursuing (Question 2). The tallies are based on girls who indicated in Question 1 on the surveys that they would like to pursue a career in which they use science on a daily basis (value of six or higher in response to Question 1 on the survey). As also noted in the interviews, these survey tallies confirm that more traditional women science careers such as nursing, vet related careers, pharmacy, physiotherapy are a more popular choice for girls interested in science careers than non-traditional careers such as doctor, forensic scientist, architect, or agriculture for example. Of the 27 girls that had indicated in Question 1 that they did not want to pursue a career using science, 11 still listed science related careers including three each specifying nursing and vet related careers, two each indicating dentistry and doctor, and one researcher.

Table 5

Tallies for Science Related Careers Listed by Girls Interested in Science

Science related career	# of girls interested
Nursing	13
Doctor (incl. dermatologist, oncologist)	6
Teacher (incl. elementary; excl. specified non-science)	6
Forensic scientist	2
Veterinarian (incl. vet tech and animal therapy)	7
Researcher (zoologist, biochemist, marine biologist, environmentalist)	6
Lab tech or medical tech	4
Dentistry (incl. assistant and hygienist)	4
Other medical (paramedic, optometrist, physiotherapist, pharmacist)	9
Other (meteorologist, agriculture, architect)	3

Based on the survey data, Grade 11 girls were on average slightly more interested in pursuing a science career (Table 6 and Figure 5) than any of the other student groups; interestingly Grade 11 boys were least interested in a science related career.

Table 6

Descriptive Statistics for Question 1

	Q1: I would like to pursue a career in which I use science on a daily basis				
	Gr. 8 Girls	Gr. 8 Boys	Gr. 11 Girls	Gr. 11 Boys	Total
Mean	5.00	5.18	5.39	4.74	5.10
Median	6.00	6.00	6.00	4.00	6.00
Std. dev	1.52	1.71	1.63	1.62	1.63
n	20	34	46	39	139

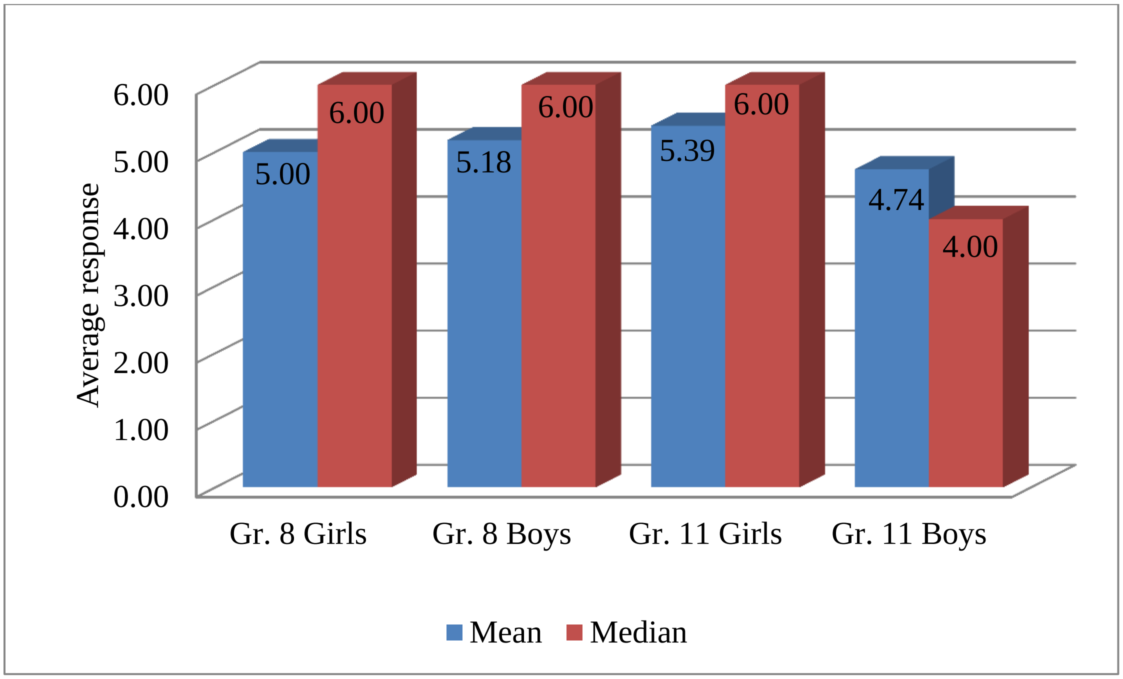

Figure 5. Average responses to Question 1: I would like to pursue a career in which I use science on a daily basis.

However boys were also more likely to state that they personally knew someone who uses science in their career (Question 4a); Grade 8 girls were least likely to agree with the statement that they personally knew someone who uses science in their career (Table 7).

Table 7

Descriptive Statistics for Question 4

		Q4: I personally know several people who use science in their career.				
		Gr. 8 Girls	Gr. 8 Boys	Gr. 11 Girls	Gr. 11 Boys	Total
Q4a	Mean	4.90	5.59	5.22	5.54	5.35
	Median	5.00	6.00	6.00	6.00	6.00
	Std. dev	1.52	1.37	1.49	1.33	1.43
	n	20	34	46	39	139
Q4b	Mean	1.26	1.18	1.53	1.26	1.33
	Median	1.00	1.00	2.00	1.00	1.00
	Std. dev	0.45	0.39	0.51	0.44	0.47
	n	20	30	40	32	122

All of the survey groups indicated that the person they know who uses science in their career (Question 4b) is male with the exception of Grade 11 girls who predominantly stated knowing women that use science in their career. Based on the interviews, the women that girls personally knew who use science in their careers seem to be predominantly nurses, vets, teachers, lab techs, etc.

> [Alicia]: my aunt is a nurse actually
> [Cathy]: in my family there's lots of nurses too, pretty much all nurses
> [Beth]: same with my fam
>
> [Donna]: my mom's friend is a vet

Women do more explaining while guys just show off. A surprising theme that emerged in the interviews is that women in science tend to do more explaining of concepts while men perform the experiments and move on to the next topic. This idea usually surfaced when we talked about women scientists portrayed in media and girls were talking about shows such as Mythbusters.

> [Donna]: women are interested in it, they kind of know what they're doing, they have interest, they like it so they explain it to everybody mostly
>
> [Emma]: if you can compare the girls to the guys in scientists, the girls they like to explain things and get deeper into it, guys kinda just like to know it and then quickly move on to the next subject. They don't take their time in the subject

Descriptors for women in science. In line with what other researchers have found (Baker & Leary, 2003; Barnett & Rivers, 2004; Buck et al., 2008; Goodchild, 2004; Ullman, 2010), most of the descriptors girls used to describe women with a science career were negative including words such as geeky, nerd, odd, no life, lack of authority, lab coat, goggles, etc. Although Kitts (2009) stated that students no longer think of scientists as men in lab coats, girls in this study repeatedly used "lab coat" as a descriptor (for examples refer to the comments made about women scientists in media by Beth, Alicia, Cindy, Donna, or Steph in Appendix D: Theme 7).

> [Yvonne]: dumb, ditzy
> [Steph]: they're geeky pretty
>
> [Beth]: lab coat...I see test-tuby people mixing the things
> [Alicia]: I see Ms. A with her crazy curly hair and the lab coat and the glasses
>
> [Beth]: I think sometimes, a lot of times, it's kind of almost a negative view upon it, 'cause it's like - wow you had no life and you just had to go do this, and that's all you did
> [Alicia]: I've heard jokes about it like people say would you rather be operated on by a Mexican doctor or a woman, and it's terrible but I've heard a lot of jokes like that
>
> [Jenny]: they (community) think they'd (women in science) be a little odd

Three girls also described women in science careers as smart or intelligent. For analysis purposes the descriptors students provided on Question 3 of the survey (What word would you use to describe a person who uses science in their job or a scientist?) were coded and assigned a numeric value as detailed in Appendix F. On average the Grade 11 girls used more positive descriptor than the other students (Table 8).

Table 8

Descriptive Statistics for Question 3

	Q3: What words would you use to describe a person who uses science in their job or a scientist?				
	Gr. 8 Girls	Gr. 8 Boys	Gr. 11 Girls	Gr. 11 Boys	Total
Mean	3.90	3.79	4.33	3.77	3.98
Median	4.00	4.00	5.00	4.00	4.00
Std. dev	1.25	1.20	0.90	1.44	1.21
n	20	34	45	39	138

However these descriptors could apply to either men or women in science. Also when the descriptors that had been provided on the survey as examples were removed from the responses, several of the students provided their own descriptors (9 Grade 8 girls, 24 Grade 8 boys, 37 Grade 11 girls, and 25 Grade 11 boys). Based solely on the descriptors the students provided themselves, girls provided almost all of the negative descriptors including words such as: boring, four eyes, mean, odd, head ache prone, freak, etc. Refer to Figure 6 for a visual representation comparing tallies of students’ own descriptors differentiated by student gender. Notice that while girls and boys both used positive descriptors for people in science, with the exception of two boys, all the negative descriptors added were from girls. A table including all students' own descriptors and tallies is included in Appendix F.

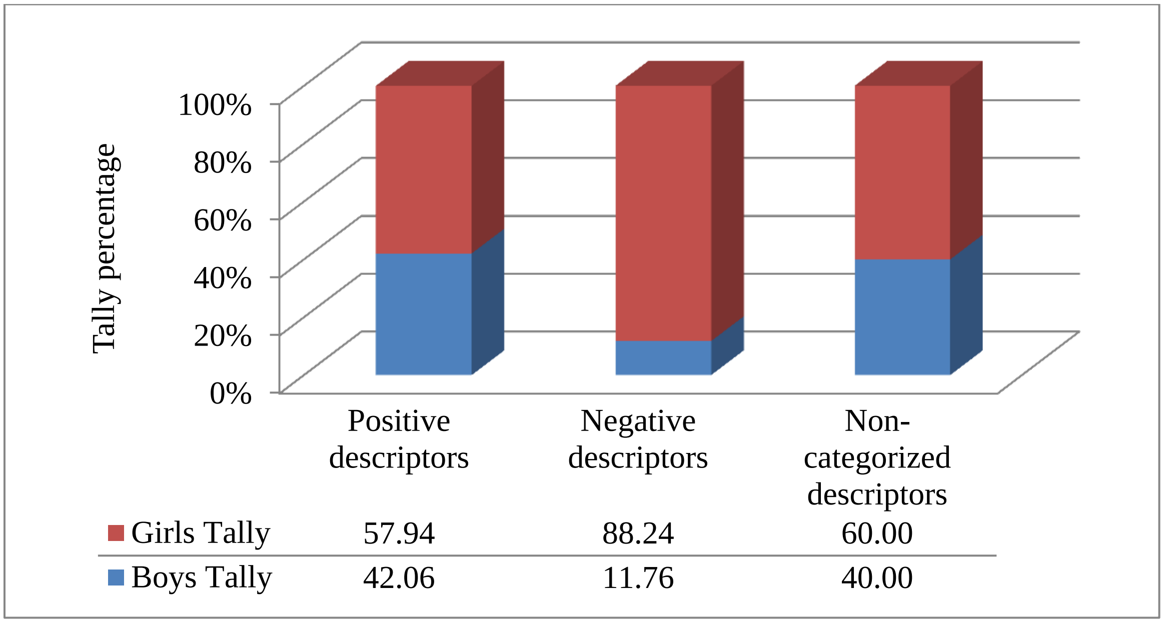

Figure 6. Tallies of students' own descriptors differentiated by student gender.

Three groups of girls thought of their female science teachers as women that use science in their careers which appears contrary to other studies (Baker & Leary, 2003; Gilmartin et al., 2007; Kitts, 2009).

> [Donna]: I thought of Ms. A she had her hair tied back and goggles and the tie-dyed lab coat and with all the stuff on it
> [MH]: would you consider her to be a scientist?
> [Jenny]: kinda yeah
> [Donna, Emma]: yeah
> [MH]: Why would you say she's a scientist? What makes her a scientist?
> [Jenny]: she's really smart, she really knows a lot about science
> [Donna]: yes she gets it too like she has all these questions practically in her head and she can just figure out and then it's there

Of the students surveyed who at the time had a female science teacher, Grade 8 girls on average agreed with Question 18: My science teacher teaches but does "real" science as well (e.g., research); in contrast, Grade 11 students were less likely to agree with that statement (Table 9). This distinction was less noticeable when the gender of the teacher was not controlled for as seen in Figure 7; however when differentiated by teacher gender, Grade 8 students with female teachers felt their teacher did real science more so than students with male teacher. The reverse trend was seen for Grade 11 students as shown in Figure 8.

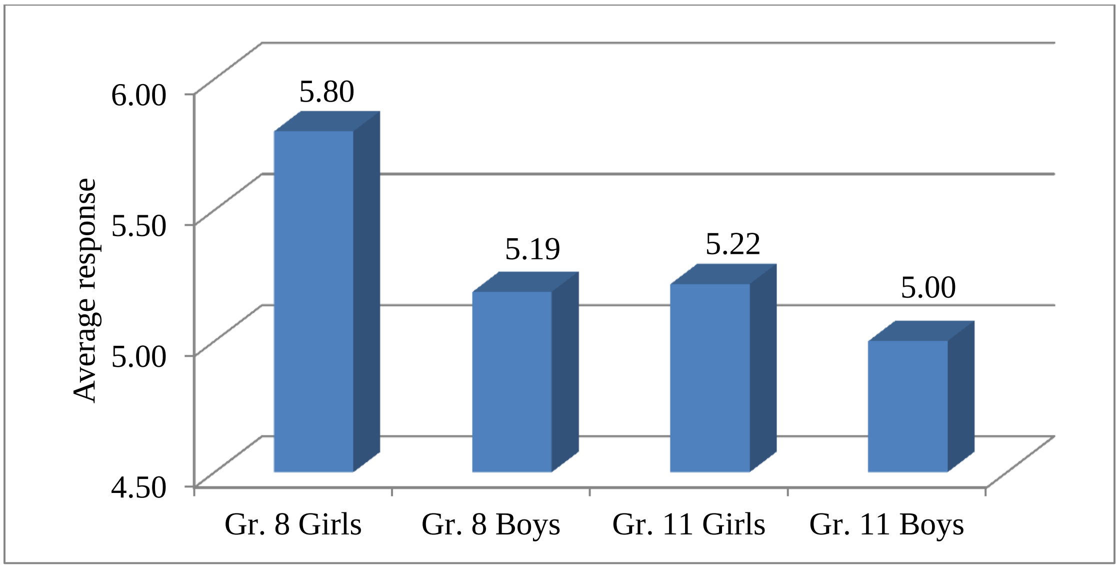

Figure 7. Non gender differentiated average responses to Question 18: My science teacher teaches but does “real” science as well (e.g., research).

Table 9

Descriptive Statistics for Question 18 Differentiated by Teacher Gender

Grade & gender	Descriptive statistic	Q18: My science teacher teaches but does "real" science as well (e.g., research).		
		Female teacher	Male teacher	Non-gender differentiated
Gr. 8 girls	Mean	6.86	5.23	5.80
	Median	6.00	6.00	6.00
	Std dev	1.07	1.74	1.70
	n	7	13	20
Gr. 8 boys	Mean	6.25	4.78	5.19
	Median	6.00	6.00	6.00
	Std dev	1.28	1.57	1.60
	n	8	23	32
Gr. 11 girls	Mean	4.94	6.20	5.22
	Median	6.00	6.00	6.00
	Std dev	1.98	1.14	1.90
	n	36	10	46
Gr. 11 boys	Mean	4.87	5.17	5.00
	Median	4.00	6.00	5.00
	Std dev	1.58	1.99	1.69
	n	24	12	36
Totals	Mean	5.24	5.21	5.24
	Median	6.00	6.00	6.00
	Std dev	1.83	1.67	1.74
	n	75	58	134

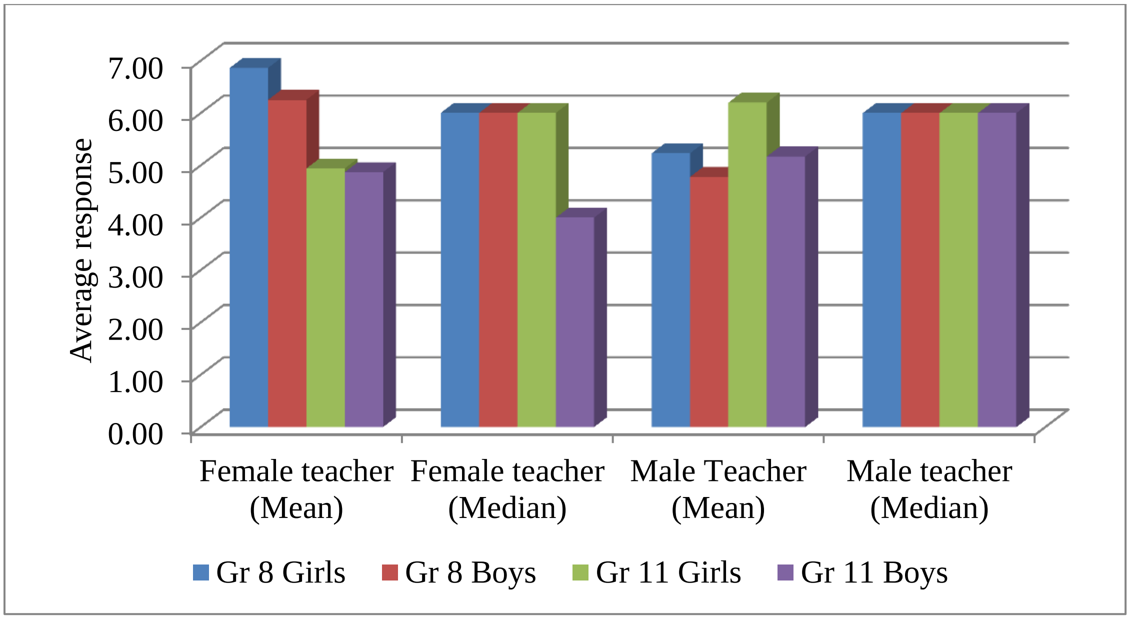

Figure 8. Teacher gender differentiated average responses to Question 18: My science teacher teaches but does “real” science as well (e.g., research).

Due to the small sample size it cannot be concluded that students’ perceptions of their teacher doing “real” science is based on gender as much as perhaps the individual teacher’s teaching style such as including stories about science outside of school, knowledgeable answers, etc. Nevertheless it is interesting to note that the Grade 8 students in this study with female science teachers felt that their teacher did “real” science while the Grade 11 girls with female science teachers did not necessarily see their teachers as doing science.

One other group, although they did not speak about a specific science teacher, thought that a science career for a woman is teaching.

> [MH]: what does a science career for a woman look like to you?
> [Cindy]: I was saying teacher
> [Karla]: yeah, that’s what I thought
> [Cindy]: teacher, researcher

Theme 3: Connecting Science Education to Life

As expected from other research studies (Baker & Leary, 2003; Bloor et al., 2007; Buck, 2002; Heilbronner, 2008; Murphy & Whitelegg, 2006), almost all of the girls in this study spoke about wanting to relate science to their life. For some girls it specifically meant being able to connect what they learn in class to real life examples and situations; for other girls even connecting their current lessons to future lessons was interesting. Some girls spoke specifically about enjoying physics class because it connects well to real life examples and other interests.

> [Katie]: I just think physics is more interesting 'cause you get to see how things work and why

Other girls preferred certain biology topics because they seemed easier to relate to:

> [Ruth]: it's easier to relate to the human body
> [Tanya]: it's real, stuff every day that you could easily know but you don't really focus on the environment every day kind of thing, and like photosynthesis and cellular respiration

The girls all spoke about enjoying classes when the teacher related topics to their life or real life experiences.

> [Cathy]: I like Ms. A 'cause she'll talk about everything she doesn't just use the textbook and curriculum. She'll go on with it more and she'll bring in stuff from the next year. Like in Grade 9 she would talk about stuff that we learn this year
>
> [Karla]: ... in Grade 6 when we got to learn about different kinds of trees and CSI investigations and all that, it was a lot more fun
>
> [Marie]: and I think that the whole class enjoyed her because she went out and she explained things that were real, that's what was happening outside and then we got to see that happen and when he teaches he talks about things that we've never seen before
> [Linda]: or never heard
> [Marie]: that kind of stops our learning, that's kinda like make-belief, kinda pretend...

Unfortunately according to the survey data, most students cannot strongly agree or even somewhat agree that what they learn in science class relates to their everyday lives. Table 10 and Figure 9 show that based on response averages, Grade 8 boys are somewhat likely to agree that they can relate their science class education to their everyday life but Grade 8 girls on average disagreed the most with the statement.

Table 10

Descriptive Statistics for Question 46

	Q46: What I Learn in Science Class Relates to My Everyday Life				
	Gr. 8 Girls	Gr. 8 Boys	Gr. 11 Girls	Gr. 11 Boys	Total
Mean	4.85	5.29	4.96	4.97	5.03
Median	5.50	6.00	6.00	4.00	6.00
Std. dev	1.35	1.62	1.44	1.72	1.55
n	20	34	46	38	138

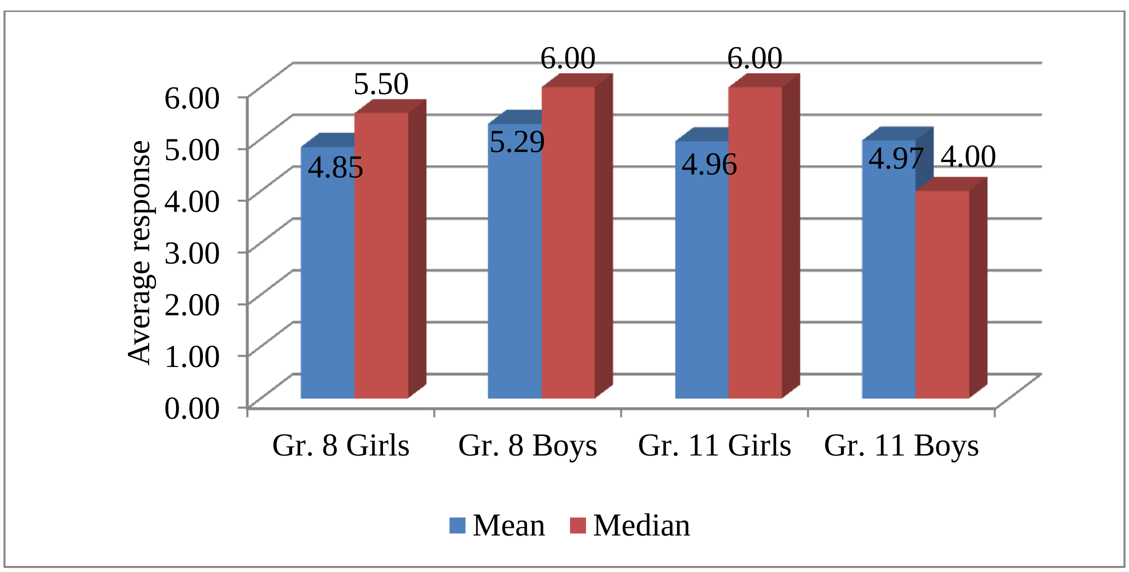

Figure 9. Average responses to Question 46: What I learn in science class relates to my everyday life.

Likewise the average student response to Question 20: My science teacher frequently talks about science that goes on outside of the classroom, was relatively noncommittal (Table 11). Although as stated in the interviews, the girls really enjoy science when it relates to the outside world, based on the survey data few connections seem to actually be made in their science classes to the outside world. However when differentiated by teacher gender notice that Grade 8 students were more likely to agree with the statement if their teacher was female (Figure 10); the opposite trend is seen for Grade 11 students. Again due to the small sample size involved in this study, this distinction may be due to the individual teacher's teaching ability rather than gender.

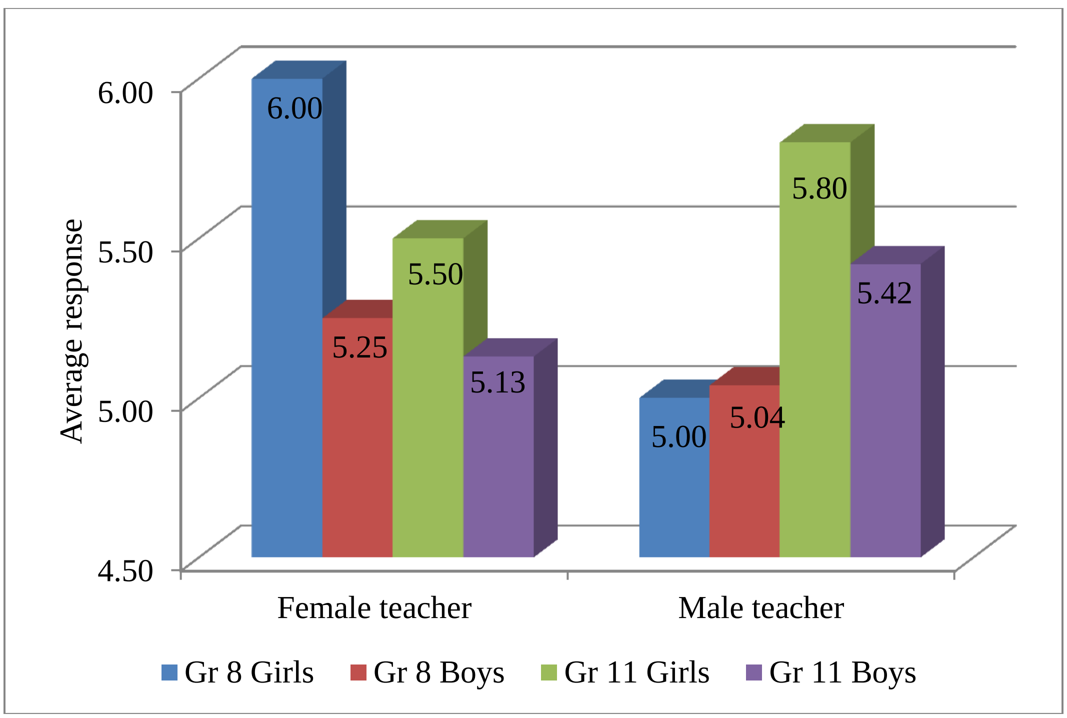

Figure 10. Gender differentiated average responses to Question 20: My science teacher frequently talks about science that goes on outside the classroom.

Table 11

Descriptive Statistics for Question 20 Differentiated by Teacher Gender

Grade & gender	Descriptive statistic	Q20: My science teacher frequently talks about science that goes on outside of the classroom.		
		Female teacher	Male teacher	Non-gender differentiated
Gr. 8 girls	Mean	6.00	5.00	5.35
	Median	6.00	5.00	6.00
	Std dev	1.63	1.53	1.60
	n	7	13	20
Gr. 8 boys	Mean	5.25	5.04	5.13
	Median	5.00	6.00	6.00
	Std dev	1.49	1.58	1.52
	n	8	23	34
Gr. 11 girls	Mean	5.50	5.80	5.57
	Median	6.00	6.00	6.00
	Std dev	1.75	1.14	1.63
	n	36	10	46
Gr. 11 boys	Mean	5.13	5.42	5.24
	Median	6.00	6.00	6.00
	Std dev	1.98	0.90	1.67
	n	24	12	38
Totals	Mean	5.40	5.24	5.34
	Median	6.00	6.00	6.00
	Std dev	1.78	1.38	1.60
	n	75	58	138

Real stories. A few of the girls spoke specifically about stories their teachers told that made science class interesting.

> [Yvonne]: he told a lot of cool stories too
> [Katie]: yeah he had really good stories about everything
>
> [Donna]: mostly Ms. A tells a lot of stories about her travels with the science career and stuff that she learned and she talks about it like it's not just always one thing that we learn about. She kind of takes off out of class and just tells us in her story and how she liked it or something
>
> [Linda]: ...she brought in telling us how Cesar Celsius invented the Celsius scale and I didn't know that, or how Isaac Newton invented the Newton scale for the scientists with the alternate zero and I just thought that was so cool to go home and know who invented the Celsius scale. And she just managed to bring everything into our everyday life and that's how it was so easy for me to remember and I thought my mind was so scientifically trained but it's not, it's just 'cause she could incorporate so much to my everyday life that it just sticks with me...

Although some of the girls in this group did not find their current science class interesting and, when asked if they wanted to know more about the scientists' stories, stated it was not really interesting to them; they prefer to just learn the basic requirement and move on.

> [Yvonne]: well we don't get much of their life story
> [Steph]: 'cause he knows we don't need to know about their background, he knows that nobody really cares about it I guess, so he doesn't even attempt to do it really very much 'cause nobody cares and it doesn't really matter
> [Yvonne]: I know you have to know the things what they did discover but I'd be fine with just finding that out

When talking about teachers who told "cool" stories, all the girls were speaking about teachers they had in the past that stood out to them; with the exception of Donna, who was speaking about her current teacher and Yvonne and Steph, who noted that they did not get many stories and did not want them either. Again, based on the low survey averages for Question 19 (My science teacher frequently tells us stories about science and scientists) as shown in Table 12, it would appear that stories are not often incorporated into the science classroom. When differentiated by gender notice that again Grade 11 students were more negative about their female teachers, Grade 11 girls more so than boys (Figure 11).

Table 12

Descriptive Statistics for Question 19 Differentiated by Teacher Gender

Grade & gender	Descriptive statistic	Q19: My science teacher frequently tells us stories about science and scientists.		
		Female teacher	Male teacher	Non-gender differentiated
Gr. 8 girls	Mean	6.00	4.46	5.00
	Median	6.00	4.00	5.00
	Std dev	1.63	1.45	1.65
	n	7	13	20
Gr. 8 boys	Mean	4.29	4.35	4.39
	Median	4.00	4.00	4.00
	Std dev	1.38	1.97	1.82
	n	7	23	31
Gr. 11 girls	Mean	4.86	5.40	4.98
	Median	4.50	6.00	5.50
	Std dev	1.81	1.35	1.72
	n	36	10	46
Gr. 11 boys	Mean	4.71	4.75	4.70
	Median	4.00	4.50	4.00
	Std dev	1.92	1.29	1.70
	n	24	12	37
Totals	Mean	4.86	4.64	4.77
	Median	4.00	4.00	4.00
	Std dev	1.81	1.64	1.73
	n	74	58	134

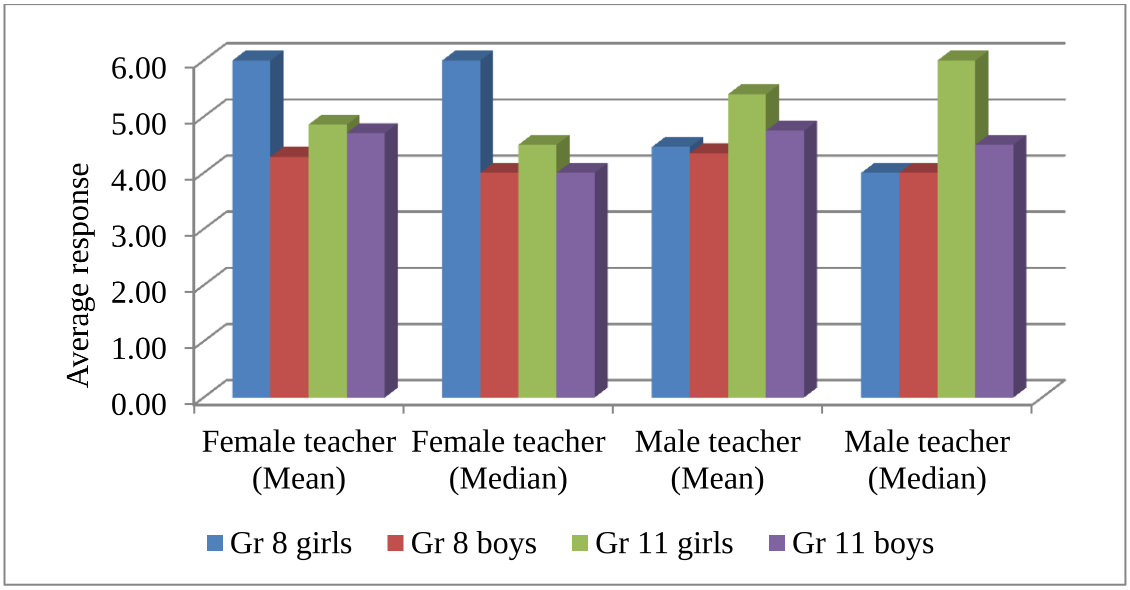

Figure 11. Teacher gender differentiated average response to Question 19: My science teacher frequently tells us stories about science and scientists.

Using creativity. Four of the girls wanting to pursue non-science careers spoke about the importance of creativity to them. This is another aspect of science education that was not explored in the survey and may warrant further investigation. None of these girls felt that science was a subject allowing for a creative element yet science requires a lot of innovative and out-of-the-box thinking (Barrow, 2010; McCormack, 2010; Nersessian, 1992, 2008).

> [Katie]: I don't know, I'm kind of more of an artsy person, I'm not very analytical or anything, I just wouldn't be happy with [a science career]

This desire to include creativity in science class or its importance in career choices did not surface through the survey responses. Table 13 and Figure 12 (Question 5) indicate what factors girls felt were important for future career choices. For these students enjoying their job or having fun in their career is very important. This could perchance link back to girls desiring to express themselves creatively but bears further investigation.

Table 13

Descriptive Statistics for Question 5

		Q5: How important is each of the following to you in choosing a career						
		Fame	Team	Salary	Enjoying	Helping	Safety	Other
% Girls	Not at all important	27	3	0	0	0	2	0
	Not very important	59	32	11	2	6	2	0
	Important	11	56	48	15	52	38	11
	Very important	3	9	41	83	42	59	20
% all students	Not at all important	17	3	0	1	1	2	0
	Not very important	56	25	9	1	10	15	1
	Important	22	58	40	24	57	35	14
	Very important	5	13	52	74	32	48	24

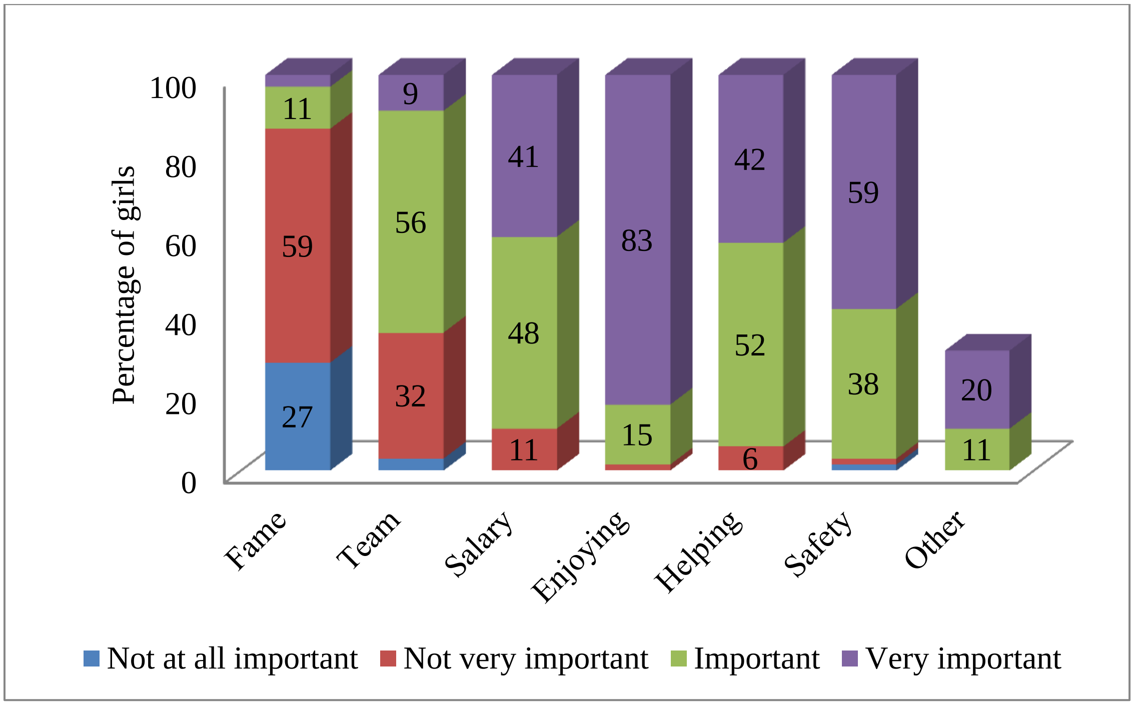

Figure 12. Percent of girls indicating level of importance for factors influencing their career choices.

A few girls also included "other" factors as important but there was no distinctive recurrence. All "other" factors mentioned by the girls, such as "good hours" or "socializing", and indicated as being important can be found in Appendix G. However as expected from previous literature on the topic of girls' interest in science, being able to help (Helping) is an important factor to girls in choosing a career (Ceci & Williams, 2007; Kniveton, 2004; Li, 2008; Lupart et al., 2004; Tan & Barton, 2008; Weinburgh, 2000; Whelan, 2001).

Helping. Eight of the girls during the interviews stated that helping others or animals, was an important aspect of a career choice for them.

> [Sara]: I think in a medical aspect working on humans health it's important 'cause it helps us learn more with bio and about the human body so we can cure things like cancer

> [Ruth]: I wanted to help people and I want do something in the medical field ...
>
> [Alicia]: ... they're helping people which is something I want to do too
>
> [Holly]: yeah, pretty much me I love animals if I could I'd help every animal in the world that was sick

Upper level science only useful for job; looks good on transcript. The Grade 11 girls spoke about upper level science education being useful only for career pursuits with some stating that they were enrolled in science courses because it would help them get into a good university, a phenomenon noticed in other studies as well (Carlone, 2003; Dentith, 2008). Most agreed though that lower level science courses provide a good general background for all students.

> [Ruth]: there's just some units in biology that have nothing to do with anything you're interested in and it's kind of harder for you to learn those and I don't know why you need to know that
> [Sara]: yeah, if it has nothing to do with your future
>
> [Anna]: it's good to have Science 10 and 20 but once you go into Biology and Chemistry and that, and you don't really need it 'cause it's more specific it's kind of pointless to take it
> [Ruth]: especially if you're not interested in it, if you were interested in it then you would probably need it because you would want to do something with it.
>
> [Yvonne]: so then when I do start applying for universities and stuff then I'll look better and knowledgeable

The survey data showed that most students do find science important other than for graduating. However on average Grade 8 boys and Grade 11 girls seemed to feel it was important more so than Grade 8 girls or Grade 11 boys (Table 14, Figure 13).

Table 14

Descriptive Statistics for Question 40

	Q40: Science is important to learn for more reasons than as a requirement to graduate from high school				
	Gr. 8 Girls	Gr. 8 Boys	Gr. 11 Girls	Gr. 11 Boys	Total
Mean	5.40	6.12	5.89	5.33	5.72
Median	6.00	6.00	6.00	6.00	6.00
Std. dev	1.47	1.39	1.27	1.68	1.47
n	20	34	46	39	139

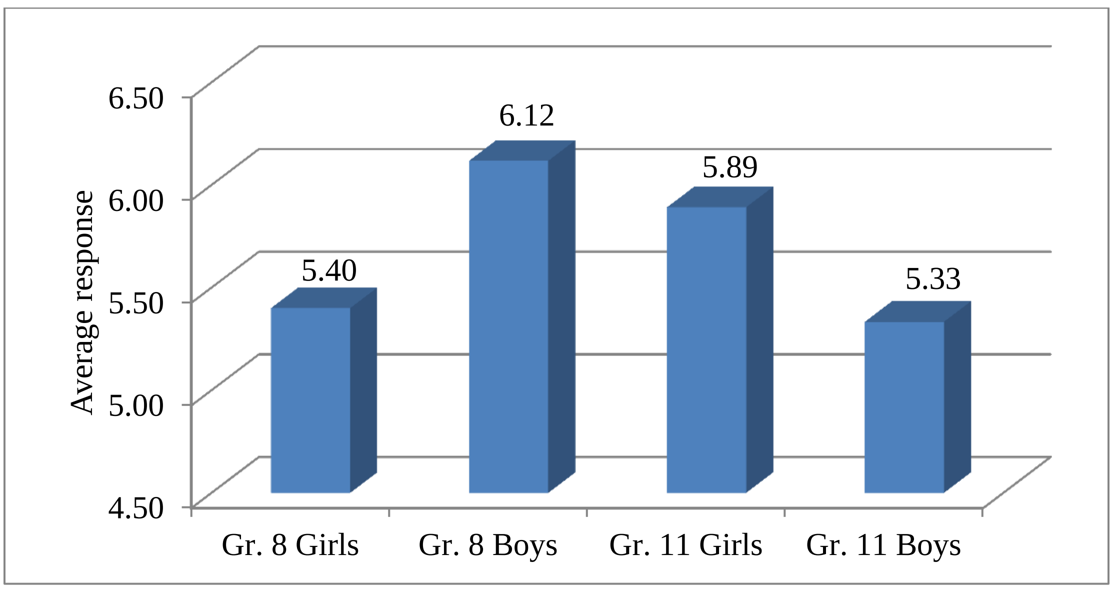

Figure 13. Average responses to Question 40: Science is important to learn for more reasons than as a requirement to graduate from high school.

Theme 4: Science Education and Science Teachers

Multiple studies have noted the importance of teachers and their methods of instruction on girls having a positive experience with science and consequently being interested in science (Baker & Leary, 2003; Blickenstaff, 2005; Brickhouse et al., 2000; Jacobs et al., 1998; Warrington & Younger, 2000). It is therefore not surprising that teacher abilities and instructional qualities surfaced in every interview and were discussed at length by these girls. As Harmon et al. (2003) note: poor science education in rural schools may be due in part to the lack of resources; this includes teachers teaching outside of their area of expertise.

Good student image – frustration when not learning. Eleven of the girls in the interviews spoke about themselves as good students or appearing smart. Repeatedly girls spoke about wanting to get good marks, performing well on tests, having high standards, and being considered smart by their peers.

> [Yvonne]: I just want to do good in it like get a good grade
>
> [Alicia]: I'm kind of an overachiever. So what I think is bad is not necessarily everybody else's idea.
> [Cathy]: yeah, we have really high, high standards that we try really hard to reach and in physics we can't
>
> [Marie]: ...And then he's like a good student does this, a good student does that. Well, we're trying to be good students and he's not giving us the things that we need to learn from it.

Along with this good student image, twelve of the girls also spoke about a fear of failure in science class and in some cases a fear of failure in a science career. Fear of failure in science class included being hesitant to ask questions because the question might be interpreted as "stupid" or being reluctant to answer questions without knowing that the response is correct. Wood (2000) and Cleaves (2005) found that girls will doubt their own abilities in science and consider themselves "stupid" even if their performance indicates otherwise.

> [Steph]: I think it's easier to learn from someone that you know a lot better in my opinion for me it is at least 'cause I'm not intimidated of the teacher that I'm gonna be like - oh I don't wanna ask a stupid question
> [Yvonne]: exactly, scared, yeah, same
>
> [Cathy]: and we don't kinda want like look dumb in front of them I guess. Don't wanna ask (not distinguishable)
>
> [Sara]: ...I don't think I'm smart enough to be a doctor or anything, if I was I would love to be a doctor
>
> In response to why she is opting for a career as a nurse instead of doctor, Donna responds:
> [Donna]: I'd be scared I'd mess up
>
> [Marie]: ...he (teacher) just makes us feel like you need to know this, if you don't know this then you're not gonna succeed in life and it's like well how are we supposed to succeed in life if you're not teaching us the proper curriculum and everything.

Because these girls are driven to do well and have high expectations of themselves, they also expressed frustration with poor science education. Several groups spent a significant amount of the interviews voicing their frustration with their science education.

> [Tanya]: it's stressing, it's stressing when you don't know what you're doing
> [Ruth]: or when your teacher says one thing and then tells you to do something different or, that kind of thing. When you don't like your teacher it's also very stressful.
>
> [Beth]: She just hated me overall. I was never in the classroom. It was a little annoying.
>
> [Linda]: there's so many words that he's put in there that we don't know the definitions to, that we're like - we have no clue what you just said
> [Marie]: yeah, he learns the, I think he talked about the Greek
> [Linda]: no it was Latin
> [Marie]: Latin words and he knows

> [Linda]: he always uses Latin and we're like we don't know Latin
> [Marie]: and when we started out, she (Linda) started saying to him, like he'd say a big word and then she'd be like two seconds later, what does that word mean? And he
> [Linda]: then he'd go on explaining, it's like I don't know what you just said
> [Donna]: with some of the guys in my class too talking so much and the girls are kinda just like k can we go in a separate class and just learn that by ourselves 'cause they're always talking and don't really care

Donna's comment above about the teacher's attention being drawn to discipline issues with the boys and the frustration it created among the girls because they felt it took away from their science learning was also found in Warrington and Younger's (2000) study.

Some of the girls in the interviews spoke about knowing the teacher well or feeling that the teacher liked them; they related it to being comfortable approaching the teacher with questions. Figure 14 shows that on average, Grade 11 girls felt their science teacher was approachable and Grade 8 girls agreed least with the statement: My science teacher is approachable.

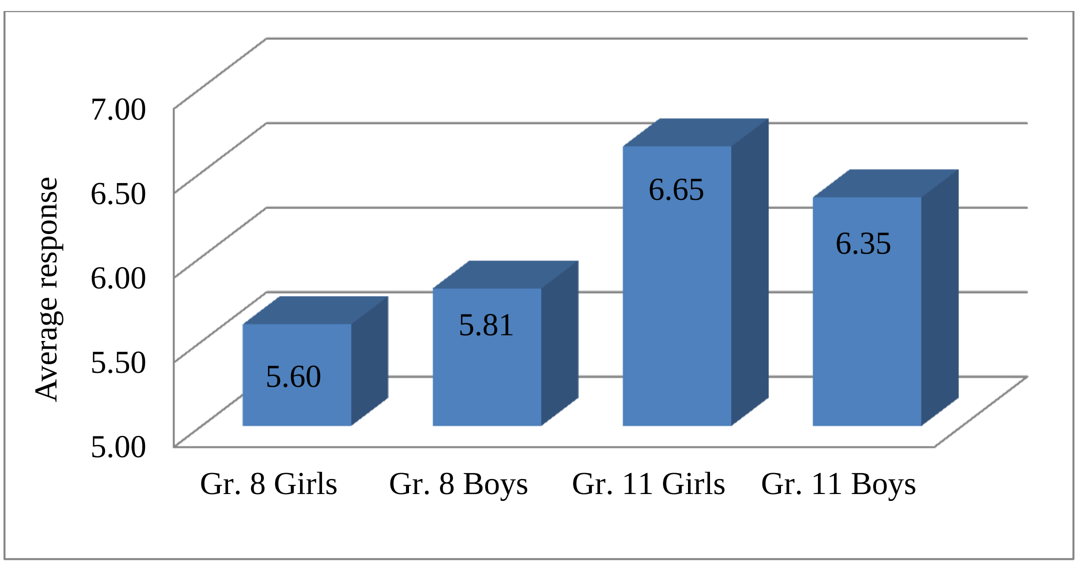

Figure 14. Average responses to Questions 16: My science teacher is approachable.

When controlling for the gender of the teacher, Grade 8 girls seemed more affected than the other groups; however all students with female science teachers felt their teacher was more approachable than if their teacher was male (Table 15, Figure 15). Note though that teacher approachability could be due to teacher personality and other factors more than to gender despite this being in line with what other studies have found (Carrington et al., 2008; Gilmartin et al., 2007; Le Mare & Sohbat, 2002).

Table 15

Descriptive Statistics for Question 16 Differentiated by Teacher Gender

Grade & gender	Descriptive statistic	Q16: My science teacher is approachable.		
		Female teacher	Male teacher	Non-gender differentiated
Gr. 8 girls	Mean	6.57	5.08	5.60
	Median	6.00	6.00	6.00
	Std dev	1.51	1.75	1.79
	n	7	13	20
Gr. 8 boys	Mean	6.00	5.65	5.81
	Median	6.00	6.00	6.00
	Std dev	0.00	1.67	1.47
	n	8	23	32
Gr. 11 girls	Mean	6.72	6.40	6.65
	Median	6.00	6.00	6.00
	Std dev	0.97	1.84	1.20
	n	36	10	46
Gr. 11 boys	Mean	6.46	6.17	6.35
	Median	6.00	6.00	6.00
	Std dev	1.25	1.80	1.42
	n	24	12	37
Totals	Mean	6.55	5.76	6.21
	Median	6.00	6.00	6.00
	Std dev	1.08	1.76	1.46
	n	75	58	135

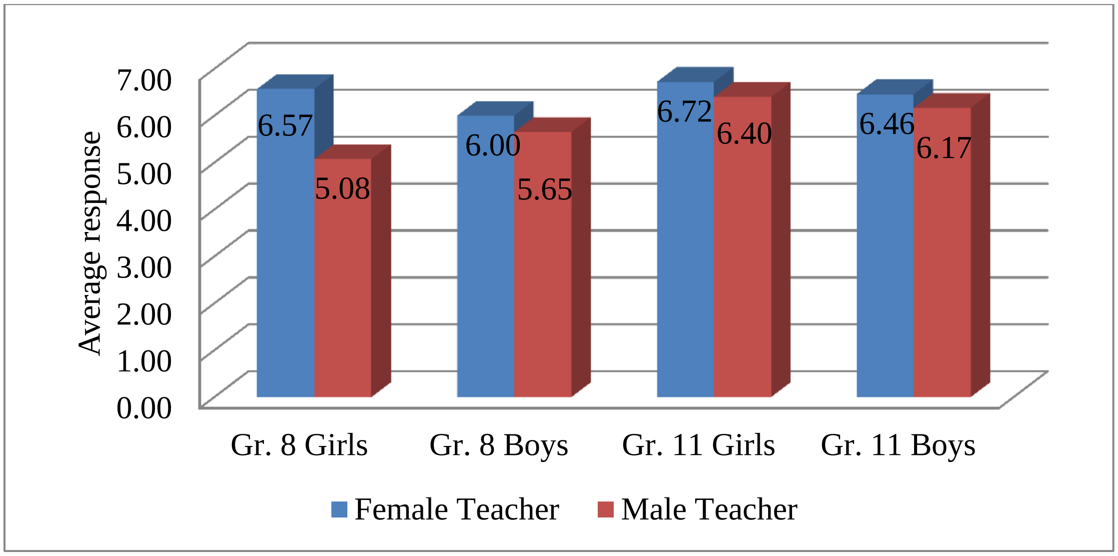

Figure 15. Survey response averages to students' perception of teacher approachability differentiated by teacher gender.

Doing experiments. As many other studies have noted, experiments make science class more interesting for most students and girls enjoy the hands-on aspect of science courses (Baker & Leary, 2003; Brickhouse et al., 2000; Ginorio et al., 2004; Lupart et al., 2004; Phillips et al., 2002; Tan & Barton, 2008; Warrington & Younger, 2000; Wood, 2000). However the girls in this study were quick to distinguish between good and "dumb" experiments. These girls also spoke about wanting to do less reading in science class and more experiments which seems to contradict what Britner and Pajares (2001, 2006) postulated that girls' are more comfortable with the language-arts/textbook based science common to elementary grades.

> [Yvonne]: yeah in elementary my Grade 5/6 teacher, he's probably the favourite teacher I've ever had in my whole life so far. He just made everything interesting and fun. 'Cause we did a lot of hands-on stuff, a lot that were like they weren't dumb experiments. I know we do experiments for, like what's a dumb one we've done, like put a chemical in something and watch it bubble, some stuff is just boring

> [Steph]: you put sugar in water and watched it dissolved was one thing that was dumb
> [Yvonne]: yeah some are just really boring but like making bottle rockets and cool stuff, it was interesting
>
> [Tanya]: we pretty much write notes and do questions
> [Sara]: yeah, I think we've only done one or two experiments
> [Ruth]: and then those ones that we do they're kind of stupid or like you're counting weeds somewhere and you're like why don't you just tell us how this is gonna end 'cause this is not interesting at all
>
> [Karla]: I'm good with the experiments and everything I just don't like just having to sit there reading out of the textbook. I learn better if I actually do it

Based on an average survey response of 5.00 to Question 49 (We do a lot of hands-on activities in science), students indicated that they did not believe they did a lot of hands-on activities in their science classes (Table 16, Figure 16). Other studies have found that studying at topic in detail (Question 48) and doing group work (Question 50) also influenced girls' interest and success with science (Blickenstaff, 2005; Fennema, 2000; Taylor et al., 2001); girls in this study however only spoke about wanting to do experiments and did not mention the other two factors.

Table 16

Descriptive Statistics for Questions 48-50

Grade & gender	Descriptive statistic	Q48: In science class, we spend a lot of time on one topic and study it in great detail	Q49: We do a lot of hands-on activities in science	Q50: We do a lot of group-work in science
Gr. 8 girls	Mean	5.10	5.55	5.40
	Median	5.00	6.00	6.00
	Std dev	1.74	1.36	1.10
	n	20		
Gr. 8 boys	Mean	4.88	5.50	5.88
	Median	6.00	6.00	6.00
	Std dev	1.65	1.56	1.37
	n	34		
Gr. 11 girls	Mean	5.24	4.57	5.00
	Median	6.00	4.00	5.00
	Std dev	1.35	1.39	1.45
	n	46		
Gr. 11 boys	Mean	5.17	4.82	5.00
	Median	6.00	4.50	4.00
	Std dev	1.30	1.57	1.45
	n	39		
Totals	Mean	5.11	5.01	5.28
	Median	6.00	6.00	6.00
	Std dev	1.47	1.53	1.42
	n	139		

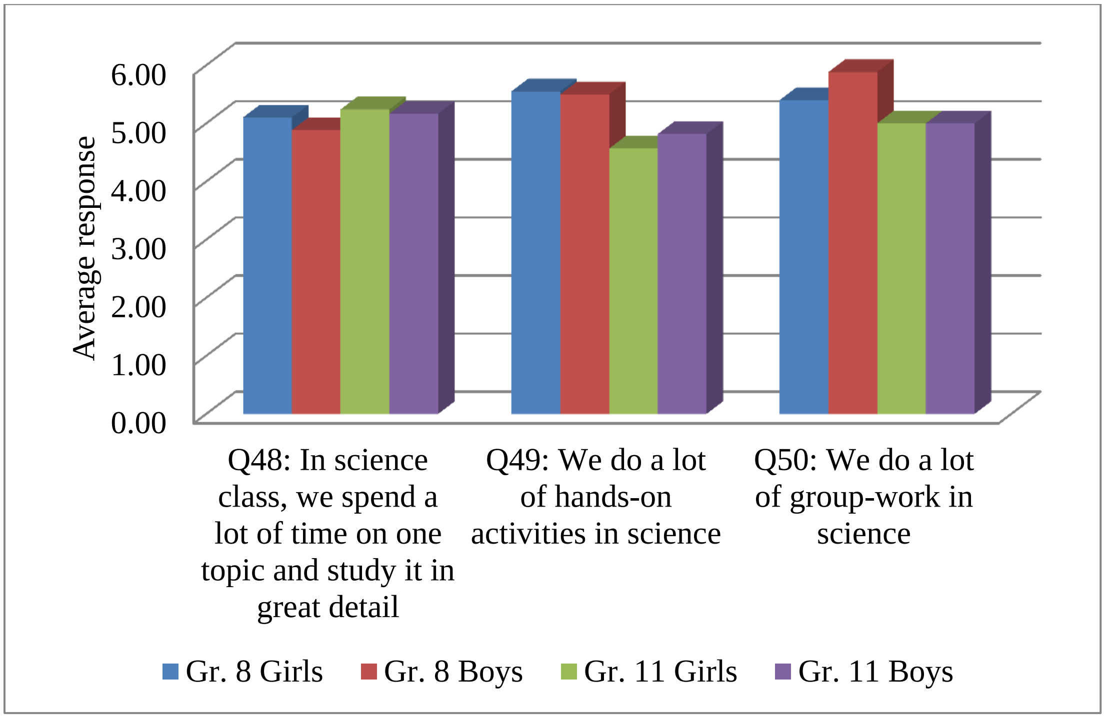

Figure 16. Average student responses to survey questions relating to Theme 4: Science education and science teachers

Participating in extra-curricular science activities. It is not surprising then that girls who are so interested in experiments became very animated and excited when discussing extra-curricular activities such as science fairs and science camps. Several of the girls spoke about participating in science related activities outside of the classroom from watching documentaries to experimenting and internet research to job shadowing.

> [Tanya]: it just seems really interesting to me, I've always been interested in forensic science and I always look things up on the computer about it and watch the shows with people doing forensic science
>
> [Karla]: I always buy little science kits just to test things out 'cause I like to

Some of the girls that had not had the opportunity to participate in structured extra-curricular science activities such as science fairs, expressed an animated desire to participate in such activities.

> [Linda]: it'd just be cool to, 'cause that's exactly what I've been talking about, the creativity you get to build something that's scientific and you get the opportunity to make it hands on and just it's your chance to be creative and show how your scientific part of your brain works

Those girls that had experienced formal out of school science activities recalled them with excitement and detail despite it having been years ago.

> [Anna]: oh, ah, there was this science fair I remember when I was in Grade 6 I think it was and you had to build something just anything and I did a little ball thing that just dropped and it turned on a fan and it was pretty cool
>
> [Alicia]: We went to Operation Minerva at X
> [Cathy]: Well you really got to take a bio class in the university so you really got to see how
> [Alicia]: ours was DNA
> [Cathy]: yeah and you got to play with DNA and you got to
> [Alicia]: watch it unravel
> [Cathy]: yeah, and you got to see your spit and stuff, it was pretty cool
> [Alicia]: you got to wear the big white suit things for when we did the sheep's blood and the gel stuff
> [Cathy]: it was pretty cool, you got to experience something different that you wouldn't be able to in the classroom

But without structured activities, few girls seem to participate in science outside of school. Question 35 asked students to indicate if they participated in science related activities outside of school including watching science documentaries, reading books, etc. Most students stated that they rarely participate in science outside of school (Table 17, Figure 17); however, interestingly more Grade 11 girls than Grade 8 girls stated sometimes or usually participating in science outside of school (Figure 18). Perhaps this is due to a better understanding of how much science is involved in daily life.

Table 17

Descriptive Statistics for Question 35

	Q35: I do science related activities outside of school				
	Gr. 8 Girls	Gr. 8 Boys	Gr. 11 Girls	Gr. 11 Boys	Total
Mean	4.20	4.88	4.30	4.36	4.45
Median	4.00	4.00	4.00	4.00	4.00
Std. dev	2.04	2.04	1.88	2.19	2.03
n	20	34	46	39	139
Frequency	% of Gr. 8 Girls		% of Gr. 11 Girls		
Never	30%		28%		
Rarely	45%		37%		
Sometimes	10%		26%		
Usually	15%		9%		

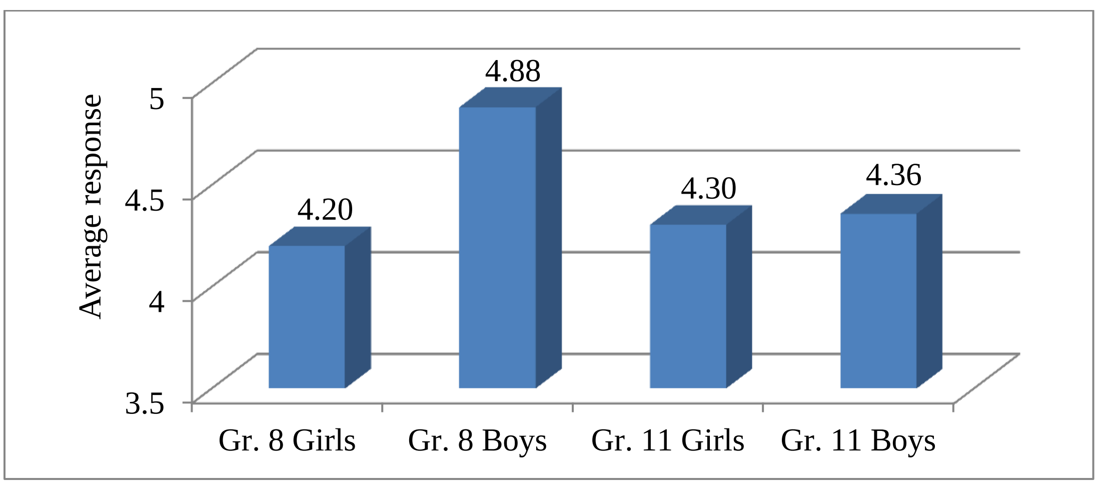

Figure 17. Average responses to Question 35: I do science related activities outside of school.

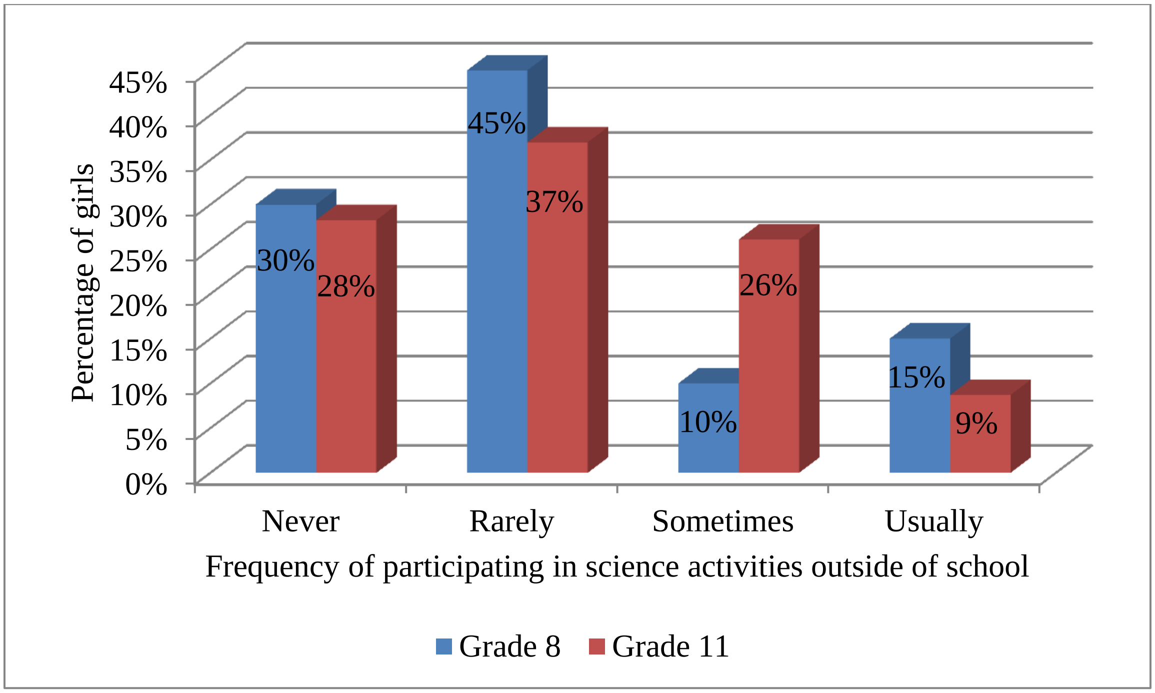

Figure 18. Percentage of Grade 8 and Grade 11 girls and their responses to Question 35: I do science related activities outside of school.

Knowledgeable teachers. All of the girls that actively participated in the interviews spoke about the importance of the teachers knowing their subject and being able to explain the topics. It corresponds to Murphy and Beggs' (2003) study who also found that poor explanations by teachers were frustrating to students. For the students in this study, poor explanations were a source of significant frustration because they felt their science teacher did not have a good enough grasp on the subject to explain it well; although mostly the girls stated that the teacher knew the subject well but just could not explain it. Table 18 summarizes the aspects of science teachers and teaching styles that girls found helpful or detrimental to learning science.

Table 18

Positive and Negative Teaching Qualities Discussed in Interviews

Positive Quality	Negative Quality
1. Lots of hands-on, fun experiments	1. No experiments or dumb/boring experiments; experiments not linked to lesson
2. Interesting and fun	2. Science is not made interesting
3. Some notes but balanced with projects and experiments	3. Spend most of the time rewriting notes from textbook & doing questions
4. Students are comfortable asking questions	4. Students are afraid to ask questions, confused
5. Explanations made sense	5. Teacher used language the students did not understand
6. Teachers know what they are teaching	6. Inexperienced – new teacher or first time teaching subject
7. Knowledgeable teachers	7. Teacher giving different answers at different times
8. Teacher takes time to explain and makes sure everyone understands	8. Teacher moves too fast, doesn’t take time to explain
9. Teacher calls on everybody, nobody left out	9. Teacher appears to choose favourites
10. Teacher shows interest and care for students	10. Teacher appears to not care – does other things during class e.g., iPhone
11. Teacher is organized – reviews material and makes review easy	11. Teacher gets frustrated with students when they do not have work done
12. Teacher uses games for marking and calling on students	12. Lack of classroom management
13. Prizes or draws for students that achieve	13. Teacher gives lots of work but does not mark it
14. Teacher relates topic to real world	14. Teacher expects students to teach themselves
15. Students do well on tests	15. Teacher gets off track, does not focus on subject
16. Cool stories, stories about scientists	16. Teacher lectures students about copying but does not give other solution for learning material
17. Teacher broke material down into manageable chunks	17. Teacher does not help
18. Teacher is enthusiastic, energetic	18. A lot of rules but students do not show respect for them
19. Teacher develops relationship with students outside of class--e.g., coaching	19. Not liking teacher is stressful

The students did not speak of them in the dichotomy in which they are presented here; the dichotomy as it appears in Table 18 was developed through the summarizing process of all the interviews. The following are specific comments about teachers the girls felt were not knowledgeable in the subject:

> [Katie]: ‘cause our teacher sucks at answering questions
>
> [Katie]: yeah, I don’t think she knows her subject at all which is weird ‘cause she’s a bio major but I don’t think she knows most of what’s happening. She’s really boring, she’s really bad explaining and answering questions.
>
> [Sara]: her background she said’s in biology so she knows what she’s doing she just isn’t experienced in it so she isn’t very good at it
>
> [Cindy]: he’s really nice and everything sometimes he like, it’s kinda hard sometimes because he doesn’t know how to explain it so you get it but most of the time he does, he just needs to read over his stuff a little bit more and he even says that himself because it takes him a couple of tries to get what he’s trying to say, so it’s just kinda hard to get what he’s saying if he can’t explain it as well as he needs to
>
> [Karla]: when we had him in Grade 6 I think he was better because he, we were younger and I think it was easier science but now that we’re in Grade 8 I think it’s a little bit harder for him so he just needs to keep reading about it and figure how he’s going to explain things

The following comments are about teachers the girls felt were knowledgeable in their subject. Notice Tanya’s comments below about the difference one teacher can make in girls’ interest in science which Warrington and Younger (2000) also found in their study.

> [Yvonne]: he knows what he’s talking about, that’s what I like, ‘cause he relates it to anything like if you are a hockey player or volley ball player he’ll relate something to that
>
> [Tanya]: it was her first year and so she’s kinda again with our teacher this year, and the teacher that came in he’s, is he a science teacher now?...but he taught math and science I think last year but

> he's taught at bigger schools in X so he's experienced and when he came in and started teaching I actually started learning more just the way he taught I guess
> [Anna]: yeah, my mark actually went up when he came
>
> [Alicia]: my favourite teacher Grade 5 and 6, I think it was Grade 5 and 6, he was really into science that's kind of what got me into it...
> [Alicia]: He did a lot with environmental science before he was a teacher
> [Cathy]: He put a lot of like in the class
> [Alicia]: she had the same teacher
> [Cathy]: yeah, he didn't do so much with the English and the Social but he did a lot with the class in science stuff so it really emphasized it so it was actually much more cooler than learning about everything else and after that you just kind of wanted to go with it. I found it much more interesting the way he did it.
>
> [Linda]: ...it's just one of the funnest classes that you could have 'cause she brought so many experiments into, she's been teaching that for so many years she just knows how to explain it to a kid my age.

In fourteen instances the girls spoke about male science teachers as influential; eight of those were positive influences. Twenty instances they spoke about influential female science teachers of which twelve were positive. Table 19 and Figure 19 summarize the average survey responses to Questions 13 and 14 dealing with current teacher influence; Table 20, Figures 20 and 21 summarize student responses to influence of past science teachers (Questions 25-30). Table 20, Figures 20 and 21 are based on students that indicated agreeing or strongly agreeing with Questions 25 and 27 respectively.

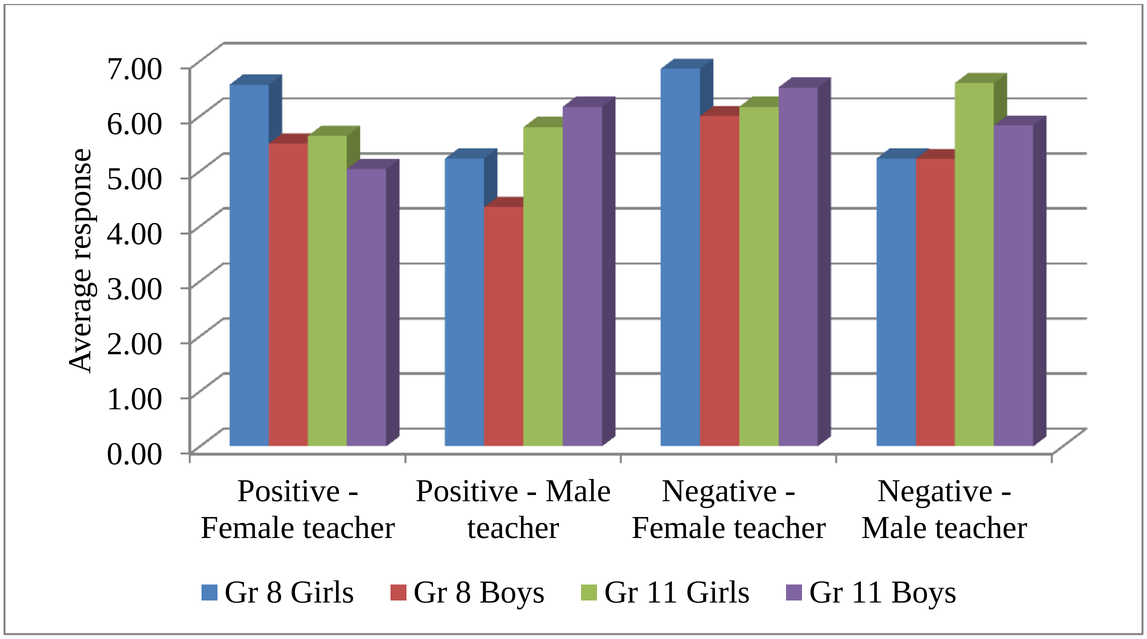

Figure 19. Teacher gender differentiated average responses to Questions 13 and 14 dealing with the influence of the most recent science teacher.

Table 19

Descriptive Statistics for Questions 13 & 14 Differentiated by Teacher Gender

Grade & gender	Teacher gender	Female	Male	Female	Male
	Descriptive statistic	Q13: My most recent science teacher has a strong positive influence on me.		Q14: My most recent science teacher has a strong negative influence on me. (reversed)	
Gr. 8 girls	Mean	6.57	5.23	6.86	5.23
	Median	6.00	6.00	8.00	6.00
	Std dev	1.51	1.92	2.27	2.09
	n	7	13		
Gr. 8 boys	Mean	5.50	4.35	6.00	5.22
	Median	5.00	4.00	6.00	6.00
	Std dev	1.77	1.87	1.51	2.15
	n	8	23		
Gr. 11 girls	Mean	5.64	5.80	6.17	6.60
	Median	6.00	6.00	6.00	6.00
	Std dev	1.51	1.99	1.46	1.35
	n	36	10		
Gr. 11 boys	Mean	5.04	6.17	6.52	5.83
	Median	6.00	6.00	6.00	6.00
	Std dev	1.99	1.34	1.62	1.80
	n	24	11		
Totals	Mean	5.52	5.17	6.32	5.59
	Median	6.00	6.00	6.00	6.00
	Std dev	1.73	1.91	1.59	1.97
	n	75	57		

Note. Responses the Question 14 are reversed, thus a high number indicates stronger disagreement with the statement.

Table 20

Student Response Percentages for Questions 29 & 30 Differentiated by Teacher Gender

Q29: What gender was the science teacher that had the strongest positive influence on you?			
		Female Teacher	Male Teacher
Gr 8 Girls	%	56.25	43.75
	n	16	
Gr 8 Boys[a]	%	50.00	42.31
	n	26	
Gr 11 Girls	%	60.00	40.00
	n	35	
Gr 11 Boys	%	33.33	66.67
	n	24	
Total	%	50.50	47.52
	n	101	
Q30: What gender was the science teacher that had the strongest negative influence on you?			
		Female Teacher	Male Teacher
Gr 8 Girls	%	14.29	85.71
	n	7	
Gr 8 Boys	%	35.29	64.71
	n	17	
Gr 11 Girls	%	27.27	72.73
	n	22	
Gr 11 Boys	%	50.00	50.00
	n	14	
Total	%	33.33	66.67
	n	60	

[a]Two Grade 8 boys (7.69%) indicated having had both male and female teachers with a positive influence.

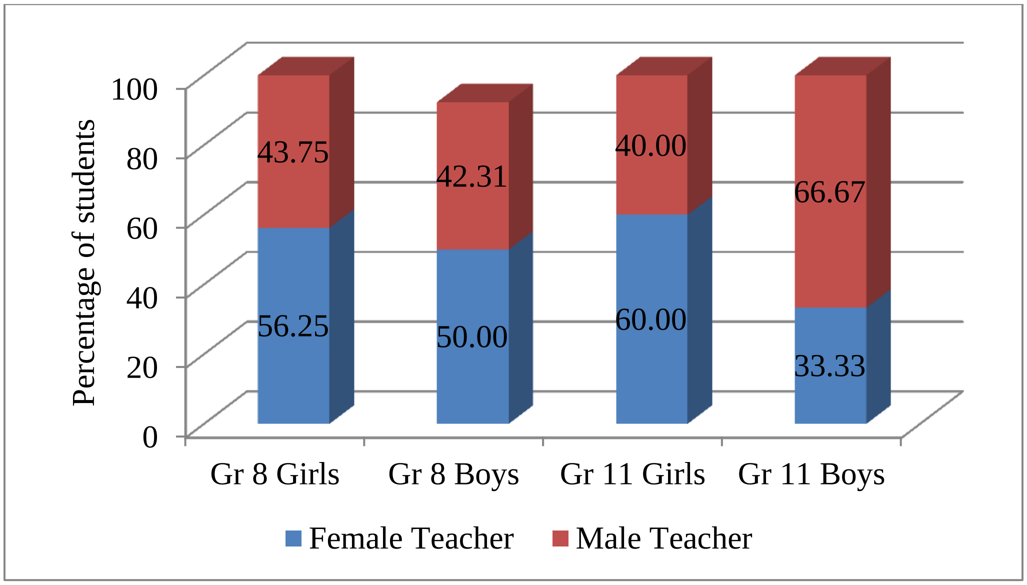

Figure 20. Percentage of students reporting that a science teacher in the past had a positive influence differentiated by teacher gender.

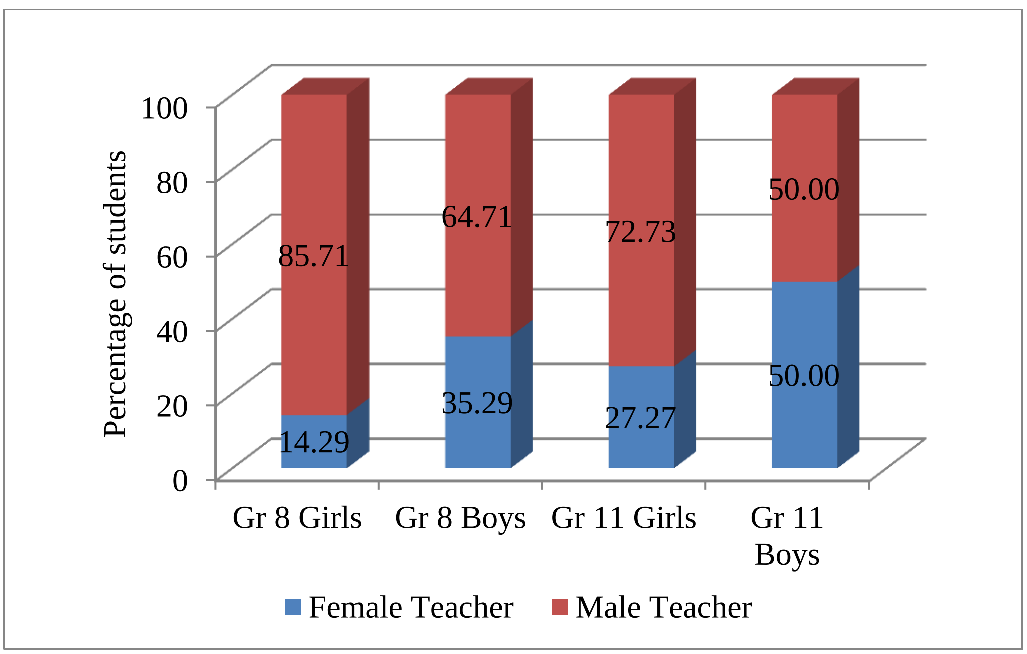

Figure 21. Percentage of students reporting that a science teacher in the past had a negative influence differentiated by teacher gender.

Notice that girls stated having had positive influential female science teachers more so than male teachers. Of the students who reported having a science teacher in the past who influenced them negatively, most stated that the teacher was male. Again due to the small sample size and characteristics of rural populations, this may be more a reflection of an individual teachers' teaching style than their gender and bears further investigation with a larger population. The most frequently mentioned reason why a teacher was influential, either positive or negative, was due to quality instruction including being able to explain, helping, doing experiments, and telling stories (Table 21, Figures 22 and 23).

Table 21

Percentage of Student Responses as to Why Their Teachers Were Influential

Factor	Past teacher – Positive influence	Past teacher – Negative influence	Current teacher
Made science fun (negative: did not make science fun)	27.27	24.00	10.87
Quality instruction (incl.: explaining, helping, experiments, stories)	42.05	42.00	61.96
Teacher expectations	13.64	6.00	15.22
Classroom management	10.23	24.00	8.70
Other	6.82	4.00	3.26

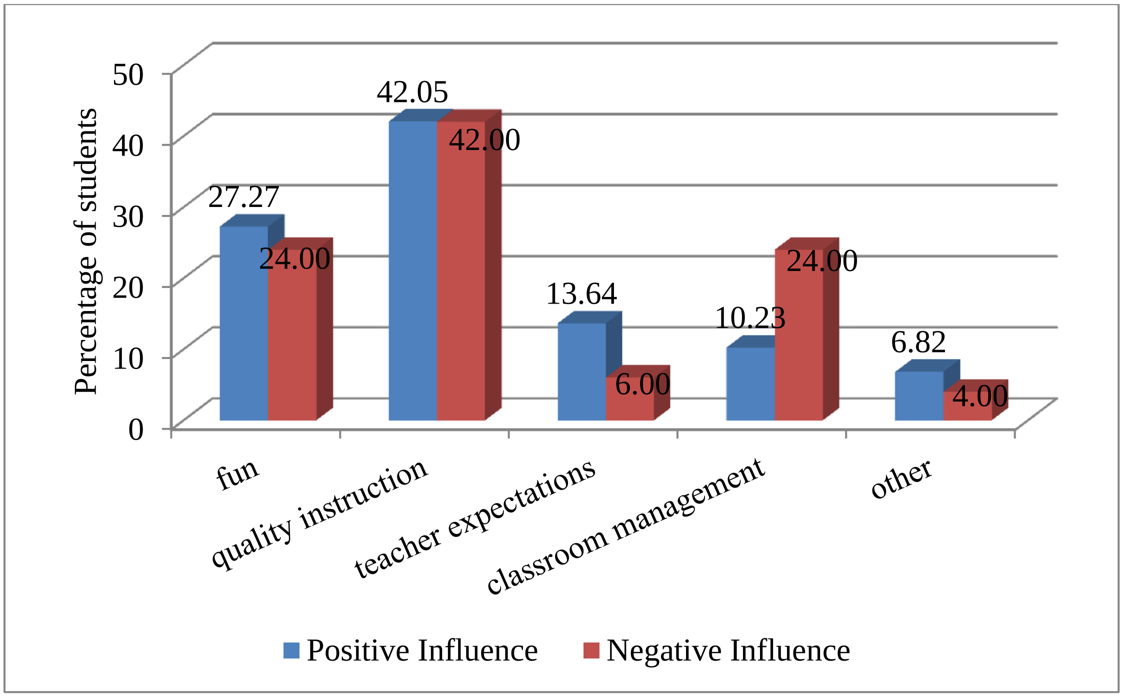

Figure 22. Percentage of students indicating factors that caused past teachers to have a positive or negative influence on them.

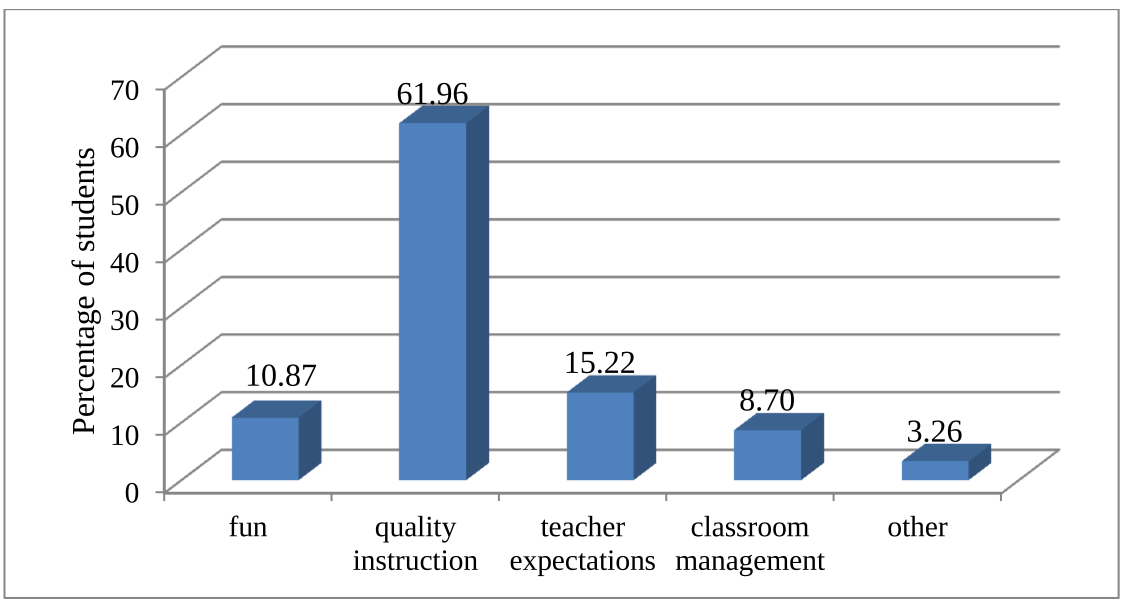

Figure 23. Percentage of students who indicated factors that cause their current teacher to be influential, either positive or negative.

Making science fun was the second most frequently mentioned factor after quality instruction. But for students that indicated their teacher had a negative influence, the lack of classroom management was stated just as frequently as science not being fun.

When asked about current teachers however, Grade 8 students rated their female science teachers as having a more positive influence and Grade 11 students indicated their male science teacher seemed to have a more positive influence on them. Grade 8 girls were the most positive about their female science teachers; they were also more likely to talk to their female teachers about a science career (Table 22, Figure 24) while Grade 11 girls were more likely to talk to their male teachers.

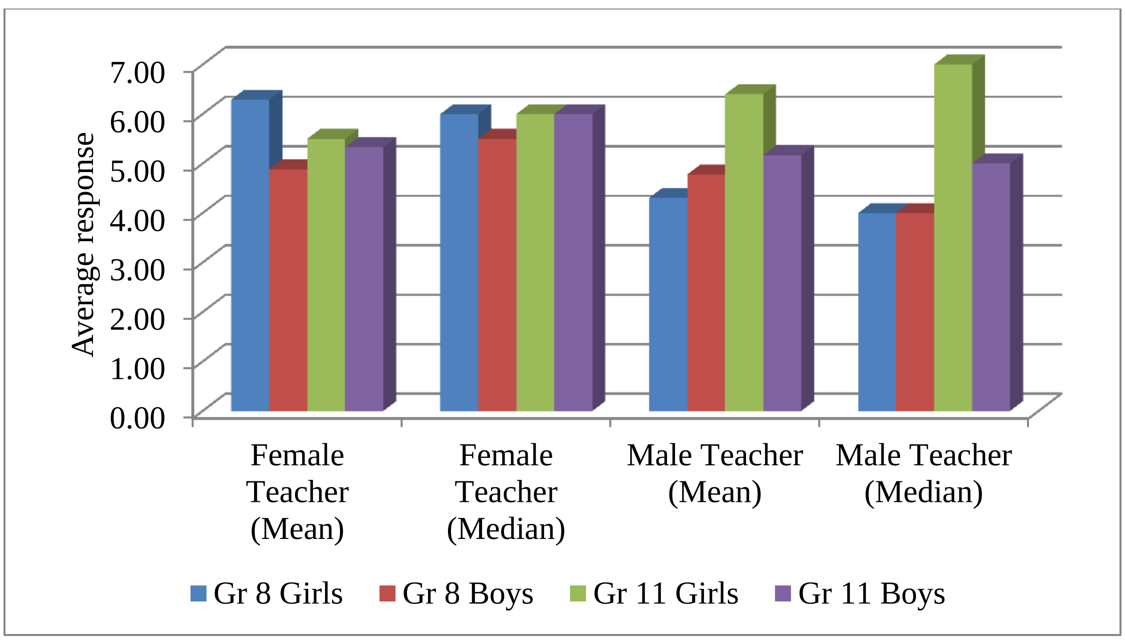

Figure 24. Average responses to Question 17: I would talk to my science teacher about pursuing a career in science.

Table 22

Descriptive Statistics for Question 17 Differentiated by Teacher Gender

Grade & gender	Descriptive statistic	Q17: I would talk to my science teacher about pursuing a career in science.		
		Female teacher	Male teacher	Non-gender differentiated
Gr. 8 girls	Mean	6.29	4.31	5.00
	Median	6.00	4.00	5.00
	Std dev	1.38	2.14	2.10
	n	7	13	20
Gr. 8 boys	Mean	4.88	4.78	4.84
	Median	5.50	4.00	4.50
	Std dev	1.46	1.68	1.59
	n	8	23	32
Gr. 11 girls	Mean	5.50	6.40	5.70
	Median	6.00	7.00	6.00
	Std dev	1.38	2.07	1.58
	n	36	10	46
Gr. 11 boys	Mean	5.33	5.17	5.30
	Median	6.00	5.00	6.00
	Std dev	1.83	2.17	1.90
	n	24	12	37
Totals	Mean	5.45	5.03	5.28
	Median	6.00	4.00	6.00
	Std dev	1.55	2.03	1.77
	n	75	58	135

No survey item directly asked about how well students perceived their teachers to understand a topic or how well their teacher is able to explain concepts. Survey questions 17-20 however can be used to give an overall idea of how knowledgeable students felt their teachers are in science. Grade 11 girls being more positive about their male science teachers on these items could potentially indicate that Grade 11 the girls felt their male science teachers were more knowledgeable but, due to the relatively small sample involved in this study, this could well be due to the teachers' individual teaching ability rather than teacher gender as documented in other studies (Carrington et al., 2005; Martin & Marsh, 2005).

Theme 5: What is Important About Role Models

Only a few girls interviewed had individuals who in their minds were well defined role models; and even fewer of those girls were willing to talk about their role models in the group setting. In looking at the survey data, of 139 students surveyed, 111 indicated they had one or more role models (Question 7) and 108 of those provided specifics about their role models. Of the 19 girls selected for interviews, 16 of them indicated and provided specifics about their role models on the survey.

To avoid biasing students, the term role model was only defined if students' asked for clarification; in which case role model was then defined as someone who provides encouragement, inspiration, or guidance. One Grade 11 boy although having indicated that his role model was female, when asked for his role model wrote "brother", the gender for his role model was therefore changed to male for analysis purposes. Table 23 summarizes the students' survey data with regard to role models. Figure 25 shows that girls more often reported having a role model than boys did, and Grade 11 students more likely stating they had a role model than Grade 8 students of that same gender. Therefore especially Grade 11 girls stated having role models. However notice that while boys had almost no female role models, girls reported having male role models. Predominantly though, role models reported by students were gender specific. In the interviews it was also the Grade 11 girls interested in science careers who felt that female role models in science careers would be beneficial to their own career paths.

Table 23

Summary of Role Model Data from Question 7

Q 7: Do you have one or more individuals as a role model? Who? Gender									
	Total number of students in group	Number that indicated having a role model	% of group indicating having a role model	Number that indicated their role model is male	% of group indicating their role model is male	Number that indicated their role model is female	% of group indicating their role model is female	Number that indicated their role models are both. female and male	% of group indicating their role models are both female and male
Gr. 8 girls	20	16	80.00	3	18.75	10	62.50	3	18.75
Gr. 8 boys	33	25	75.76	23	92.00	0	0.00	2	8.00
Gr. 11 girls	46	41	89.13	9	21.95	25	60.98	7	17.07
Gr. 11 boys	37	29	78.38	23	79.31	2	6.90	4	13.79

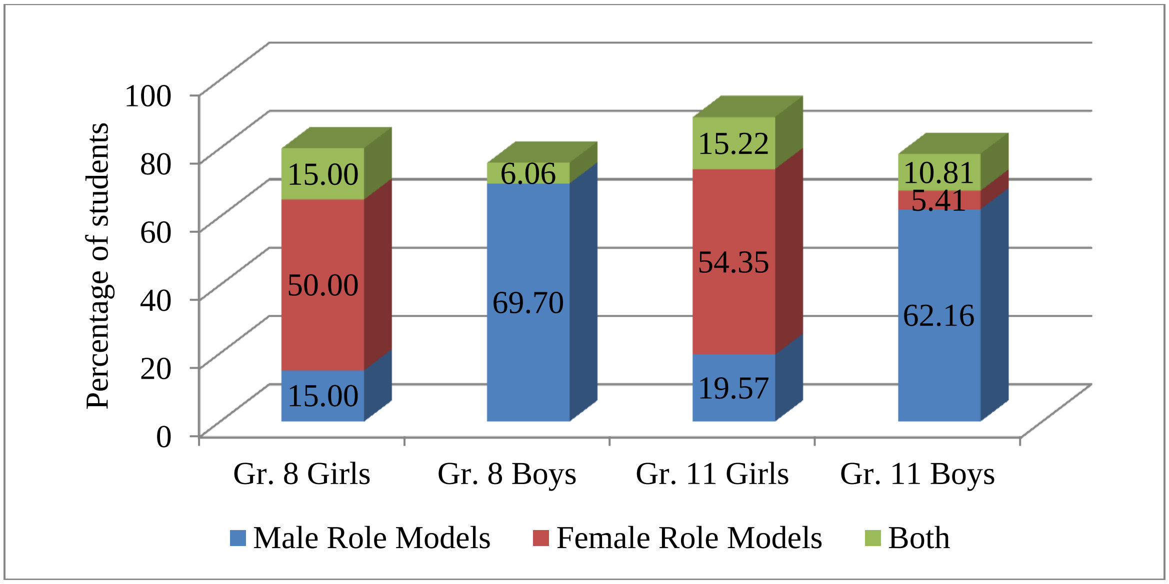

Figure 25. Percentage of students who indicated having a role model.

Table 24 and Figure 26 summarize the types of role models students listed into seven categories. The "Other" category is potentially high because some students did not indicate a relationship but rather a name of the role model; if the name was not relatively famous, it was difficult to determine in some cases if their role model was family, friend or some other individual in their life. Those who did not provide detailed role model information were also included in the "Other" category. Note that one Grade 11 girl specifically indicated "doctors who are on the oncology unit in children's hospitals" as her role model and another Grade 11 girl listed "David Suzuki" as her role model. These two role models were put into their own categories since they represented the role model types of central interest to this study; unfortunately no other students indicated specifically having role models with a science career with the exception of one Grade 8 girl who indicated her female science teacher as her role model and one Grade 8 boy who stated his male science teacher as his role model.

Table 24

Role Models Categorized into Types

	Total	Gr. 8 girls	Gr. 8 boys	Gr. 11 girls	Gr. 11 boys
Family	68	10	17	23	18
Friends	2	1	0	1	0
Teacher	8	1	2	3	2
Celebrity	17	4	5	5	3
Doctor	1	0	0	1	0
Scientist	1	0	0	1	0
Other	13	0	1	6	6

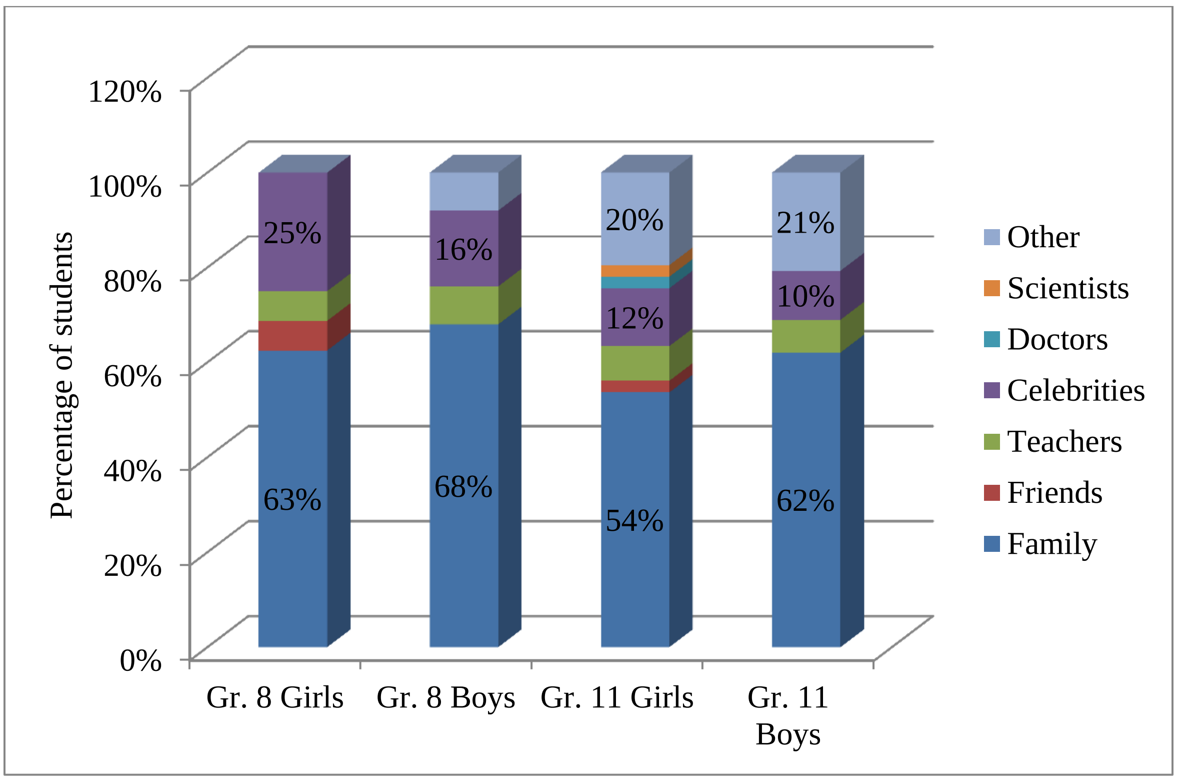

Figure 26. Role model types.

Of the students that indicated having one or more role models, the average student agreed that role models have a strong influence on their career choice as can be seen in Table 25. Figure 27 indicates that with the exception of Grade 11 girls, female role models seemed to have a greater influence on students. Those that indicated they had both male and female role models were included in the analysis of influence of female role models.

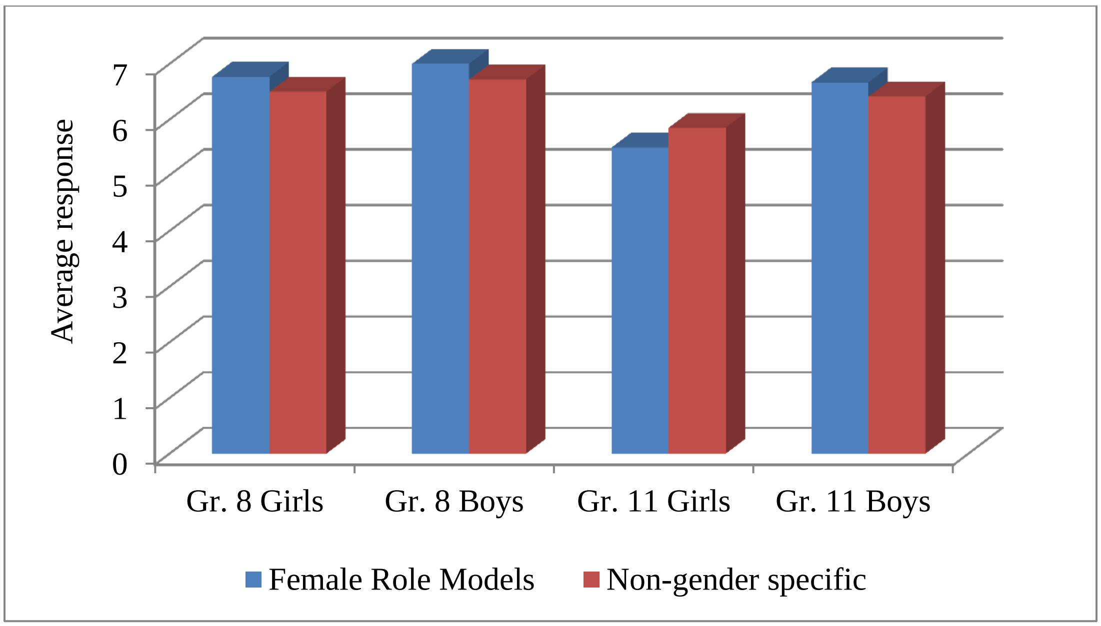

Figure 27. Average responses to survey Question 8: My role model has a strong influence on me.

Table 25

Descriptive Statistics for Question 8

Q8: My role model has a strong influence on my career choice.			
Grade & gender	Descriptive statistic	Female role model	Non-gender specific role model
Gr. 8 girls	Mean	6.77	6.50
	Median	6.00	6.00
	Std dev	1.30	1.55
	n	13	16
Gr. 8 boys	Mean	7.00	6.72
	Median	7.00	8.00
	Std dev	1.41	1.62
	n	2	25
Gr. 11 girls	Mean	5.50	5.85
	Median	6.00	6.00
	Std dev	1.76	1.75
	n	32	41
Gr. 11 boys	Mean	6.67	6.41
	Median	7.00	6.00
	Std dev	1.63	1.52
	n	6	29
Total	Mean	6.00	6.29
	Median	6.00	6.00
	Std dev	1.71	1.65
	n	53	111

Note. Statistics are based only on those students indicating that they had one or more role models.

The reluctance of girls to share about their role models in the group setting was a drawback of this type of interview. In the interviews five Grade 8 girls spoke about role models; three of those role models were women. Six of the Grade 11 girls spoke about role models of which five were women. Of the girls that spoke about their role models and had a good understanding of what the role model meant to them, three characteristics kept resurfacing: 1. being able to relate personally to the role model, 2. the role model having overcome barriers or a strong belief in their dreams and 3. the role model achieving those dreams and being successful.

Being able to identify with role models. Other studies have also shown that being able to identify with a person is important in choosing a role model (Britner & Pajares, 2006; Buck et al., 2008; Gilmartin et al., 2007; Karunanayake & Nauta, 2004; Zirkel, 2002). For the girls in this study being able to identify with their role model included a range from as personal as a good friendship with the role model to common interests.

> [Steph]: I actually got to meet her and talk to her and she just told me to, she grew up in this tiny town like we do and she pushed her way to be on the Olympic team and she's only 24 and she's already been in the Olympics two times and she's crazy good at everything and then she's kinda like me, she really likes animals and when she's done with hockey she wants to open a vet clinic and work with that and she's just been my role model
>
> [Marie]: I used to have her as a ... teacher...
>
> [Alicia]: I have a friend, you know the new cancer clinic that opened up in X? She is one of the head nurses there.

Overcoming barriers or believing in their dreams. Three of the role models according to the girls overcame hurdles and in some cases personal difficulties; the fourth role model was a source of encouragement for the girl to believe in her dreams and their possibility.

> [Steph]: ...and she pushed her way to be on the Olympic team
>
> [Alicia]: ... my friend who works at the clinic...was diagnosed with brain cancer a couple years ago and it really made her work that much harder to help with cancer research and such.
>
> [Linda]: the first year she tried out for So You Think You Can Dance Canada she didn't make it past the top 40 and it was just so cool to see how she went to schools in Canada like to Vancouver and went and studied more dance for a year and has tried her hardest and then she ended up winning the next year. She went back even though she knew it was a hard thing to do and she got injured, her ribs had all been cracked and broken but she'd still keep going 'til the very, very end.

Success of the role model. In the end the role models were all successful in their field of interest. The girls that had these role models stated planning on pursuing the same career as their role model or a career closely related.

> [Steph]: she's only 24 and she's already been in the Olympics two times and she's crazy good at everything
>
> [Marie]: she was a very famous teacher and dancer. She used to have concerts, where she would have plays and she did Romeo and Juliet and things like that

In the interviews when asked if they had a role model some girls flat out said no, others talked about individuals who encourage them right now or inspire them to do better; in some cases the role model question was followed up by the question if they had someone who inspired them, motivated them, or encouraged them. The excerpts below include information about individuals the girls mentioned who they felt positive about and who had some impact on them to various degrees but who they did not identify as role models.

> [Tanya]: one of my mom's friends in university she took classes in it and she said it was really interesting but once it got to the real thing it was a little like I don't know if I want to do this but I seem really interested in it so
>
> [Donna]: I just like horses and we have a friend and she went to BC for horse therapist and she says she just loves it so I said why not me
>
> [Cathy]: but then there's some of them who you see and there's so much that they did and from the time that they did it and how much they had to overcome like say religion or something was a huge thing
> [Alicia]: Galileo
> [Cathy]: yeah, that's who I was gonna say, where everything is supposed to be the same and then he goes and he just basically says everything opposite to what everybody has already believed, to be able to do that was pretty big on his part

Girls interested in science stated that they felt the presence of a female role model in their field of choice would be helpful to them,

> [Sara]: because then you can see what routes they took and stuff it's easier to relate to a girl in a workplace than a guy you know what I mean working your way up in whatever you want to do

Other girls more generally stated that they would seek out someone who had been successful in the career they would like to pursue, although this may be in the form of a mentor or guide.

> [Cindy]: I would talk to someone very successful and they would lead me in the right path. I'm not sure, I think my teacher now would lead me in his own path

Teachers as role models. Only two of the Grade 8 girls considered their science teachers as their role models.

> [Jenny]: our teacher right now and she's also our volleyball coach. I kind of look up to her
>
> [Karla]: my science teacher kind of... he always encourages you to do your best so even if you're not doing very good or whatever he takes extra time to help you and encourages you to do your best and everything and so

From the surveys not many students considered their teachers as role models. Nine students of 139 listed a teacher, principal or coach as their role model. Six of those role models were male teachers. Of those nine students, four girls stated that a teacher was their role models; of the four girls, one girl stated having a male teacher as her role model. However according to the data summarized in Table 26 and Figure 28 teachers were still considered the second most influential on their career choices by all students (excluding "Others").

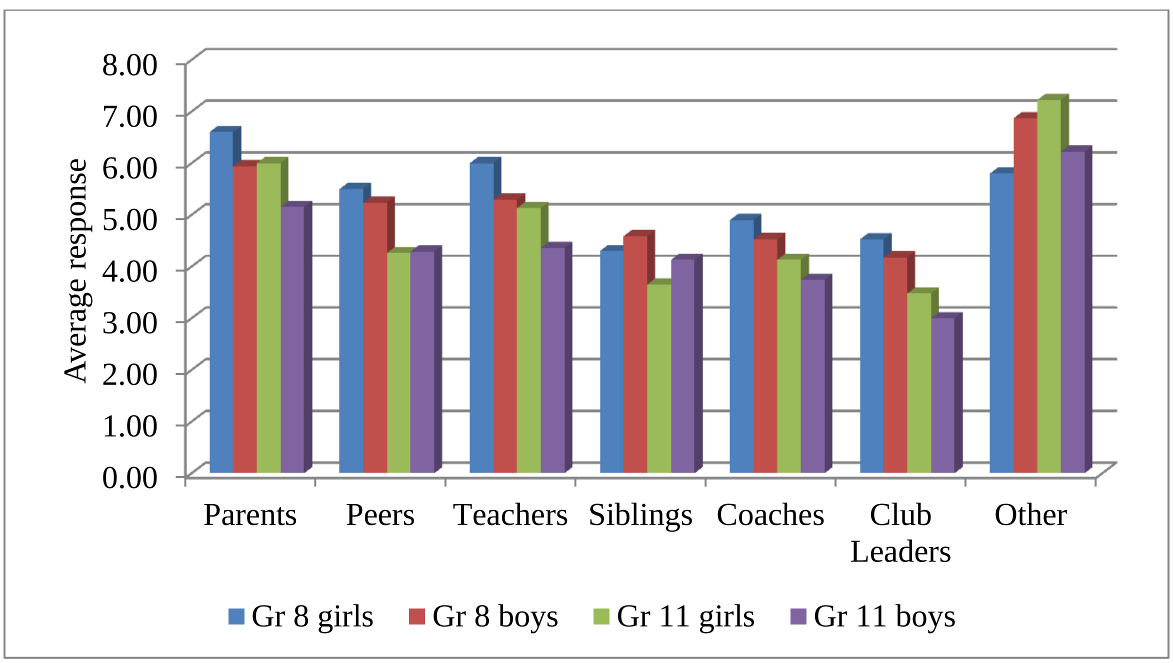

Figure 28. Influence of groups on students' career choices (Question 6).

Table 26

Descriptive Statistics for Question 6

		Q6: How much do each of the following influence your career choices:						
		Parents	Peers	Teachers	Siblings	Coaches	Club Leaders	Other
Gr 8 girls	Mean	6.60	5.50	6.00	4.30	4.90	4.53	5.80
	Median	6.00	6.00	6.00	4.00	5.00	4.00	6.00
	Std. dev	1.14	1.82	1.84	2.18	2.00	2.09	1.75
	n	20	20	20	20	20	19	10
Gr 8 boys	Mean	5.94	5.24	5.29	4.59	4.53	4.18	6.87
	Median	6.00	6.00	6.00	4.00	4.00	4.00	8.00
	Std. dev	1.87	1.30	1.96	1.81	1.93	1.80	1.69
	n	34	34	34	34	34	34	23
Gr 11 girls	Mean	6.00	4.26	5.13	3.65	4.13	3.48	7.22
	Median	6.00	4.00	6.00	4.00	4.00	4.00	8.00
	Std. dev	1.46	1.77	1.61	1.80	2.00	1.60	0.97
	n	46	46	46	46	46	46	9
Gr 11 boys	Mean	5.15	4.29	4.36	4.13	3.74	3.00	6.22
	Median	6.00	4.00	4.00	4.00	4.00	2.00	8.00
	Std. dev	1.76	1.33	1.94	1.75	1.53	1.45	2.54
	n	39	38	39	39	39	38	9
Totals	Mean	5.83	4.69	5.08	4.11	4.23	3.66	6.61
	Median	6.00	4.00	6.00	4.00	4.00	4.00	8.00
	Std. dev	1.67	1.63	1.88	1.86	1.88	1.76	1.80
	n	139	138	139	139	139	137	51

The “Other” category included predominantly other family members such as grandparents and cousins (28%), members of specific professions such as doctors and police officers (19%), friends (15%), self (13%), and other non-categorized responses such as pets, media, etc. Grade 8 students stated being more likely to be influenced by their teacher on career choice than Grade 11 students; and girls appear to be more influenced by teachers than boys of the same grade level (Table 27). With the exception of Grade 8 boys it appears that influence of the teacher on career choices varied very little based on the gender of the teacher (Figure 29).

Table 27

Descriptive Statistics for Question 6c Differentiated by Teacher Gender

Grade & gender	Descriptive statistic	Q6c: Influence of teachers on student career choices	
		Female teacher	Male teacher
Gr. 8 girls	Mean	5.71	6.15
	Median	6.00	6.00
	Std dev	1.80	1.91
	n	7	13
Gr. 8 boys	Mean	4.50	5.57
	Median	5.00	6.00
	Std dev	1.77	1.90
	n	8	23
Gr. 11 girls	Mean	5.17	5.00
	Median	6.00	6.00
	Std dev	1.68	1.41
	n	36	10
Gr. 11 boys	Mean	4.25	4.33
	Median	4.00	4.00
	Std dev	2.15	1.67
	n	24	12

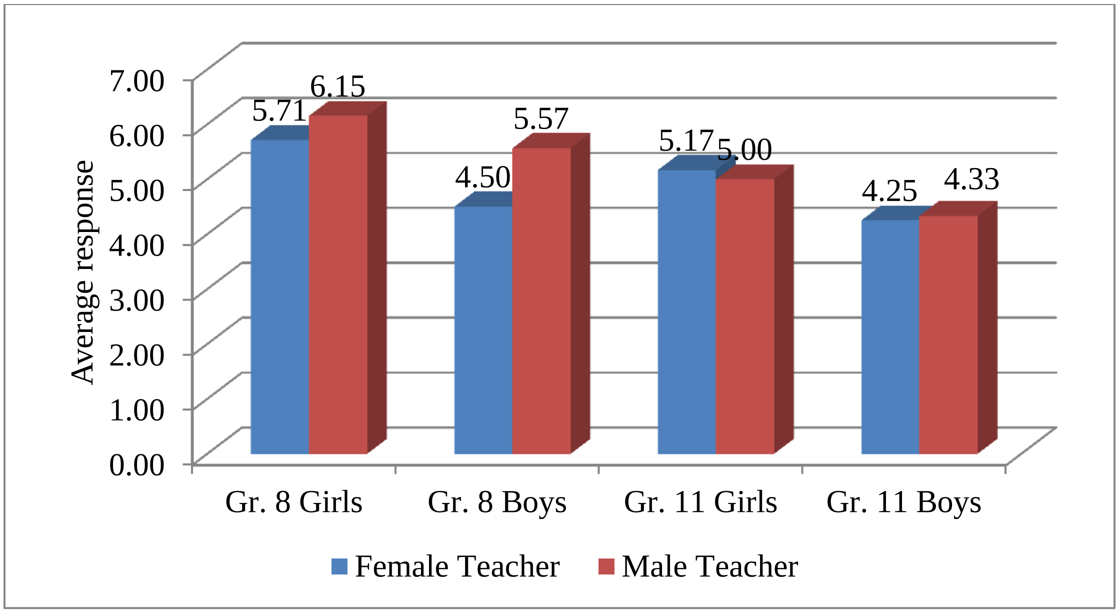

Figure 29. Average responses to Question 6c: Teachers influence on career choices.

Theme 6: Parental and Peer Support

Almost all of the girls felt that their parents would be supportive, happy, proud, excited, even ecstatic if they told their parents they wanted to pursue a science career. Several studies have shown that parents are an important source of support for girls (Bystydzienski, 2009; Farmer, 2009; Kniveton, 2004; Rosser, 2004).

> [Cathy]: if I was to go do something when they can't, they only have a few options with what they can do and I have all these options and I can be a doctor, like the highest position, then they'll be ecstatic, and super happy and proud

> [Donna]: they know that guys can't just do everything so if you only had a daughter and then a son then they can be like ok so they're kinda equal. But then the daughter achieves more than the son they're kinda sometimes more supportive on the daughter because they're like k you're my girl and you're doing all this that girls don't really do

Peers seemed to have very little influence as was expected from Hardré et al.'s (2009) study on rural students. While some of the girls admitted that the reaction from their peers may not be positive they did not feel that it would deter them from pursuing a science career if that is what they wanted to do.

> [Yvonne]: they'd probably call me a nerd and be like oh
>
> [Sara]: my friends would never say anything negative to it or anything, they wouldn't be like you're a nerd but it's just not, they don't really care
> [Ruth]: it's maybe not something they would do but it's
> [Sara]: yeah, like when we graduate and stuff they'll probably support in our choices but they're not gonna

Importance of fathers' opinions. Overall father's seemed to be influential on girls' interest in science and possibility of pursuing a science career. Five of the seven girls that spoke about one of their parents interacting with them about career choices or interest in science, spoke specifically about their fathers.

> [Yvonne]: I don't know if my dad would for me, one time when I was talking to him about schooling and what I want to do, he tells me there's too many engineers so I shouldn't be one, like fine, but I guess it could go back to how a guy can be more successful in something like that than a woman
>
> [Tanya]: yeah, I don't really talk about it with my friends, I know my dad wants me to, he just always says - you always have wanted to go into forensic science and I think that would be a good thing for you. He thinks it's positive and supports me

Two girls spoke specifically about the influence of their mothers on their career aspirations or interest in science:

> [Sara]: my mom is a lab tech...my mom told me, she said it's a good job but she wouldn't recommend it to me 'cause she said there's not much branching out you can do from it than with other things
>
> [Marie]: I think my mom would be happy for me because I want to pursue my dream, I believe I can, I think she would be excited that I shared that I know what I want to be when I'm older, that I have a future, that what I want to be is something that I will be happy to do, something that she may not agree with but she

> knows that I will be happy and that I'm pursuing something that makes me most interested and most excited about

Perhaps the reason mothers seem more influential on these two girls is the absence of their fathers: Sara's parents are divorced and Marie's father works away from home. This potential explanation requires further investigation. Even though Marie was not sure if her mother would agree with a science career choice, only Yvonne, after initial hesitation, outright admitted that her interest in a science career was overtly discouraged.

In general though the interview results agree with the average survey responses as displayed in Figure 30: Students felt they would be more supported by parents than by peers (Table 28).

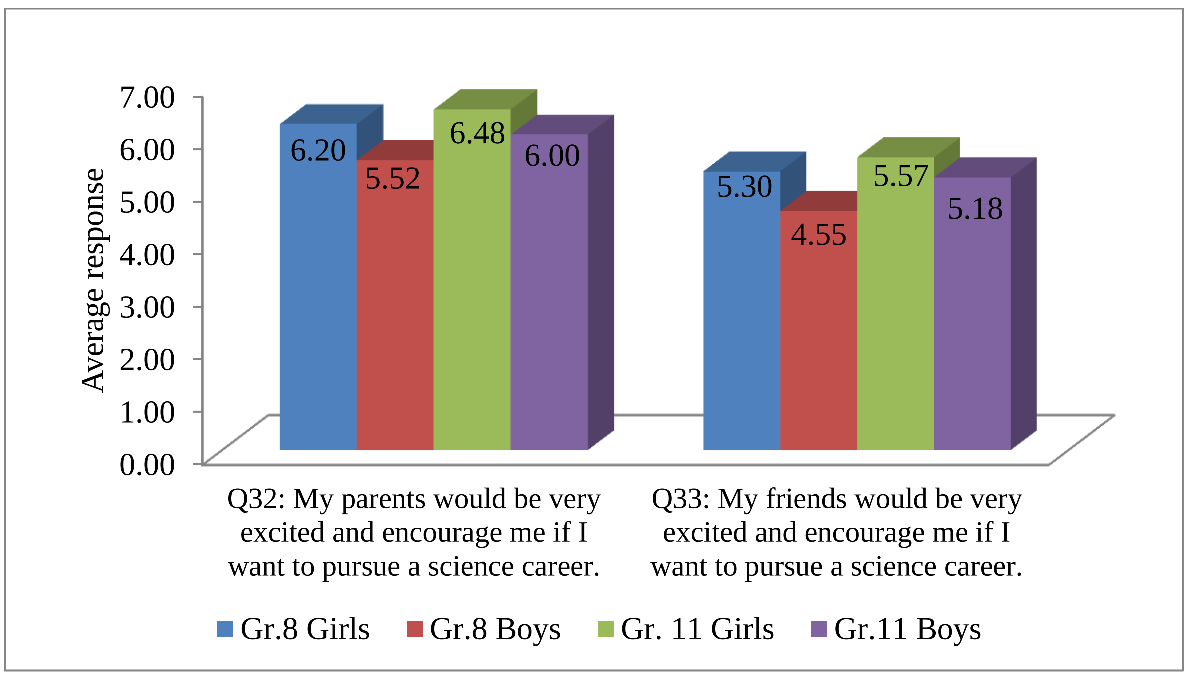

Figure 30. Average survey responses about parental and peer support for pursuing a science career.

Table 28

Descriptive Statistics for Questions 32 & 33

	Q32: My parents would be very excited and encourage me if I want to pursue a science career.				
	Gr. 8 Girls	Gr. 8 Boys	Gr. 11 Girls	Gr. 11 Boys	Total
Mean	6.20	5.52	6.48	6.00	6.07
Median	6.00	6.00	6.00	6.00	6.00
Std. dev	1.70	1.73	1.21	1.59	1.56
n	20	33	46	39	138
	Q33: My friends would be very excited and encourage me if I want to pursue a science career.				
Mean	5.30	4.55	5.57	5.18	5.18
Median	6.00	4.00	6.00	4.50	6.00
Std. dev	1.63	1.68	1.33	1.50	1.54
n	20	33	46	38	137

Of the 139 students surveyed, 19 reported having at least one parent in a science related career. Table 29 shows survey tallies for parental science careers with girls reporting eight of their parents having science careers. Notice that mothers with science related careers were predominantly nurses although two boys did report their mothers being an engineer and a scientist.

Table 29

Parents with Science Related Careers

	Total number of students	Girls only
Fathers	4	2
➢ Teacher ➢ Geophysicist ➢ Pharmacist ➢ Technology		
Mothers	15	6
➢ Pharmacist	2	--
➢ Nurse (& related health care workers)	9	5
➢ Lab tech	2	1
➢ Agricultural scientist	1	--
➢ Engineer	1	--

Theme 7: Influence of Media

Not many women/ descriptors. The descriptors girls used to talk about women with science careers as portrayed in media ranged from “dumb blondes”, “creepy”, “nerdy” to “successful”, “super smart”, “attractive”. Most of the girls stated that apart from popular TV shows such as CSI, very few women scientists if any were featured in documentary type productions. Table 30 summarizes ideas girls discussed in the interviews about women with science careers in media.

Table 30

Summary of Girls' Comments about TV Shows and Documentaries

Title	Media Type	Comments
How It's Made	Documentaries	fun
Mythbusters	Documentaries	One girl on show, lots of experiments
Dr. Suzuki, Bill Nye		Most shows star men as scientists
General Comments	Documentaries	Main scientist are always guys, experts are guys; but if women on the show then they are super smart and explain more, more confident than men too, successful, seem very interested in it, few experiments and a lot of reading
Big Bang Theory	TV show	Guys are super smart, girl is bimbo, or girl scientists are nerdy and creepy
House, Gray's Anatomy	TV show	Doctors are doing all the tests, surgery etc but in reality doctors don't do everything
CSI	TV show	Women just good looking, not realistic, positive image of women in science, realistic view of what they have to do but not how they look, women equal to men on show
General Comments	TV	Guys are smart, girls are dumb blondes messing up on experiments, dressed up though, guys with lab coats and glasses

Table 31 then summarizes the comments based on women with science careers as portrayed in TV shows versus documentaries.

Table 31

Summary of Descriptors of Female Scientists on TV Shows Versus Documentaries

Female scientists on TV shows are:	Female scientists in documentaries are:
Dumb blondes	Rarely seen
Unable to do experiments	Super smart
Nerdy	Confident
Creepy	Successful
Unrealistic: good looking	Very interested in topic

> [Yvonne]: on TV you always see the guys that are the smart ones...and you see these dumb blondes trying to do science
>
> [Yvonne]: when I think about it if I was to make a movie for myself I would always have the guy with the glasses in the coat pouring the chemical into something and then I'd see a girl try it and explode
>
> [Katie]: on TV there's usually the really hot science girl but then there's the
> [Yvonne]: and then there's the really, one with the mole on her nose or something
>
> [Alicia]: they only have girls on there 'cause they look good
> [Cathy]: yeah, but for the main ones if you watch a documentary or something it's always a guy
> [Alicia]: the ones we watched in class even there is no girls

The more positive descriptors:

> [Cathy]: I have to say more confident than men cause if you watch anything the woman will feel like she knows exactly what she's talking about but a guy will stutter when he's explaining stuff and he'll kinda wander off until he kinda gets to the point. But the women seem to have to know more to be able to explain it
>
> [Cindy]: well, they're attractive, they're successful and smart
>
> [Linda]: it depends, some days I watch Mythbusters and they have to go most of the time to a scientific formula to figure out how to bust the myth and a lot of times yes there is women scientists that are there to help them

Based on survey results as shown in Table 32 and Figure 31, most of the students thought men were predominantly portrayed with science careers in media (Question 9); although Grade 8 students more so than Grade 11 students reported seeing women with science careers in media.

Table 32

Percentage of Students Who Think Men or Women Are Scientists in Media

	Q9: Do you think most of the people with science careers portrayed in media are men or women?				
	Gr. 8 Girls	Gr. 8 Boys	Gr. 11 Girls	Gr. 11 Boys	Total
Men	70.00%	75.00%	82.61%	84.21%	79.41%
Women	25.00%	21.88%	15.22%	10.53%	16.91%
Both	5.00%	3.13%	2.1%	5.26%	3.68%
n	20	32	46	38	136

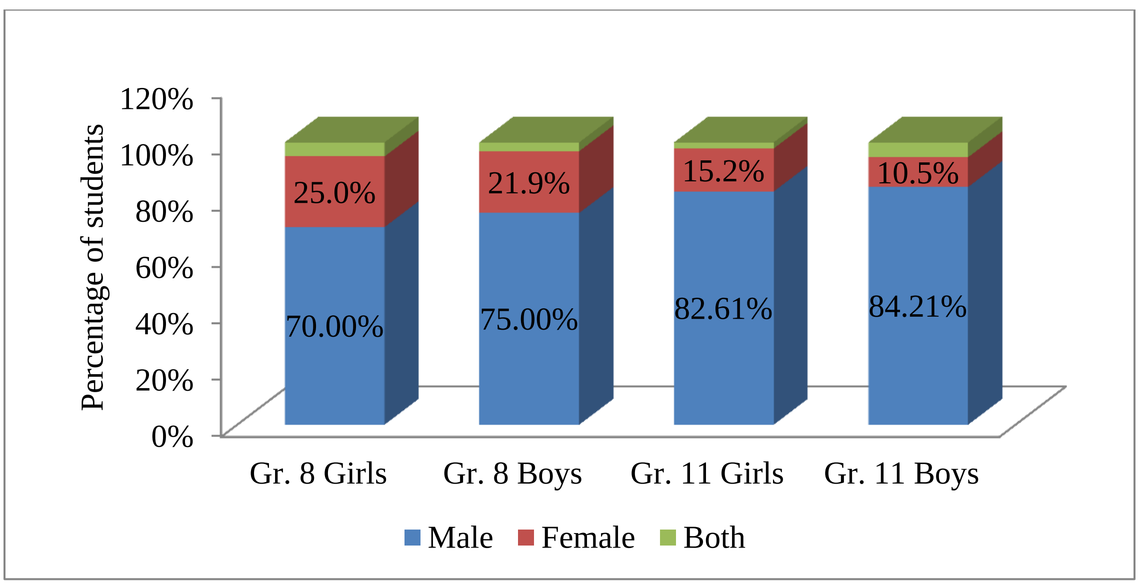

Figure 31. Students’ perception of gender of people with science careers predominantly portrayed in media.

Survey questions 10 and 11 dealt with dichotomous descriptors for men and women with science careers as portrayed in the media. In evaluating Question 10 and 11, not all students seemed to understand the dichotomous descriptors and circled certain descriptor pairs instead of single descriptors; those were excluded from the following data analysis. However note that this does not mean that students who felt both descriptors were fitting were excluded; for that purpose, the dichotomous pairs were coded as 1=negative descriptor, 2=both descriptors selected, 3=positive descriptor. After the effected entries had been removed, 121 survey responses remained for Questions 10 and 11 on which the following analysis in Figure 32 is based. Figure 32 and Table 33 show that overall students felt media portrayed women with science careers more positively than men with the exception of competence where men rated only slightly higher than women. Other studies have also found that women in science are generally considered less competent than men (Brownlow et al., 2000; Fox et al., 2006; Gilbert, 2001).

Table 33

Percentage of Students Who Describe Scientists in Media with Positive or Negative Descriptors

	Female scientists as portrayed in media			Male scientists as portrayed in media		
Descriptors	Positive	Neutral	Negative	Positive	Neutral	Negative
Attractive/Unattractive	82.64	1.65	15.70	38.02	2.48	59.50
Well-groomed/Unkempt	91.74	--	8.26	76.86	0.83	22.31
Intelligent/Nerdy	75.21	0.83	23.97	62.81	2.48	34.71
Competent/Incompetent	81.82	--	18.18	85.95	--	14.05
Respected/Not respected	76.03	0.83	23.14	76.03	--	23.97
Balanced life/Always working	54.55	0.83	44.63	24.79	0.83	74.38
Family & friends/ Lonely	79.34	1.65	19.01	47.93	--	52.07
Interesting individual/ Boring individual	73.55	--	26.45	57.02	--	42.98
Positive role model/ Negative role model	89.26	--	10.74	86.78	0.83	12.40

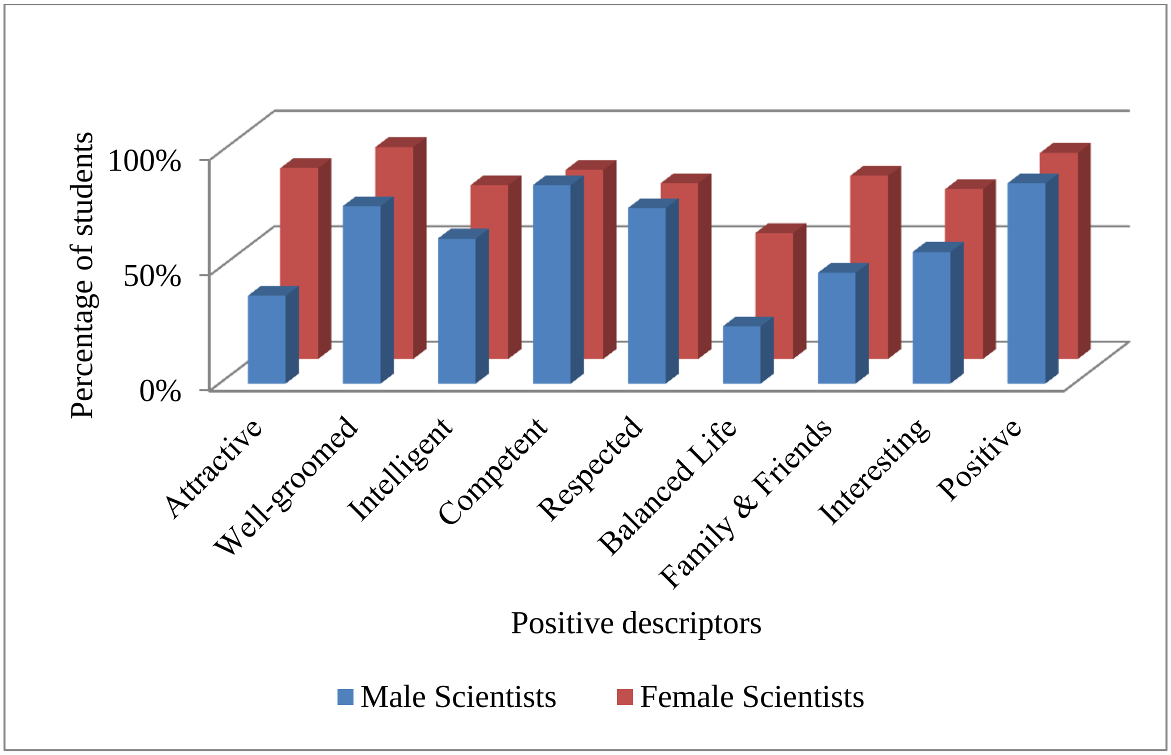

Figure 32. Percentage of students who indicated positive descriptors for men or women with science careers as portrayed in media.

Gives idea of what day to day aspect of job is like. Five of the girls interviewed spoke about not having a very clear idea of what is involved in certain science careers, wanting a better idea, better visualization of what an actual science job is like or media providing a good idea of what the career involves.

> [MH]: Do you think that CSI is a realistic portrayal of what it means to be a woman in a forensic science career?
> [Tanya]: yeah, it's showing what you're going to have to go through like that it's not fake or anything
> [Sara]: I think in that aspect but I don't think everyone working in a lab or anything is gonna be that good looking all the time, I think the looking, what they're doing aspect probably, but what they look like probably not
> [Tanya]: and what they have to investigate it's all realistic and everything but it's not gonna be as easy as they make it look on TV shows, like they find things so fast, but it'll be around that

> [Marie... I think that I would be able to pursue a dream like that if I had more of a understanding of how it's like to be a scientist. I'd think I'd have to know more about how they work, how they think, how they have to
> [Linda]: how they think their brain works
> [Marie]: yeah how do they go through their days knowing some things and then knowing other things and then bringing them together to make something that seems impossible.

Work – family balance. Some girls stated not wanting to have families of their own while other girls for whom family is important stated consciously looking at careers that they know will permit them to accommodate family commitments.

> [Steph]: I don't want fam, I don't want kids at all
> [Yvonne]: yeah that's the same with me, I'm not a big family person I'd way rather have a better career than
> [Katie]: I'm just the opposite, I'd rather have a family than a big career...yeah mine are more stuff from home, stuff that I can do with my kids
>
> [Ruth]: one of the reasons that I wanna do diagnostic medical sonography is there is less on call kind of stuff and night shifts that kind of thing it's more like I choose what I wanted to do because it's not as
>
> [Donna]: 'cause probably usually when you're interested in something your kids look up to you their like k you're my role model I like you you're my mom or dad so they'll probably like the same things that you do they'll do the things you do and they'll want to be you
> [Jenny]: they'll be interested in same as you do and learn about... say you were a vet they'd probably want to tag along on things you do just to see those kind of things

Based on survey average responses to Question 36 (I think that it must be difficult to balance a science career and a family), Grade 11 girls were less likely to think that it is difficult to balance a family and a career. Although from the interviews, girls that were interested in a family were consciously considering careers that would give them the flexibility needed to be with their families. However note that the average of all student responses was "agree" (value of 4) with the statement in Question 36 (Table 34, Figure 33).

Table 34

Descriptive Statistics for Question 36

	Q36: I think that it must be difficult to balance a science career and a family (reversed)				
	Gr. 8 Girls	Gr. 8 Boys	Gr. 11 Girls	Gr. 11 Boys	Total
Mean	4.55	4.44	4.89	4.46	4.61
Median	4.00	4.00	4.50	4.00	4.00
Std. dev	1.10	1.50	1.55	1.33	1.42
n	20	32	46	39	137

Note. Responses to Question 36 are reversed, thus a high number indicates stronger disagreement with the statement.

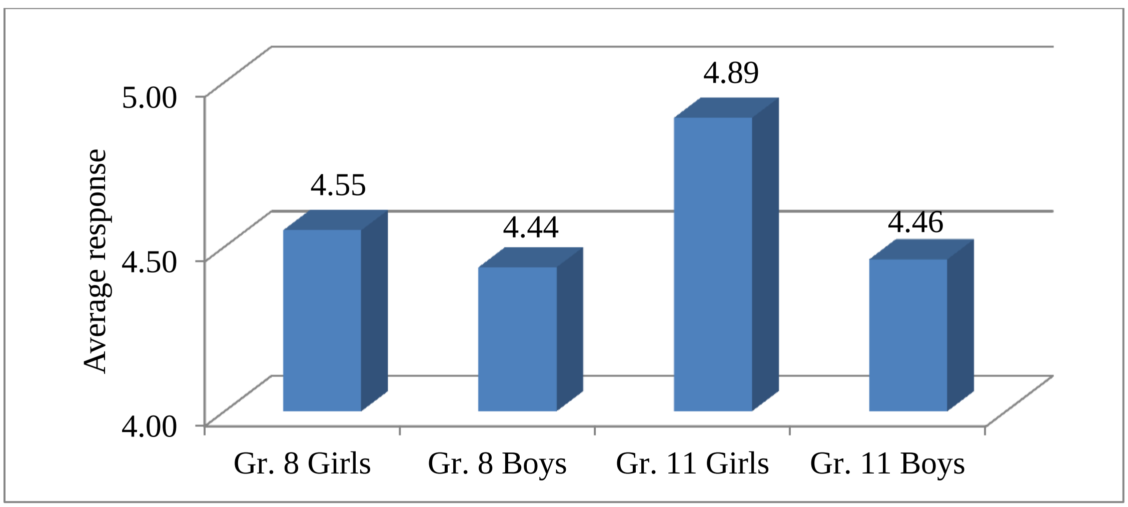

Figure 33. Average responses to Question 36 (reversed): I think that it must be difficult to balance a science career and a family.

Men are experts, women are assistants. Eight girls in the interviews spoke about men being experts, the main person or having authority, while women are mere assistants. This theme was not exclusive to discussions about the portrayal of women with a science career in media and girls commented that it is evident in many areas of society.

> [Cathy]: I always see them as they're kind of not the main person, like the dentist or not the main dentist
> [Alicia]: they're the assistant
> [Cathy]: they're the assistant, and then doctor they're like the nurse they're not the actual doctor, they're never
> [Alicia]: yeah, in a perfect world it would be equal, but when you see it in real life a lot of time they aren't
> [Cathy]: the main like big person I guess
> [Beth]: the head honcho
> [Alicia]: less authority
>
> [Donna]: yeah, or there's doctors that are males like mostly all the doctors here are males, all of them and then the assistants are girls
> [Jenny]: like the nurses
> [Jenny]: yeah like right now so many place in X it's the male is the head main person and then the females are the paperwork or the nurses that kind of thing
> [Donna]: like assistants they're not like I've haven't
> [Jenny]: yeah, they're not the big man out there
> [Donna]: yeah I haven't really seen a real doctor that's a girl

As previously noted in Figure 28, students overall feel media portrays women in science as more positive. Note that when broken down by student grade level and gender, Grade 8 girls think women in media are portrayed as less competent, an idea that emerged in the interviews as well (Table 35, Figure 34). In contrast Grade 8 girls did not feel that male scientists were portrayed as incompetent as the women (Figure 35).

Table 35

Perception of Scientists in Media Differentiated by Student Grade Level and Gender

Scientists			Attractive	Well-groomed	Intelligent	Competent	Respected	Balanced Life	Family & Friends	Interesting	Positive Role Model
Gr 8 Girls	Female	Mean	2.65	2.88	2.53	2.29	2.53	2.41	2.65	2.65	2.76
		Median	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
		Std. dev	0.79	0.49	0.87	0.99	0.87	0.94	0.79	0.79	0.66
		n	17								
	Male	Mean	2.06	2.65	2.53	2.65	2.76	1.71	2.29	2.41	2.76
		Median	3.00	3.00	3.00	3.00	3.00	1.00	3.00	3.00	3.00
		Std. dev	1.03	0.79	0.87	0.79	0.66	0.99	0.99	0.94	0.66
		n	17								
Gr 8 Boys	Female	Mean	2.69	2.69	2.54	2.54	2.69	2.23	2.69	2.62	2.77
		Median	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
		Std. dev	0.74	0.74	0.86	0.86	0.74	0.99	0.74	0.80	0.65
		n	26								
	Male	Mean	1.31	2.46	2.42	2.46	2.23	1.85	1.92	2.08	2.69
		Median	1.00	3.00	3.00	3.00	3.00	1.00	1.00	3.00	3.00
		Std. dev	0.74	0.90	0.90	0.90	0.99	1.01	1.02	1.02	0.74
		n	26								
Gr 11 Girls	Female	Mean	2.80	2.95	2.44	2.80	2.41	1.90	2.51	2.46	2.85
		Median	3.00	3.00	3.00	3.00	3.00	1.00	3.00	3.00	3.00
		Std. dev	0.60	0.31	0.90	0.60	0.92	1.00	0.87	0.90	0.53
		n	41								
	Male	Mean	1.93	2.56	2.24	2.95	2.66	1.24	1.83	2.12	2.90
		Median	1.00	3.00	3.00	3.00	3.00	1.00	1.00	3.00	3.00
		Std. dev	1.01	0.84	0.97	0.31	0.76	0.66	1.00	1.00	0.44
		n	41								
Gr 11 Boys	Female	Mean	2.51	2.78	2.57	2.68	2.54	2.08	2.62	2.30	2.73
		Median	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
		Std. dev	0.84	0.63	0.83	0.75	0.84	1.01	0.76	0.97	0.69
		n	37								
	Male	Mean	1.84	2.54	2.11	2.68	2.46	1.46	1.97	2.08	2.59
		Median	1.00	3.00	3.00	3.00	3.00	1.00	1.00	3.00	3.00
		Std. dev	0.96	0.84	0.99	0.75	0.90	0.84	1.01	1.01	0.80
		n	37								

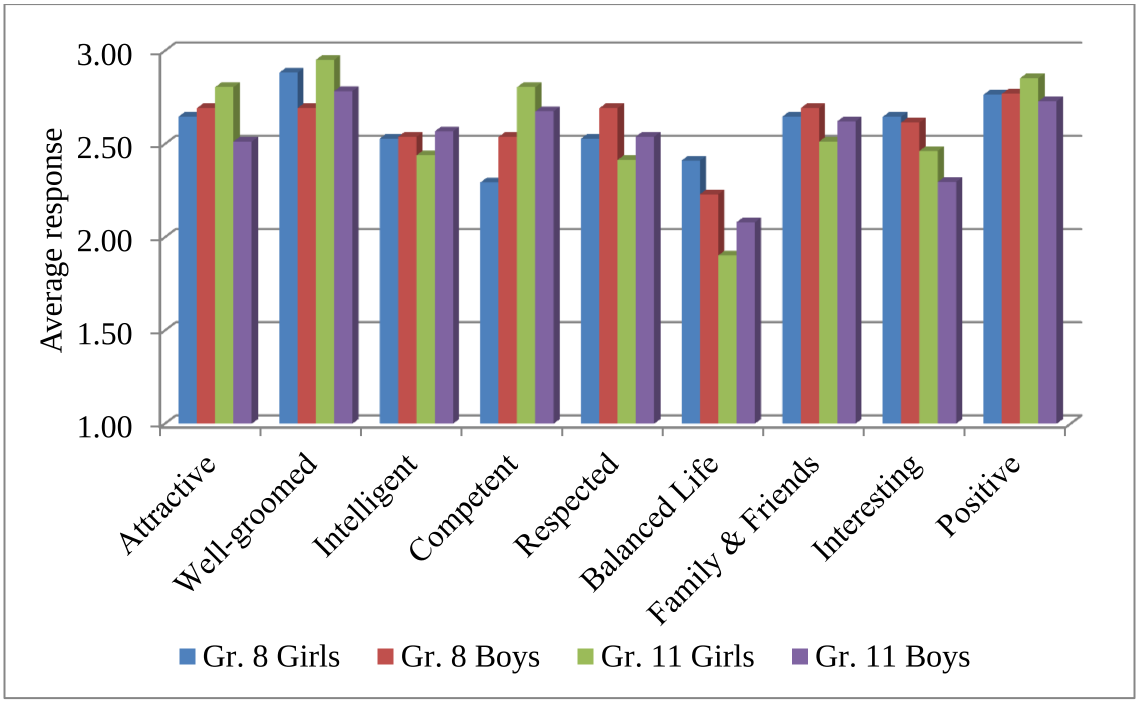

Figure 34. Students' average responses to how media portrays women with science careers.

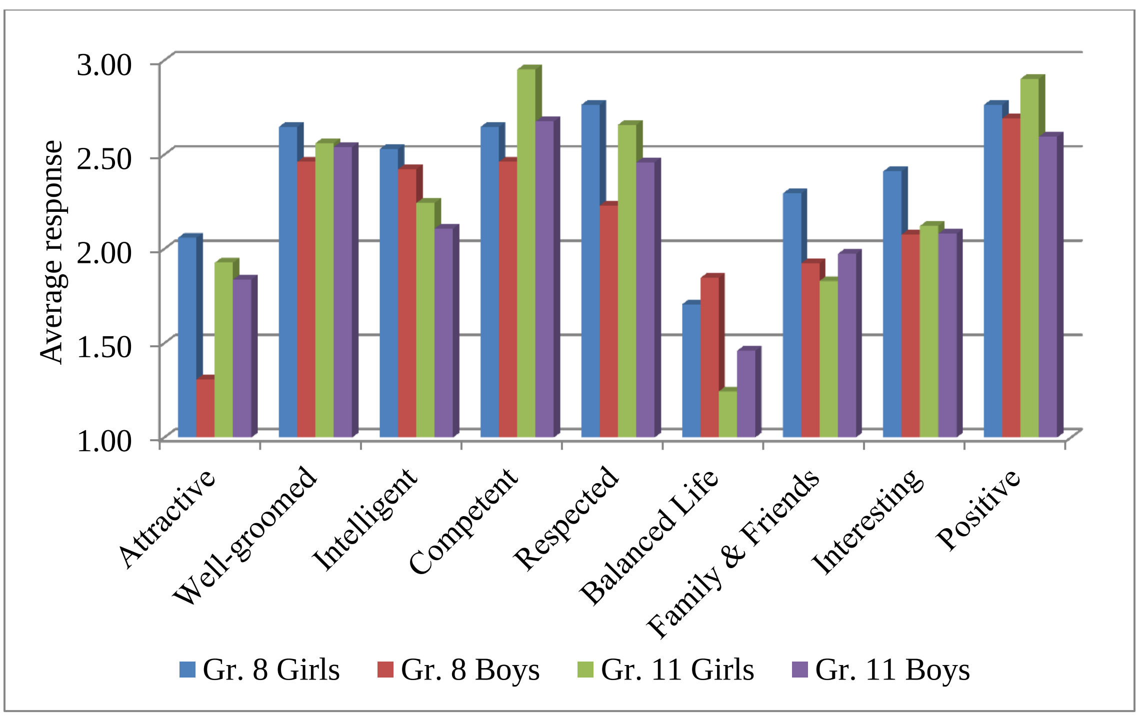

Figure 35. Students' average responses to how media portrays men with science careers.

Lack of women with science careers. Seven girls spoke about the few numbers of women with science careers represented in media and also classroom discussions.

> [Alicia]: ...it's like one woman for every 5 or 10 men that does
>
> [Beth]: have you noticed in the media most of them are guys
> [Alicia]: yeah, that's what I was getting at, Dr. Suzuki, Bill Nye
>
> [Cathy]: for the main ones if you watch a documentary or something it's always a guy
> [Alicia]: the ones we watched in class even there is no girls
>
> [Cathy]: we knew all the guys most of them because of textbooks and there's never ever any women in them

Three of the girls initiated conversations about the list of scientists names on the survey and noted that they knew very few of the female scientists names. The list of names on the survey that students referred to in the interviews consisted of ten female scientists' names and ten male scientists names. Scientists' names were chosen to include as many well-known scientists as possible, current and past, Canadian and international, as well as covering various science disciplines. Table 36 and Figure 36 show what percentage of students recognized certain number of scientists' names. Note that almost 70% of students did not recognize any female scientists' names, while only 14% of students did not recognize any male scientists' names. In fact over 50% of students knew at least four male scientists from the list, while barely 7% of students recognized four or more female scientists' names.

Table 36

Percentage of Students Who Recognized Female and Male Scientists' Names

	Gr 8 girls		Gr 8 boys		Gr 11 girls		Gr 11 boys		Total	
Scientists Names	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male
Zero names known	70.00	25.00	76.47	17.65	58.70	4.35	71.79	15.38	68.35	13.67
1-3 known	20.00	40.00	5.88	32.35	41.30	13.04	25.64	2.56	25.18	18.71
4-5 known	10.00	30.00	8.82	35.29	0.00	32.61	2.56	17.95	4.32	28.78
6-8 known	0.00	5.00	0.00	11.76	0.00	50.00	0.00	58.97	0.00	36.69
9-10 known	0.00	0.00	8.82	2.94	0.00	0.00	0.00	5.13	2.16	2.16

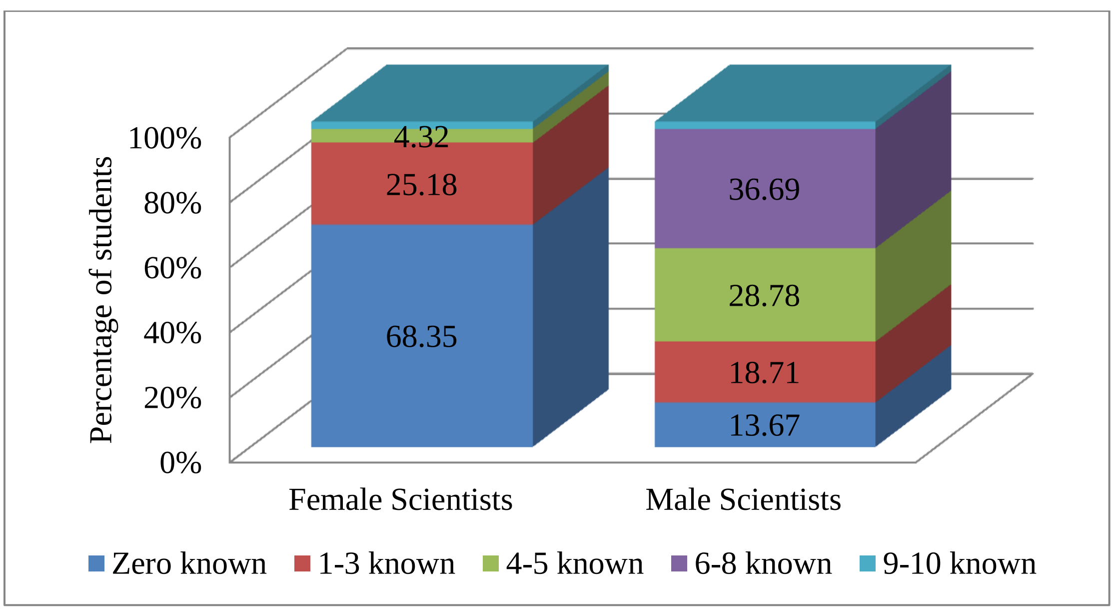

Figure 36. Percentage of students who recognized scientists from list of twenty names.

Breaking the recognition of scientists' names down by student grade level and gender, Figure 37 shows that Grade 11 students recognized more scientists than Grade 8 students which can be expected with more science education. Interestingly Grade 11 girls recognized three or fewer female scientists' names, while at least some Grade 8 girls stated recognizing four or five female scientists' names.

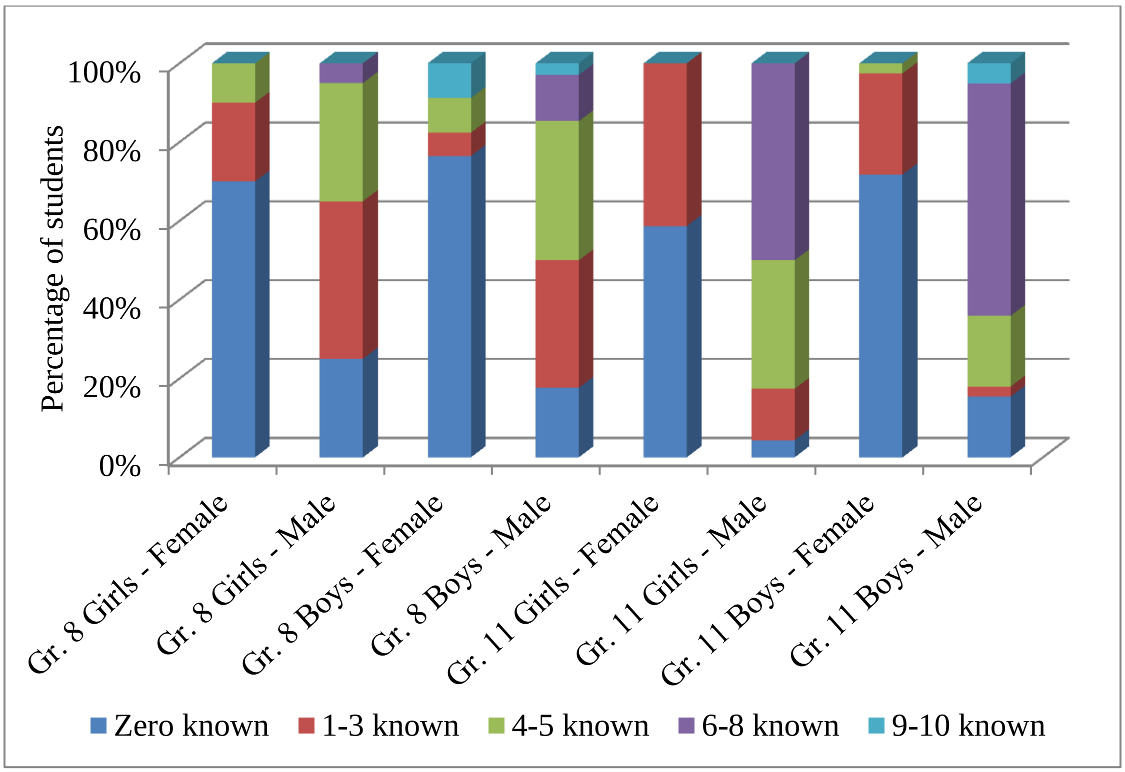

Figure 37. Percentage of students who recognized scientists names from list differentiated by student grade level and gender.

Table 37 shows which scientists' names the girls in the interviews recognized and how many girls recognized the name along with any additional information the girls were able to provide about the scientists.

Table 37

Scientists' Names Identified by Girls in Interviews

Scientist	Grade 8	Grade 11	Why?
Marie Curie	2	6	Discovered Uranium or Radium
Jane Goodall	2	6	chimps
Roberta Bondar		1	
Barbara McClintock		2	
Stephen Hawking	6	9	Guy in the wheelchair, make fun of him on Simpsons, scientist
Benjamin Franklin	9	10	electricity
Louis Pasteur		3	pasteurization
Isaac Newton	6	10	Newtons unit
Charles Darwin	3	10	
Albert Einstein	9	10	
Jacques Cousteau	4	6	Scuba diving
David Suzuki	8	7	Environmentalist
James Watson	5	7	DNA double helix
		Tally	
Female Scientists	4	13	
Male Scientists	50	72	

However one Grade 8 group of girls spoke about Gail Michener, a female scientist they had recently learned about in class; these girls were excited in talking about her research. Another Grade 8 group spoke about Amelia Earhart as being a female scientist; they believed that she had invented the airplane.

Chapter 5: Discussion

As previously stated, while boys' survey results were included in the results for comparison, the focus of this study is girls' perceptions. Based on observations such as their desire to help people, enjoying the hands-on aspects of science, and wanting to be able to relate their science education to life, the girls who participated in this study seem to fit with the majority of students that have participated in the research discussed in relatively recent literature. It is possible that themes emerging from this study such as the desire to incorporate creativity with science or the view that women explain more while men just do the experiments, may also be found in other populations. More research to confirm this and the effect of being able to visualize a future in science as a woman should be conducted.

In order to summarize the results, the discussion below is focused around four categories based on interest in science: 1. Girls that are interested in traditional female science careers, 2. Girls that are interested in non-traditional science careers, 3. Girls who lost their interest in science, 4. Girls who do not see their interest as fitting in with science. These four categories illuminate the range of girls' interest in science. In the following discussion one or two girls' narratives as presented through the interviews are used to exemplify each category; how role models did or could affect their interest in science is discussed for each girl. The term traditional science career is used in the sense that the girls spoke about it in the interviews; for example, nursing and veterinarian related careers but not doctor or scientist. Each girl's story is focused through the interview themes highlighted in Chapter 4: Results.

Girls That Are Interested in Traditional Female Science Careers

According to this group of girls, science careers for women are generally careers such as nursing or vet school. Lack of women in other science careers such as engineering has been well documented (McKenzie, 2007; Predoi-Cross, 2008/2009; Statistics Canada, 2007) and even the girls in this study noted that they know little about and see few women with these type of science careers. This lack of visible women in non-traditional science careers prevents girls from potentially identifying them as role models. However women in traditional science careers can be effective role models for girls like Alicia interested in pursuing a science career.

The influence of role models: Alicia. Alicia would like to become a nurse. Her Grade 5/6 teacher sparked her interest in science but a friend of hers is a nurse and like her, Alicia wants to help others through her career. Several studies have documented that a desire to help others, animals or the planet is important to girls in choosing their careers (Ceci & Williams, 2007; Kniveton, 2004; Li, 2008; Lupart et al., 2004; Tan & Barton, 2008; Weinburgh, 2000; Whelan, 2001). When asked though why she prefers a more traditional female science career like nursing to, in this group's opinion a less traditional career like doctor through which she would also be able to help others, Alicia responds:

> [Alicia]: first it's a lot more schooling, a lot more expensive. That's mostly what's holding me back from doing that.

However, Alicia identifies the nurse as her role model and talks about her on three different occasions throughout the interview. As a close personal friend Alicia is able to identify with her role model which other studies suggest is important for girls in choosing role models (Britner & Pajares, 2006; Buck et al., 2008; Gilmartin et al., 2007; Karunanayake & Nauta, 2004; Zirkel, 2002). Lockwood (2006) stated that student specifically chose role models because the role models had overcome barriers and still reached their goals; likewise Alicia's role model also had to overcome significant difficulties but still succeed in her career which can be noted from how Alicia describes this nurse's knowledge of her craft:

> [Alicia]: ...she knows a lot about Physics or whatever would be involved with that. She's talked to me about it because I did a project on it last year and I got some information from her. But she was pretty helpful though she knew way more about it than any of the websites. She could explain it way better because she used it every day.

Studies, such as Li's (2008), have shown that role models can increase girls' interest in science and self-efficacy; or even help in forming their identity (Kitts, 2009). The presence of women in traditional female science careers allows them to be role models for girls like Alicia. The question remains if Alicia would have considered a career as a doctor, not viewing the commitment to schooling required for such a career as an obstacle that would deter her but rather to be overcome, if she had a female doctor as a role model. But as the girls in this study stated, they did not know of any female doctors personally.

Girls That Are Interested in Non-traditional Science Careers

Participation in science outside of the classroom: Cathy. In contrast to Alicia, Cathy wants to become a doctor. According to Cathy and her peers, very few women are doctors and Cathy wants to set an example. Although Cathy and Alicia have similar backgrounds in regard to their science education, Cathy is driven to be a doctor in part because she does not want to act as the assistant (nurse):

> [Cathy]: if you think of a doctor you don't really think of it as being a girl so it'd be kind of a different thing and I'd be able to say I'm a doctor and I'm a girl. But if you say nurse then

> everyone's like oh well there's so many that are already girls so it must not be that hard to do. Kinda like that. And if you're a doctor than more people will be interested into what you're doing and they'll ask more questions but if it's a nurse it'll just be like how was your day, what did you do. But if it's a doctor they'll want to know more I guess.

Cathy enjoys biology and works hard at physics. Her interest in science was sparked by her Grade 5/6 science teacher whose enthusiasm for science was infectious. Fun experiments and great stories made Cathy, and some of her classmates, find science interesting. Cathy's positive experience with school science was followed by participation in a science camp at a nearby university where she experienced science hands-on by investigating, for example, DNA. Even two years later she and her friend excitedly and in detail recall the experience.

> [Cathy]: you got to play with DNA and you got to
> [Alicia]: watch it unravel
> [Cathy]: and you got to see your spit and stuff, it was pretty cool
> [Alicia]: you got to wear the big white suit things for when we did the sheep's blood and the gel stuff
> [Cathy]: it was pretty cool, you got to experience something different that you wouldn't be able to in the classroom

Like Alicia, Cathy knows women that are nurses but herself wants to be the "main person", not an assistant like so many women in science careers seem to be. Cathy is excited about her subject and finds ways to engage with it out of class. Speaking about Watson and Crick, Cathy states:

> [Cathy]: I did a whole worksheet on that 'cause A brought it on the bus and then I just took it from him and did it

Influence of media: Tanya. Like Cathy, Tanya too finds ways to keep her interests and passion for forensic science alive apart from the science classroom. Tanya has not had very many positive experiences with science in the classroom but is still driven to pursue a forensic science career.

> [Tanya]: which is frustrating ‘cause I had a bad science teacher last year. I didn’t go to school here for science last year and my Grade 10 science teacher was bad too

She first became interested in forensic science when a family friend talked about it. Although this friend sparked her interest in the subject, she was not able to deal with the realities of the career and as a result Tanya does not consider her to be a role model.

> [Tanya]: one of my mom’s friends in university she took classes in it and she said it was really interesting but once it got to the real thing it was a little like I don’t know if I want to do this but I seem really interested in it so

But Tanya receives a lot of support from her father to pursue a forensic science career. Tanya also states that TV shows, like CSI, are influential for her and keep her interested in forensic science. While she may not consider the looks of the women in CSI shows as realistic, or the time frame in which they solve crimes, she does believe that the show is a good reflection of the job and tasks forensic scientists have to complete.

> [Tanya]: yeah, it’s showing what you’re going to have to go through like that it’s not fake or anything

> [Tanya]: and what they have to investigate it’s all realistic and everything but it’s not gonna be as easy as they make it look on TV shows, like they find things so fast, but it’ll be around that

She also acknowledges that women in CSI shows are equal to their male counterparts, something not necessarily true for other science careers portrayed in media.

> [Tanya]: they’re just as good, they do the same jobs and some of them have specific things that they’re really good at and other people work like, they’re all kind of separated and then there’s some guys and girls that do the same jobs and they’re equal at it, not one is better than the other

Several studies have documented that girls do not have a clear idea of what is involved in a science career and therefore cannot see themselves doing science (Baker & Leary, 2003; Brickhouse, 2001; Buck et al., 2008; Carlone, 2003; Ginorio et al., 2002; Li, 2008; Ullman, 2010). For Tanya, shows like CSI give her an idea of what the job is like and allow her to visualize herself using science.

For girls interested in science careers that do not have popular TV shows associated with them, women in media might not encourage them to pursue their interests in science. Studies have found that generally women in science careers are portrayed as less competent by the media (Brownlow et al., 2000; Fox et al., 2006; Gilbert, 2001). As Tanya stated above, this is not true for the shows she watches but other girls in this study agreed that in general women are considered less competent. Also, unlike Tanya's situation again, generally few women in science are represented in media or even textbooks and class discussions (Barnett & Rivers, 2004; Belkin, 2008; Fried & MacCleave, 2009; Halpern, Aronson et al., 2007; Taylor et al., 2001; Ullman, 2010; Wood, 2000). Again most of the girls in this study agreed with these studies that they learn little about women in science or see few women with science careers.

Questions remain: Will Cathy and Tanya persevere and someday become a doctor and a forensic scientist? If they had female role models in non-traditional science careers could it help them navigate the path to attaining their goals more successfully? However, what Cathy and Tanya do show is that positive experiences with science outside of the classroom, and maybe even despite negative science classroom experiences, can potentially reinforce and perhaps even sustain their interest in science.

Girls Who Lost Their Interest in Science

The need for support: Yvonne. Parental support when choosing a career is important to girls (Bystydzienski, 2009; Farmer, 2009; Kniveton, 2004; Rosser, 2004) and while most parents seem to be supportive of girls entering a science career (Kitts, 2009), there are still stories like Yvonne's. Yvonne is good at math and enjoys physics. At one point she wanted to become an engineer and approached her parents with the idea who promptly dissuaded her from pursuing an engineering career. When asked if her parents would support her choice to pursue a science career, Yvonne responded:

> [Yvonne]: I don't know if my dad would for me, one time when I was talking to him about schooling and what I want to do, he tells me there's too many engineers so I shouldn't be one, like fine, but I guess it could go back to how a guy can be more successful in something like that than a woman

Several studies have documented the influence of fathers especially on their daughter's career choices, self-efficacy, and interest in science (Gates, 2002; Scott & Mallinckrodt, 2005; Tenenbaum, 2009; Tenenbaum & Leaper, 2003). Yvonne feels too that her friends would make fun of her and call her names like nerd if she chose to pursue a science career. More than any other girl interviewed she felt men were more likely to be successful in non-traditional female science careers such as engineering. This feeling that men are more likely to be hired or will be more successful in a science career has been found in other studies as well (Adams, 2008; Halpern et al., 2007/2008; Kniveton, 2004; University of Alberta, 2000). When pressed for an answer why she felt this way, Yvonne responded:

> [Yvonne]: I don't really know much about engineering but when I think of it I think that guys can get further in it, like become more successful doing it than women can

> [Yvonne]: I think people trust guys over girls ... looking from a science angle
> [Yvonne]: I think that they feel that guys have more dominance, like they have a better say, they have more power overall

This idea that boys are smarter, better, a “macho motto” as one of the other girls in the interviews called it, has also been noted in other studies (Belkin, 2008; Rosser, 2004; Whelan, 2001). Perhaps the lack of recognition women in science receive (Fox, 2001; Rosser, 2004; Whelan, 2001) contributes to this mentality for these girls.

In the face of these negative beliefs and stereotypes, it is difficult to persevere and therefore not surprising that a traditional career choice is more appealing (Barnett & Rivers, 2004; Bystydzienski, 2009; Hyde, 2005; Lupart et al., 2004; Warrington & Younger, 2000). For Yvonne it means that she is opting for a more traditional career such as accounting which still allows her to use her math skills but not her interest in physics.

Poor science classroom experiences: Karla. Karla has liked science since early on in elementary school. She always talked about wanting to be a scientist, did experiments outside of school, and felt supported and encouraged by her parents and friends.

> [Karla]: when I was younger I always told them I was gonna be a scientist, I don’t know why, I just really liked science when I was younger and so they were kinda of proud of me and everything and they were encouraging me to get my grades up and they were proud of me

Unfortunately, as Brickhouse et al. (2000) note, even girls with a genuine interest in science can quickly lose interest with poor instruction and difficult teacher interactions. As one such example, Karla in this study had a very negative experience with a science teacher and is now no longer interested in a science career.

> [Karla]: science for sure, ever since A (last year), my favourite subject was science all the way from Grade 2 to Grade 7 and then last year it just kinda changed ‘cause of that teacher
>
> [Karla]: she would get mad at me and then on my vocab when we had to define words, I would go up and ask her a question and she’d say just figure it out yourself so it’d take me a while to do that

Several studies have documented that a positive experience with science education can be very influential on girls (Baker & Leary, 2003; Blickenstaff, 2005; Brickhouse et al., 2000; Jacobs et al., 1998; Warrington & Younger, 2000). Not only did Karla feel she could not approach her teacher for help, she no longer found science class fun. For her, as for girls in other studies, experiments make science class fun (Baker & Leary, 2003; Brickhouse et al., 2000; Ginorio et al., 2004; Lupart et al., 2004; Phillips et al., 2002; Tan & Barton, 2008; Warrington & Younger, 2000; Wood, 2000).

> [Karla]: I’m good with the experiments I just don’t like just having to sit there reading out of the textbook. I learn better if I actually do it

Science education has not improved for Karla and she felt that her current teacher did not have a good grasp of the subject. As Baker and Leary (2003) found in their study, these negative experiences decrease students’ positive attitudes towards science. Unfortunately with the poor science instruction Karla has been experiencing she has lost her interest in science. Neither Karla nor Yvonne have role models that could have potentially assisted them in sustaining their interest in science and non-traditional science careers in the face of these obstacles.

Girls Who Do Not See Their Interest Fitting With a Science Career

Making a connection: Linda. Linda wants to be a dancer or maybe a dance teacher. One of the most important criteria to her in choosing a career is her ability to express herself creatively and have fun in her job. Carlone (2003) notes that our current methods of science instruction rarely allow students to think creatively and explore. Yet using her creativity is exactly what Linda wants to do:

> [Linda]: ...I don't think that'd ever come across my mind is taking up a career in science because I like to be creative so unless science became more creative and became more fun and easy for me to do creatively then I don't think I could take it because I like to express myself with a fun job and that's what I think of my future is having a fun job and having it to be creative and expecting what and just being able to share my opinion and express myself

Creativity is important in science (Barrow, 2010; McCormack, 2010; Nersessian, 1992, 2008) and Linda recognizes that there are occasions where she could be creative in science but she feels that she has not been given those opportunities yet. In speaking about science fairs, Linda states:

> [Linda]: it'd just be cool 'cause that's exactly what I've been talking about like the creativity you get to build something that's scientific and you get the opportunity to make it hands on you get to just ex-, and it's your chance to be creative and show how your scientific part of your brain works

Linda occasionally participates in science activities outside of school by watching documentaries about marine biology. She states always having loved learning about fish and the underwater world but cannot see a use for it.

> [Linda]: if my dad is watching TV sometimes he'll be watching Discovery Channel and there'll be things like Whale Wars and then there'll be this documentary about fish in the ocean and stuff. I love to learn about the ocean 'cause I'm very, very, very interested, I always have been since I was little in the ocean, underwater life 'cause I just think it's amazing but would I say that I get a whole bunch out of it besides knowing hey I know what that fish is and I know what that fish is, then I wouldn't say I get much out of it.

Unfortunately Linda finds science class frustrating because poor teaching prevents her from learning as much as she would like. In the interviews Linda repeatedly talks about good science experiences in the past where her teacher connected the science lessons to life outside of school and lamented the lack of connections made in negative science class experiences.

> [Linda]: it was so cool ‘cause right at that time we were learning how to measure the earthquakes and hectares and if it was an eight how destructive it was but it was a one then it was, it’s just enough for the most sensitive of an animal to hear. We just thought that was so interesting and then we got really into the Haiti thing and it was just cool to go home and see on TV and be like, look at that, it’s like: what we’re learning right now is what’s going on out there. And it’s more fun to learn about when there’s stuff going on around the world, it would have been so cool if we could have incorporated the Chile miners into our studies because I think those things are really cool to learn about, when you’re sitting there learning about buoyancy and density and how things float, it’s like: well all I’m gonna need to know that for is boats but we learned about structures last year and how things float. Like the Titanic we learned about and I thought that was a lot of fun to learn about too ‘cause it’s outside world but when we’re just sitting there, he’s just telling us all this, why don’t you incorporate some big disaster that’s happened in the past or something into it just to make it more interesting and wanna get us to know about it.

Several studies have shown that it is very important for girls to be able to connect what they learn in science class to their life or life outside of school (Baker & Leary, 2003; Bloor et al., 2007; Buck, 2002; Heilbronner, 2008; Murphy & Whitelegg, 2006). Based on the girls in this study, unfortunately few connections seem to be made in science classes to real life. So students like Linda who are interested in aspects of science and are good at science cannot see themselves pursuing a science career because it is too analytical and not creative enough.

Conclusion

This study did present some interesting ideas not widely discussed in other literature on girls' interest in science, such as the desire to incorporate creativity into science education and women in science explain more than men. Otherwise girls in this study fit in with girls studied by other researchers on this topic with a few exceptions; girls in this study did not believe that boys have a better attitude toward science which contradicts several studies (Britner & Pajares, 2006; Heilbronner, 2008; Lupart et al., 2004; Weinburgh, 2000). The girls in this study, whether interested in pursuing a science career or not, still used words such as lab coat to describe men and women with science careers which is contrary to what Kitts (2009) found. Other studies too note that students do not think of their science teacher as someone who does "real" science studies (Baker & Leary, 2003; Gilmartin et al., 2007; Kitts, 2009), but several of the girls in this study did consider their female science teacher as doing "real" science. Britner and Pajares (2001, 2006) stated that girls' are more interested in science in elementary school because it is more textbook based and involves reading, but girls in this study specifically stated multiple times that they did not enjoy reading in science and preferred hands-on learning instead.

From the survey data it is interesting to note that Grade 11 students overall responded with more stereotypical answers than Grade 8 students. Grade 11 students reported that their male teachers do real science and incorporated more science outside of the classroom while Grade 8 students felt that way about their female teachers. As previously noted, due to the small sample size and few teachers discussed in this study, this observation may be due more to teaching ability than gender but it does provoke curiosity. Especially since Grade 11 students agreed more with statements such as: Boys are better at science, boys have a better attitude toward science, men are more likely to be hired for science careers, or women receive less recognition than men. It almost appears as if Grade 8 students have a more egalitarian view of science and do not question their ability as girls or later as women to succeed in science; Grade 11 girls on the other hand appeared much more sceptical of women being equal members in the science arena. What happens between Grade 8 and Grade 11 that causes girls to create more gender distinctions in science and question their opportunities and abilities as women to engage in a science career?

There are many factors that influence girls' interest and desire to pursue a science career. This study set out to determine the effect role models have on student interest, specifically if female role models could encourage more rural girls to enter science careers. Unfortunately most of the girls in this study did not have female science role models or even knew of very few female scientists. This study's first question was: Does the gender of the teachers affect girls' interest in science? While teachers were reported as being influential on girls' career choices in this study, only nine participants indicated that their teacher is their role model. This study found that female teachers appeared to be more influential on girls than male teachers but due to the small sample size this is not conclusive. It does however align with studies that have found female teachers to be considered more approachable by students (Carrington et al., 2008; Gilmartin et al., 2007; Le Mare & Sohbat, 2002). On the other hand it could be that the female teachers in this particular study were very good teachers while the majority of male teachers in this study were not so good and thus the influence of the female teacher is more due to teaching ability than gender (Carrington et al., 2005; Martin & Marsh, 2005). It would appear then that quality science instruction is crucial to girls' interest in science; the teacher being female may help but is of no use if her science knowledge is lacking and quality of instruction is poor.

The second question – does the lack of positive visible female role models in science discourage girls from pursuing science careers – appears to have some merit. Girls in this study all commented on how little they know about women in science and most of them expressed a desire to know more about them. In the case of Yvonne knowing of successful women in engineering could have helped sustain her interest and overcome other barriers such as the lack of parental support to pursue her desire to be an engineer; but as she lacks the knowledge of other women engineers she feels that it is not a career in which women can be successful. In contrast Tanya sees women in media as successful forensic scientists and despite poor quality science education, even being able to visualize and know that women can be successful in this career has motivated her to continue gaining knowledge about it outside of school. A few of the girls in this study, as found in other studies as well, stated that they wanted female role models in science careers who could show them how to reach their goals, guide and encourage them (Fox et al., 2006; Gilmartin et al., 2007; Huguet & Regner, 2007; Lockwood, 2006). Especially because girls seek to identify with their role model it is beneficial to have female role models in non-traditional careers.

Besides the lack of role models for girls in this study, there were other limitations to this study. Predominantly only girls that were interested in science volunteered to be interviewed and so there are only a few girls who were not interested in science that participated in the interview discussions. The group interviews, although they went well, posed some potential problems not previously considered. The groups were formed solely on the basis of students' responses to survey Question 41: Science is interesting. Since I had no personal knowledge of the students this meant that potentially girls that did not get along ended up in the same groups. In some of the interviews the body language of certain girls and looks exchanged gave me the impression that there were tensions between some of the girls; this may have limited the responses girls were willing to divulge in the interviews. Girls were especially hesitant to talk about role models; girls that on the surveys had stated having role models refused to talk about them in the group settings. Another drawback was that in some interviews one or two girls dominated the conversation, in some cases interrupting others and finishing their sentences. Despite my efforts to go back to the girls that were interrupted, it was somewhat frustrating and I wanted to minimize disruptions to the flow of the conversations between the girls. A few girls too were hesitant to share any information and thoughts; it was difficult to get them to participate deeper and elaborate on some very surface level responses they gave.

Other factors such as cultural background, religion, socio-economic status (Baker & Leary, 2003) were not addressed in this research because the only factor under study was the potential effect of role models on girls' science interest. These findings can provide the basis for further study as far as influencing factors are concerned or expanding the study to a larger sample of girls rather than this specific population. It may also be beneficial to study how girls' perceptions change when they are exposed to positive role models of female scientists in media; to determine if, as a result, girls' are better able to make a connection between science taught in the classroom to real life; if girls' have a clearer understanding of what scientists do and who they are; and if, as a result, girls' are able to see ways in which, for example, physical science related careers can be used to help others, such as society or the planet. Can role models show girls that science is not solely a man's world? Can role models help students sustain their interest in science in the face of difficulties? Apart from a quasi-experimental study with role models it may also be beneficial to conduct individual interviews with girls to reduce the limitations found in this study through the group interviews. As previously noted, the issue is complex and good quality education and female role models are not the only aspects influencing girls' career choices. However for those girls that do show an interest in science and enjoy it, role models may just make a difference.

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Appendix A: Student Interest in Science - Survey

Please check the box that best matches your response to the following statements:

1. I would like to pursue a career in which I use science on a daily basis.

Strongly Disagree	Disagree	Agree	Strongly Agree

2. List your top three careers that you may consider doing:

____

____

____

3. What words would you use to describe a person who uses science in their job or a scientist? (e.g., cool, nerd, fun, repetitive, smart, weird, respected, loner, etc.)

4. I personally know several people who use science in their career.

Strongly Disagree	Disagree	Agree	Strongly Agree

Are the people you know mostly men or women? M F
(if both please circle the gender of the person you know better)

5. How important is each of the following to you in choosing a career:

a. Fame

Not at all important	Not very important	Important	Very important

b. Working with a team

Not at all important	Not very important	Important	Very important

c. Earning a good salary

Not at all important	Not very important	Important	Very important

d. Enjoying your work

Not at all important	Not very important	Important	Very important

e. Helping others

Not at all important	Not very important	Important	Very important

f. A safe work environment

Not at all important	Not very important	Important	Very important

g. Other: (please specify) ____

Not at all important	Not very important	Important	Very important

6. How much do each of the following influence your career choices:

a. Parents

Not at all	Very little	Somewhat	Significantly

b. Peers

Not at all	Very little	Somewhat	Significantly

c. Teachers

Not at all	Very little	Somewhat	Significantly

d. Siblings

Not at all	Very little	Somewhat	Significantly

e. Coaches

Not at all	Very little	Somewhat	Significantly

f. Club Leaders

Not at all	Very little	Somewhat	Significantly

g. Other: (please specify) ____

Not at all	Very little	Somewhat	Significantly

7. Do you have one or more individuals as a role model? Y N

If yes, who is your role model: ____
What gender is your role model? M F

8. My role model has a strong influence on my career choice.

Strongly Disagree	Disagree	Agree	Strongly Agree

9. Do you think most of the people with science careers portrayed **in the media** (TV, movies, magazines) are men or women? M F

10. How do you think **men with science careers** are generally portrayed **in the media** (TV, movies, magazines)? Circle the word in each row that you think is most applicable:

Unattractive / Attractive
Well-groomed / Unkempt
Nerdy / Intelligent
Incompetent / Competent
Respected / Not respected
Balanced life / Always working
Lonely / Family & friends
Interesting individual / Boring individual
Positive role model / Negative role model

Any other descriptors that you can think of: ____________________________________

11. How do you think **women with science careers** are generally portrayed **in the media** (TV, movies, magazines)? Circle the word in each row that you think is most applicable:

Unattractive / Attractive
Well-groomed / Unkempt
Nerdy / Intelligent
Incompetent / Competent
Respected / Not respected
Balanced life / Always working
Lonely / Family & friends
Interesting individual / Boring individual
Positive role model / Negative role model

Any other descriptors that you can think of: ______________________________________

____

If you **currently** have more than one science teacher, please answer the following statements based on the science teacher that influences you the most at this time.

12. What gender is your most recent science teacher? M F

13. My most recent science teacher has a strong **positive** influence on me.

Strongly Disagree	Disagree	Agree	Strongly Agree

14. My most recent science teacher has a strong **negative** influence on me.

Strongly Disagree	Disagree	Agree	Strongly Agree

15. Please specify why this teacher has a strong influence on you:

____

____

16. My science teacher is approachable.

Strongly Disagree	Disagree	Agree	Strongly Agree

17. I would talk to my science teacher about pursuing a career in science.

Strongly Disagree	Disagree	Agree	Strongly Agree

18. My science teacher teaches but does “real” science as well (e.g., research).

Strongly Disagree	Disagree	Agree	Strongly Agree

19. My science teacher frequently tells us stories about science and scientists.

Strongly Disagree	Disagree	Agree	Strongly Agree

20. My science teacher frequently talks about science that goes on outside of the classroom.

Strongly Disagree	Disagree	Agree	Strongly Agree

21. My science teacher treats boys and girls the same.

Strongly Disagree	Disagree	Agree	Strongly Agree

22. Boys get more attention than girls from my science teacher (including being disciplined for behaviour).

Strongly Disagree	Disagree	Agree	Strongly Agree

23. My science teacher has high expectations for me in science class.

Strongly Disagree	Disagree	Agree	Strongly Agree

24. My science teacher has equally high expectations for the girls and boys in my class.

Strongly Disagree	Disagree	Agree	Strongly Agree

25. I have had at least one science teacher **in the past** who had a strong **positive** influence on me.

Strongly Disagree	Disagree	Agree	Strongly Agree

26. Please specify why this teacher has a strong influence on you:

____
____

27. I have had at least one science teacher **in the past** who had a strong **negative** influence on me.

Strongly Disagree	Disagree	Agree	Strongly Agree

28. Please specify why this teacher has a strong influence on you:

____
____

29. What gender was the science teacher that had the strongest **positive** influence on you?

M F

30. What gender was the science teacher that had the strongest **negative** influence on you?

M F

31. What are your parents' professions?

Father:____

Mother: ____

☐ (Please check here if you do not live with your parents, have little contact with them, or are with guardians.)

32. My parents would be very excited and encourage me if I want to pursue a science career.

Strongly Disagree	Disagree	Agree	Strongly Agree

33. My friends would be very excited and encourage me if I want to pursue a science career.

Strongly Disagree	Disagree	Agree	Strongly Agree

34. I am more likely to make decisions based on...

Thinking through steps and options	A strong sense about what is the best option	Both equally

35. I do science related activities outside of school (such as watching science shows on TV, reading science books or articles, doing experiments, etc...)?

Never	Rarely	Sometimes	Usually

Please specify what you do:____

36. I think that it must be difficult to balance a science career and a family.

Strongly Disagree	Disagree	Agree	Strongly Agree

37. I think that in science, women receive the same recognition that men do.

Strongly Disagree	Disagree	Agree	Strongly Agree

38. I think that men are more likely to be hired than women for science careers.

Strongly Disagree	Disagree	Agree	Strongly Agree

39. Please circle the names in the list below that you know use(d) science in their career: Please put a star beside any name(s) that you recognize but believe he/she is not a scientist.

Julie Payette	Stephen Hawking
Jocelyn Burnell	Benjamin Franklin
Stephanie Kwolek	Louis Pasteur
Gertrude Elion	Jonas Salk
Harriet Brooks	Isaac Newton
Rachel Carson	Charles Darwin
Marie Curie	Albert Einstein
Jane Goodall	Jacques Cousteau
Roberta Bondar	David Suzuki
Barbara McClintock	James Watson

40. Science is important to learn for more reasons than as a requirement to graduate from high school.

Strongly Disagree	Disagree	Agree	Strongly Agree

41. Science is interesting.

Strongly Disagree	Disagree	Agree	Strongly Agree

42. Boys are better at science than girls.

Strongly Disagree	Disagree	Agree	Strongly Agree

43. Boys have a better attitude and are more positive about science than girls.

Strongly Disagree	Disagree	Agree	Strongly Agree

44. Science is difficult.

Strongly Disagree	Disagree	Agree	Strongly Agree

45. I am good at science.

Strongly Disagree	Disagree	Agree	Strongly Agree

46. What I learn in science class relates to my everyday life.

Strongly Disagree	Disagree	Agree	Strongly Agree

47. What I learn in science class is abstract and complex.

Strongly Disagree	Disagree	Agree	Strongly Agree

48. In science class, we spend a lot of time on one topic and study it in great detail.

Strongly Disagree	Disagree	Agree	Strongly Agree

49. We do a lot of hands-on activities in science.

Strongly Disagree	Disagree	Agree	Strongly Agree

50. We do a lot of group-work in science.

Strongly Disagree	Disagree	Agree	Strongly Agree

51. Please circle the science classes that you have completed or are currently enrolled in:

Science 8	Science 9	Science 10	Science 14
Science 24	Biology 20	Biology 30	Chemistry 20
Chemistry 30	Physics 20	Physics 30	Other: _______

52. Please circle the science classes that you still plan to take before graduating from high school:

Science 8	Science 9	Science 10	Science 14
Science 24	Biology 20	Biology 30	Chemistry 20
Chemistry 30	Physics 20	Physics 30	Other: _______

I am in Grade: 8 11

I am ________________ years old.

I am a: boy girl

Please print your name here
if you are willing to participate in an interview: __________________ ________________
(First Name) (Last Name)

(If you are willing to be interviewed about science, I will contact you through the school to schedule a time.)

Thank you

Appendix B: Group Interview Prompting Questions:

1. What do you think about science? Why do you feel that way? Do you look forward to science class? Are you afraid to ask questions?

2. Is science important to learn? Why or why not? Is it useful for the future?

3. Other than homework, do you do science related activities outside of school; these could include watching science shows on TV, reading science books or articles, doing experiments?

4. Who are your role models? Who do you want to be like? Do they relate to your career choice? Why? What about this person makes them your role model?

5. Do you personally know anyone who uses science in their career? Are any of them women? What do you think of them?

6. Tell me about your science teachers (present and past). Did any of them stand out to you and leave an impression on you? What and how?

7. Would you talk to your science teacher about a science career? Do you think they know what it means to be a scientist? Do you consider your science teacher a scientist? Do they have a connection to “real” science?

8. What does a science career for a woman look like to you? Or what does a woman in a science career look like to you?

9. What do you think people in general think about girls who are interested in science or women scientists? Why?

10. What about scientists in media – movies, TV, magazines – When you see scientists in the media, what are they like?

11. How do you think your parents would react if you told them you wanted to be a scientist? Your friends? Why?

12. Do you ever worry or think about trying to balance a science career and a family? Please explain.

13. Can you name some scientists that you think are important, who you enjoyed learning about, or who you found inspirational? Any women scientists? Who are they? Why do you think they are important?

14. Re. survey question #39: Are you familiar with any of the other names on this list that you did not circle? What do you know about them?

Appendix C: Survey Data Not Included in Discussion

Grade & gender	Descriptive statistic	Q21: My science teacher treats boys and girls the same	Q22: Boys get more attention than girls from my science teacher (including being disciplined for behaviour)	Q23: My science teacher has high expectations for me in science class	Q24: My science teacher has equally high expecta-tions for the girls and boys in my class	Q34: I am more likely to make decisions based on...	Q47: What I learn in science class is abstract and complex
Gr 8 girls	Mean	5.90	5.00	5.90	6.00	2.25	5.30
	Median	6.00	4.00	6.00	6.00	3.00	6.00
	Std. dev	2.00	2.10	1.37	1.59	0.97	1.30
	n	20	20	20	20	20	20
Gr 8 boys	Mean	5.50	4.65	5.72	6.03	2.03	5.00
	Median	6.00	4.00	6.00	6.00	2.00	6.00
	Std. dev	1.90	1.82	1.22	1.31	0.97	1.50
	n	32	32	32	32	34	34
Gr 11 girls	Mean	6.46	4.61	6.07	6.39	2.67	5.74
	Median	6.00	4.00	6.00	6.00	3.00	6.00
	Std. dev	1.29	1.68	1.34	1.24	0.70	1.37
	n	46	46	46	46	46	46
Gr 11 boys	Mean	6.11	4.41	5.89	6.05	2.32	5.84
	Median	6.00	4.00	6.00	6.00	3.00	6.00
	Std. dev	1.41	1.66	1.41	1.00	0.93	1.35
	n	37	37	37	37	38	38
Totals	Mean	6.05	4.61	5.91	6.15	2.36	5.53
	Median	6.00	4.00	6.00	6.00	3.00	6.00
	Std. dev	1.62	1.75	1.32	1.24	0.90	1.40
	n	135	135	135	135	138	138

Appendix D: Themes and Tallies from Interviews with Pertinent Quotes

Theme:	Women are just as good at science as men
Total # of girls responded / # of total occurrences:	16 / 21
Quotes	[Steph]: I believe girls can do anything guys can pretty much [Alicia]: well, they're better, no just kidding [Beth]: o cockiness [Alicia]: I didn't say me, I said women in general, come on now [Cathy]: I agree, girls are just as good or better than [MH]: but in your opinion do you think men would be better at a science job than a woman [Beth]: it's pretty equal I think [Alicia]: I think it really does depend on the individual not the gender [Cathy]: not the gender, yup, depends how much work they want to put in [Alicia]: cause there may be men that will be better at it but there's also going to be girls that are too [Marie]: I think women can do whatever boys think that they do because when you see people doing construction you sometimes see women doing that as well, you see women being scientists, you see women doing rig moves, you see women doing everything and I think that if a woman wants to be a scientist they can do that. I think some of the smartest people in the world right now as we know it, the scientists, some of them are actually women that have found out things that some boy scientist would never find out.

Theme:	Men more likely to be successful
Total # of girls responded / # of total occurrences:	8 / 17
Quotes	[Yvonne]: I think like, I don't really know much about like other engineering and stuff like that but when I think of it, I think that guys can get further in it like become more successful doing it than women can [Katie]: I think just in general women don't get hired as much for like corporations and stuff like that [Yvonne]: and that's how it has been in the past kinda

	too just seeing what people say or seeing what people do I just see, I guess that's part of the reason why they would like hire a guy over a girls, the lady is gonna work for like two years and go get pregnant and have a kid and be out of work [Alicia]: I've heard jokes about it like people say would you rather be operated on by a Mexican doctor or a woman, and it's terrible but I've heard a lot of jokes like that [Cathy]: me too ??? cause if you're like a girl and you see a girl like the main person or whatever it's like you're really good and to be able to do that is a lot of work but if you're a guy you just you might not think they're as good for some reason, you just, you might stereotype them that they'll not succeed as much a guy would [Alicia]: ... when they do science they might be just as good as their male counterpart or whatever but the people who are, I don't know say it's a university, accepting them they might be like oh well he's a guy, you never know [Cathy]: ... the woman might be better, that they'll be like well in the long run I think a guy might be able to handle it better than a girl so that maybe they'll just choose because of that [Alicia]: they have to overcome like the sexist view other people have [Beth]: really, I think it might just be a subconscious thing drilled in that men are better than women [Alicia]: yeah, I don't know that they actually mean to do it [Beth]: yeah, it's just subconscious I find [Alicia]: And it does make a difference if it's men or women choosing what's going on too right [Beth]: if it's a woman they're more likely like lets [Alicia]: hire other women, but if it's a man he might not be as happy to do that until women get into the job it might be difficult cause if more men keep getting hired than they might just keep [Beth]: hiring more men cause they know that the men are working out [Alicia]: more men, more men, more men. So until you get more women in there it might be harder to get it more evened out

Theme:	Guys think they are better - macho
Total # of girls responded / # of total occurrences:	9 / 18
Quotes	[Yvonne]: I think people trust guys over girls kinda in a way, in like that type of sense, like looking from a science angle, just think that they are more likely to, I don't know, even going with like decision making, I see people taking the guys [Steph]: guys always have like the final say kind of thing [Yvonne]: it seems like the guys would be like I know what I'm doing [Yvonne]: I think that they feel that guys have like more dominance like they have a better say like they have more power overall [Steph]: yeah like listening to a girl like a lot of people it seems like would listen to a guy more than they'd listen to a girl [Tanya]: some people think like girls aren't good enough to do science careers. Which is kind of judgemental I guess [Sara]: yeah like stereotyping like girls like or that the guys they're always they're smarter and stuff. Like the Big Bang Theory, I really like that show and stuff, but like all the guys are like super smart and nerdy and then the only like main girl in it is a bimbo but I still like the show [Beth]: I think cause it's been like centuries and centuries that we've been taught that men are better, men are better so it's just kind of ingrained in our nature that we wanna like if it's something that's really important we want to put a man in charge of it instead of a woman [Emma]: and guys think they're way better than girls at some things that they do [Donna]: they think that they have everything like they're better, they're smarter, they're faster, they're [Jenny]: the best [Emma]: they have a macho motto [Donna]: macho man [Jenny]: yeah, they think that they're like just the toughest and like they know everything and can do everything when it's not always that way

Theme:	Women less recognized
Total # of girls responded / # of total occurrences:	7 / 10
Quotes	[Sara]: I just don't think like the recognition is the same. Cause like I know when we were doing the thing I was like yeah girls get recognized just the same then when I was going through looking at all the scientists like I barely, I only knew one of the girls but I knew like all the guys and stuff so I think the guys probably get more recognition and stuff like that even though the girls may be just as good or better [Ruth]: the same as it does for a man except getting paid $5 less? I don't know [Alicia]: they might just get overlooked more, with the actual science, actual, I don't know, subject not as much but the way other people see them it's not how smart they are it's just everybody else, if that makes sense [Linda]: I guess it'd be, what I think a career for a woman would look like, I guess it'd look almost the same, I guess it would look almost like the same as some guy, as a guy. I just don't think they get as much acknowledgement as a guy would because when you hear about laws and principles that your teachers teach you, I don't think I've ever heard of a woman who has a principle like that. And I'm sure there are, I'm sure there's tons it's just that, it just seems like they don't get as much popularity as like Albert Einstein or Isaac Newton and stuff like that.

Theme:	Women's rights recent
Total # of girls responded / # of total occurrences:	9 / 14
Quotes	[Steph]: it's just growing up like that, like that's just how it's always been it seems like, cause guys take that kind of stuff not girls but [Yvonne]: yeah, I don't know why, it's the way it's been [Katie]: just cause traditionally women are supposed to be in the home and stuff [Yvonne]: I was gonna say, yeah, like woman go have babies and their busy [Katie]: it's a recent thing that girls actually go and get actual jobs and things so

	[Ruth]: or maybe it goes back to when they, girls used to just stay at home and stuff because men were stronger and they went out and did stuff [Alicia]: well now, maybe in the past they didn't have the opportunity to do anything but it's evening out definitely [Cathy]: yeah, in the past they didn't have ...yeah, yeah...but now that we can, we are [Beth]: I just don't think we've reached that level in society yet to have them all viewed as equals since women's rights are still pretty new [Alicia]: Well, men have had a few hundred years before we did... I think a lot of the most important things we've learned in science are from so long ago that women just did not have the opportunity at that time [Linda]: I don't know, maybe it's cause, maybe science is still really into back end of the society maybe where women weren't as acknowledged as men were. Maybe it's like back way back before women had rights like that, maybe that's, science is still stuck in that society but I don't know it's just like you'd think you'd hear about it more often. [Marie]: that as she said, I think they're, the society that we have today, women are given a better chance, a better of how they can change their future but I don't think that they're given much, they're not given as much as I, that some people would like to see
Theme:	Brain differences – guys natural ability
Total # of girls responded / # of total occurrences:	9 / 21
Quotes	[MH]: so do you think that makes a difference or does that mean that those guys are just smarter at science than [Yvonne]: I don't know if it's like they're smarter or they're just, well I guess they kinda are but [Yvonne]: have the natural ability to just do it, like it's in their head easier [Ruth]: I think maybe I do because like a lot of boys are not mature enough and then they don't try as hard and that kind of thing or for some reason they are just really smart like

[Tanya]: yeah, sometimes they can just like test without studying and they get good marks

[Sara]: they might be smarter, like more able to learn and like make better ideas and stuff than girls can

[Anna]: well yeah like if you're not smart you could study and work hard to be smart so
[Sara]: or like just kinda depends how you learn and stuff and how you take things in I guess it's like
[Tanya]: I think some teachers the way they teach it's hard for you to like understand it but other teachers you can easily get it like just like that, like it's based on like you but also like how it's getting like taught to you
[Ruth]: I think like everyone has the ability to be really good at it but it just comes easier to some people than it does other people
[Sara]: like ??? and stuff like Einstein and stuff like he had a knack for science like some people are gonna have a knack for science, other people just have to work harder to get there

[Linda]: ... it was so easy for me to remember and I thought my mind was so scientifically trained but it's not, it's just cause she could incorporate so much to my everyday life that it just sticks with me.

[Linda]: ... she just gave it all up because she's been getting bad teachers and her brain's just not scientifically trained and so but yeah it's just not as many girls I guess are interested into it as much in today's society, in like schools and stuff who would take a career in science

[Linda]: ... I could just see them making just as great discoveries as a man could like they'd be cause our brains are just like everyone's brain is, I'm not gonna say it's the same cause people learn differently, but if you take two people who are really interested in science then it's not like one's is way super more advanced than the other, and if, even if it was it's not like she, the person couldn't learn as they go, cause that's what science is about to me, it's like you make a mistake well you learn from that and you keep on going. So I think they could just end up just as successful as a man could and I think that they just be an everyday scientist to me

	[Linda]: ...so you think about it and they're probably just thinking well this guy made this big discovery so maybe if we can get another guy and they're just thinking well maybe it's just how the guys mind works and it's just because they have made so many great discoveries, it's probably just like well maybe we should just keep with the guys because they just kinda shaped and formed what our world is today and to be able to show us how the world works [Linda]: yeah, it'd just be cool to like cause that's exactly what I've been talking about like the creativity you get to build something that's scientific and you get the opportunity to make it hands on you get to just ex, and just it's your chance to be creative and show how your scientific part of your brain works.
Theme:	Girls have to work hard
Total # of girls responded / # of total occurrences:	11 / 21
Quotes	[Steph]: yeah the girls in our class definitely work harder than the guys do, there's like one guy [Yvonne]: yeah you look at the front row of the class, like where people pay attention [Sara]: like it depends what it is but I think like in some aspects girls are gonna always have to work a bit harder to be up there and like if you wanted to be a scientist or something or like research you're gonna always have to work a little bit harder to be up there [Sara]: I think all the girls, is like, I don't know there is, like I don't know any girls who can just study or like just write a test and get a good mark. Most of the girls I think, even if they could, they still study. [Ruth]: yeah like ... probably could just write the test and get a good mark [Sara]: yeah or .. but they both study [Ruth]: they study anyway [Cathy]: yeah, we have really high high standards that we try really hard to reach and in physics we can't it. [Cathy]: cause we really want to try, we really want to get it, like we don't sit there and just kinda do our work, we like do our work to like as much as we can and

	everything and we don't give like small answers we elaborate and [Alicia]: detail [Cathy]: ask questions like when it's not to the whole class but when the teacher comes over [MH]: if you wanted to, do you think you could be a scientist? [Linda]: if I wanted to I think I could, if I really worked hard for it
Theme:	Typical jobs for women – Nursing and vet; doctor less typical
Total # of girls responded / # of total occurrences:	12 / 25
Quotes	[Katie]: they usually go into bio, like stereotypically [Yvonne]: yeah like doctors or like a veterinarian [Steph]: yeah vet tech and stuff like that [Katie]: yeah they usually go into like vet school and med school [Yvonne]: ...when I think engineer I don't really think women I don't know why it's just not something you'd [Steph]: yeah you just don't [Yvonne]: if someone is like designing a building or something, it doesn't seem like the woman would be in charge [Ruth]: I think maybe that it like depends on the field but I think maybe in the medical field or something they might have an upper hand or it depends, they might have the upper hand sometimes; like being a nurse I think maybe women have the upper hand there [Sara]: I think like to, in our heads and stuff, it seems more common to have the males be the doctors and stuff but like there's still lot, a lot of really good female like if I was, like I don't think I'm smart enough to be a doctor or anything, like if I was I would love to be a doctor but [Alicia]: oh yeah, my aunt is a nurse actually [Cathy]: lots of, in my family there's lots of nurses too, pretty much all nurses [Beth]: same with my fam

	[Cathy]: and they're all girls, none of them are, the guys are all with construction and all that boring stuff [Cathy]: well, when you think about women you think of jobs that they'll have it's like a teacher or librarian, you don't really [Beth]: or a nurse [Alicia]: homemaker [Cathy]: yeah, you never really think of like the big things and when you think of a guy they can be pretty much [Alicia]: doctor, lawyer [Cathy]: yeah, all that big stuff but [Beth]: firefighter [Cathy]: you never really think of a women as [Cathy]: if you think of a doctor you don't really think of it as being a girl so it'd be kind of a different thing and I'd be able to say I'm a doctor and I'm a girl. But if you say nurse then everyone's like oh well there's so many that are already girls so it must not be that hard to do. Kinda like that. And if you're a doctor than more people will be interested into what you're doing and they'll ask more questions but if it's a nurse it'll just be like how was your day, what did you do. But if it's a doctor they'll want to know more I guess. [Alicia]: you get to be an example for other people too. Like doc, nurses are just so common [Cathy]: yeah, when they're women
Theme:	Women explain more/ guys just show off
Total # of girls responded / # of total occurrences:	3 / 3
Quotes	[Emma]: if you can like compare the girls to the guys in scientists, the girls they like to explain things and get deeper into it, guys kinda just like to know it and then quickly move on to the next subject. They don't take their time in the subject [Linda]: they're just very eager to help I find like if they're I usually find like if it's a guy and I'm not trying to be like rude or offensive or anything but it's just like they're just gonna tell you what they know and they're gonna show it off but and they're not all like that but I find that most the women on that show who do try to help them they are just so eager to help them figure out how and to explain to them well this is how that worked

	and this is why this happened. Cause they're just so eager to show them well hey this is how this works and they want to teach them something new
Theme:	Descriptors for women in science
Total # of girls responded / # of total occurrences:	10 / 20
Quotes	[Yvonne]: dumb, ditzy [Yvonne]: pretty, I don't know, she, well actually no, kinda geeky, there's a mixture [Steph]: they're geeky pretty [Beth]: labcoat [Alicia]: labcoat, I kind of think nurse more than doctors but that should probably change I think [Cathy]: nurse more than doctors [Beth]: I see like test-tuby people like mixing the things [Alicia]: I see Ms. ... with her like crazy curly hair and the labcoat and the glasses [Beth]: really I see someone with like the, I don't know how to describe, just like [Cathy]: I always see them as they're kind of not like the main person, like the dentist or not like the main dentist [Alicia]: they're like the assistant [Cathy]: they're the assistant, and then doctor they're like the nurse they're not the actual doctor, they're never [Alicia]: yeah, in like a perfect world it would be equal, but when you see it in real life a lot of time they aren't [Cathy]: the main like big person I guess [Beth]: the head honcho [Alicia]: less authority [Cathy]: me too ??? cause if you're like a girl and you see a girl like the main person or whatever it's like you're really good and to be able to do that is a lot of work but if you're a guy you just you might not think they're as good for some reason, you just, you might stereotype them that they'll not succeed as much a guy would [Alicia]: but on the flip side when a woman does it, it's a bigger achievement than when a man does because it's like one women for every 5 or 10 men that does

	[Donna]: when I think of, well like when you said that I thought of Ms. .. like she had her hair tied back and goggles and the tie-dyed lab coat and like with all the stuff on it so that's what I pictured [Jenny]: like they think they'd be like a little odd [Donna]: mostly everybody is like stay at home moms or they have like to deal with paperwork or they help other people and not just do a science career [Jenny]: smart
Theme:	Teachers as women in science
Total # of girls responded / # of total occurrences:	7 / 8
Quotes	[MH]: so would you consider her to be a scientist or not so much? [Jenny]: kinda yeah [Donna, Emma]: yeah [MH]: yeah, because of that because she goes and does the experiments or why? Why would you say she's a scientist? What makes her a scientist? [Jenny]: she's really smart like she really really knows a lot about science [Donna]: yes like she she like gets it too like she has all these question practically in her head and she she can just like figure out and then it's like there ??? [MH]: ... what does a science career for a woman look like to you? [Cindy]: I was saying teacher [Karla]: yeah, that's what I thought [Cindy]: teacher, researcher
Theme:	Connections
Total # of girls responded / # of total occurrences:	16 / 35
Quotes	[Katie]: I just think physics is more interesting `cause you get to see like how things work and why but then I guess bio's the same but I don't care a cell works, it's a cell [Yvonne]: cause science is everything kinda, like technology [Katie]: yeah it's good to know how everything works around you even if you're not gonna make a career out of it

[Yvonne]: ...he relates it to anything like if you are like hockey player or volley ball player like he'll relate something to that
[Steph]: so he helps like each individual learn how they want to pretty much like he can adjust to how you want to learn if you don't understand something, like if you go ask a question and he'll relate it to something that you know about so it'll help you learn it, I like that

[Ruth]: it's easier to relate to the human body
[Tanya]: it's real, stuff like every day that you could easily know but you don't really focus on the environment every day kind of thing, and like photosynthesis and cellular respiration it's not something like

[Alicia]: well, like cooking is science
[Cathy]: yah, everything is

[Cathy]: Ms. .... I like Ms. ... 'cause she'll talk about everything she doesn't just like use the textbook and curriculum. She'll like go on with it more and she'll bring in stuff from like the next year. Like in Grade 9 she would talk about stuff that we learn like this year and stuff. And..

[Cathy]: yeah, and she really like explains everything to like a better point and brings in real life situations and makes it that much more interesting

[Linda]: the earthquakes, that was a good one
[Marie]: yeah earthquakes that were happening in Haiti and
[Linda]: yeah and like it was so cool 'cause right at that time we were learning how to measure the earthquakes and hectares and if it was an eight how destructive it was but it was like a one then it was, it's just enough for the most sensitive of an animal to hear. We just thought that was so interesting and then we got really into the Haiti thing and it was just cool to go home and see on TV and be like, look at that, it's like: what we're learning right now is what's going on out there. And it's more fun to learn about when there's stuff going on around the world like, it would have been so cool if we could have incorporated the Chile miners into our studies because I think those things are like really cool

to learn about, when you're sitting there learning about like buoyancy and density and how things float, it's like: well all I'm gonna need to know that for is boats but we learned about structures last year and how things float like that. Like the Titanic we learned about and I thought that was a lot of fun to learn about too cause it's outside world but when we're just sitting there, he's just telling us all this, why don't you incorporate some like big disaster that's happened in the past or something into it just to make it more interesting and wanna get us to know about it.

[Marie]: and I think that the whole class enjoyed her because she went out and she explained things that were real, that's what was happening outside and then we got to see that happen and when he teaches he talks about things that we've never seen before and that
[Linda]: or never heard
[Marie]: like that kind of stops our learning, that's like well kinda like make-belief, kinda pretend, that's not real kind of thing but like when we see it visually, I'm a visual learner, I like to see things that we're learning about and so when we were talking about the earthquakes last year, I got to see it on TV and I thought okay so there is where everything happens. I know where the earthquake starts and everything. Now when he talks about things like buoyancy and everything he shows us, he shows us like two or three experiments but it's nothing really that would show us what the world has to, what the world shows

[Linda]: and then once you do get to that stuff, like you just know well this is how that happened so maybe, so it'll be easier to understand cause you take like every day examples, or just examples and relate to the science you know then that could help me for miles and miles cause it's like, like I said I learn by doing and stuff but if you have a good enough example for me to hear then it's, I can picture it in my head just so easily and then it's like I can picture myself doing that and I can just learn it so easily

Theme:	Stories
Total # of girls responded / # of total occurrences:	7 / 10
Quotes	[Yvonne]: he told a lot of cool stories too, like [Katie]: yeah he had really good stories about everything [Yvonne]: well we don’t get much of their life story [Steph]: cause he knows we don’t need to know about their background, he knows that nobody really cares about it I guess, so he doesn’t even attempt to do it really very much cause nobody cares and it doesn’t really matter in chem. [Yvonne]: I know you have to know the things what they did discover but I’d be fine with just finding that out instead of like [Alicia]: And he had like real life stories not just read the textbook see what it means [Donna]: mostly like Ms. ... tell a lot of stories about her travels with the science career and stuff that she what she learned and she kind of like she talks about it like she it’s not just always one thing that she like we learn about. She kind of takes of out of class kind of and just like tells us in her story and how she liked it or something [Linda]: ...I’m a big person for like the weather, I like to go home, see what the weather is gonna be like and I always check out thermometer and it’s so cool to see, like she brought in telling us who invented, how Cesar Celsius invented the Celsius scale and I didn’t know that, or how Isaac Newton did the invented the Newton scale for the scientists with the alternate zero and I just thought that was so cool to go home and know who invented the Celsius scale. And she just managed to bring everything into our everyday life and that’s how it was so easy for me to remember...

Theme:	Importance of creativity
Total # of girls responded / # of total occurrences:	4 / 10
Quotes	[Linda]: yeah, it’d just be cool to like cause that’s exactly what I’ve been talking about like the creativity you get to build something that’s scientific and you get

	the opportunity to make it hands on you get to just ex, and just it's your chance to be creative and show how your scientific part of your brain works [Linda]: if, I totally think that somebody could somehow convert it into that and if it did end up something I really liked than yeah like if it was super creative I could totally go home and see myself saying I want to take a career in science because I just learn so creatively and so hands on that it's just like this is what I want to do [Marie]: I think the creativity could be put in there if someone very creative I think they would be able to change and do things that some scientists they do put their mind but not as much creativity as they would like into it. And with someone that has great creativity and likes to do things like that would put so much energy and things into that would just make other people think well I didn't really like science and now I've learned something that in my day I never learned.
Theme:	Upper level science only useful for job
Total # of girls responded / # of total occurrences:	5 / 6
Quotes	[Ruth]: there's just some units in biology that have nothing to do with anything you're interested in and it's kind of harder for you to learn those and I don't know why you need to know that if you [Sara]: yeah, if it has nothing to do with your future [Ruth]: yeah like if you're going, you'd be better off knowing something else really well I think than trying to learn a little bit of stuff [Anna]: it's good to have Science 10 and 20 but once you go into Biology and Chemistry and that, you don't really need it cause it's more specific, it's kind of pointless to take it [Ruth]: especially if you're you're not interested in it, then if you were interested in it then you would probably need it because you would want to do something with it. [Alicia]: I think like Grade 7, 8, 9, the lower sciences, yes, but now that you're into like the more complicated stuff it's not as applicable to everyday stuff

Theme:	Looks good on transcript
Total # of girls responded / # of total occurrences:	5 / 5
Quotes	[Yvonne]: so when I do start applying for universities and stuff then I'll look better and knowledgeable, if I go and write SATs and I don't know, just you'd know more in general [Tanya]: a lot of people are doing all three just so they have them [Sara]: yeah, that's why I'm doing all three [Alicia]: I think I need it for when I graduate most likely. It's really difficult though

Theme:	Good / smart student image
Total # of girls responded / # of total occurrences:	11 / 27
Quotes	[Yvonne]: yeah plus I just want to do good in it like get a good grade [Tanya]: well, either way if I have a bad science teacher I find a way to keep my mark up, even if I have to ask other people with backgrounds in science like questions and stuff. That's what I've done before [Beth]: social studies though, if you fling out a comment, everyone's like whoa you're smart in the middle of a conversation. Just saying [Cathy]: yeah, but if you say something like scientific everybody is like huh, can you explain that and you're just like no [Beth]: yeah but then you've gotta explain it [Cathy]: no not necessarily [Alicia]: no, they just assume you're smart [Alicia]: I'm kind of an overachiever. So what I think is bad is not necessarily everybody else's idea. [Cathy]: yeah, we have really high high standards that we try really hard to reach and in physics we can't it. [Linda]: I ask a lot of questions just because I really like getting good grades. Like last year I was on the honour roll every term in every subject so I do make sure I ask a lot of questions just cause I just wanna do really good in school so whenever I don't get something I ask

	questions and then sometimes, some days he'll just sit down and talk with me 'til he makes it in a way that I can understand so [Marie]: ... And then he's like a good student, a good student does this, a good student does that. Well, we're trying to be good students and he's not giving us the things that we need to learn from it. [Linda]: ... I just I did look forward to it cause it's just one of those classes it's like ah, it's gonna be a good class, I know it's gonna be easy for me, I know I'm gonna learn something and I know it's gonna be fun while I'm doing it... [Karla]: I think Grade 6 was easier too I was getting better marks on my tests and everything but now that we're in Grade 8 and he doesn't know how to explain things as clear it's just, it's kind of a little bit harder but it's still good
Theme:	Fear of failure
Total # of girls responded / # of total occurrences:	12 /18
Quotes	[Steph]: I just know him better too so it's nice, I think it's easier to learn from someone that you know a lot better in my opinion for me it is at least cause I'm not intimidated of the teacher that I'm gonna be like oh I don't wanna ask a stupid question [Yvonne]: exactly, scared, yeah, same [Anna]: it depends if I know what we're doing and I get it then yeah but if I don't [Tanya]: it's stressing, it's stressing when you don't know what you're doing [Tanya]: unless I'm unsure about the question [Ruth]: you don't know what you're asking and then you're just confused [Sara]: ...I don't think I'm smart enough to be a doctor or anything, if I was I would love to be a doctor but [Cathy]: and we don't kinda want like look dumb in front of them I guess. Don't wanna ask ???

	[Marie]: yeah I ask questions when there's, when it's needed. I don't like really, when he asks questions and I don't understand I don't really raise my hand 'cause, he says there's no stupid answer, but when I answer I just want to get it right, not like something like it isn't and then he's like no that's not right. That just frustrates me so I just let other people explain it and then he explains and then you're like oh ok, now I get it. [Donna]: I'd be scared I'd mess up [Marie]: ...he just makes us feel like you need to know this, if you don't know this then you're not gonna succeed in life and it's like well how are we supposed to succeed in life if you're not teaching us the proper curriculum and everything. And then he's like well, you should know this and it makes me feel like he, he doesn't really want us to be there when he's stressed...
Theme:	Frustration
Total # of girls responded / # of total occurrences:	8 / 15
Quotes	[Tanya]: it's stressing, it's stressing when you don't know what you're doing [Ruth]: or when your teacher says one thing and then tells you to do something different or, that kind of thing. When you don't like your teacher it's also very stressful. [Tanya]: which is frustrating cause I had a bad science teacher last year. I didn't go to school here for science last year and my Grade 10 science teacher was bad too and so [Beth]: She just hated me overall. I was like never in the classroom. It was a little annoying. [Donna]: yeah so like with some of the guys in my class too like talking so much and the girls are kinda just like k can we go in a separate class and just learn that by ourselves cause they're always talking and don't really care [Linda]: just because it's just, it's just like that, I get it and then some things I really don't so it just really frustrates me like some things I just get like that and some when I don't it's just like well why can't I get this,

	like I got that and then I'll ask for help and it's just like he can't help me cause he uses his words to such a, like he teaches us to such his extent and not ours that's just like well I get frustrated and I don't wanna be in a class where I have to sit there and be frustrated all class [Linda]: we're not learning anything
Theme:	Experiments
Total # of girls responded / # of total occurrences:	13 / 37
Quotes	[Katie]: bio experiments are always more like stuff we already know...we did like for physics he was go run up these stairs and we're gonna find out the power in your legs by doing this equation and all that and it was kinda cool just to see stuff that but all our bio experiments are like what affects the growth of weeds? The sun we know that [Yvonne]: in elementary my Grade 5/6 teacher, he's probably the favourite teacher I've ever had in like my whole life so far I don't know. He just made everything interesting and fun. Cause we did a lot of like hands-on stuff, a lot that were like they weren't dumb experiments. I know we do experiments for like, what's a dumb one we've done, put a chemical in something and watch it bubble, like some stuff is just boring [Steph]: you put sugar in water and watched it dissolved was one thing that was dumb [Yvonne]: yeah some are just really boring but making like bottle rockets and cool stuff, it was interesting [Tanya]: no, we pretty much write notes and do questions [Sara]: yeah, I think we've only done like one or two experiments [Ruth]: and then those ones that we do they're kind of stupid or like you're counting weeds somewhere and you're like why don't you just tell us how this is gonna end cause this is not interesting at all [Tanya]: he just kind of expected us to teach ourselves like he didn't really care really he just kinda, he would give us booklets and just expect us to do the work. Like we did a lot of labs and stuff but he didn't really help and he'd always be on his iPhone and stuff in class.

	[Tanya]: yeah, we still took some notes and we did more like projects and stuff [Sara]: yeah I think it's when you get the hands-on stuff and you're involved and you're actually doing it and seeing it when it like you learn more and it gets easier [Emma]: I like the experiments that you do [Jenny]: yeah, we do a lot of experiments and it's good [Jenny]: if like she tells an experiment in class then you just try it outside of school [Marie]: yeah but the best one that'd we say was when we had test tubes and we were experimenting on how dense they were and the volume and everything. And then he just took off from that and kind of made us take a turn and that turn was really hard for us cause nobody was like, nobody knew what to do, everybody was like well, we were just doing this and now you're teaching us a different thing and it was like a whole different thing that we don't even know, we didn't even finish the last thing... [Karla]: it would be more fun if we got to learn by doing [Karla]: like when we were learning with our batteries and stuff we would always do experiments and like building things with batteries, like we made houses with light bulbs and door bells and a whole bunch of different stuff with wires and batteries and everything and it was really fun so we learned a lot from that [Karla]: it's like last year I just kinda stopped losing interest because I don't know it just wasn't like Grade 7 science wasn't the same as elementary school science. It was harder and it's like, it's kinda less interesting than it was in Grade 6 when we got to learn about like different kinds of trees and like CSI investigations and all that, it was a lot more fun
Theme:	Reading
Total # of girls responded / # of total occurrences:	7 / 10
Quotes	[Tanya]: ...she doesn't really know everything so she's just learning how to teach it to us so it's really hard for us cause it's like all we really do is we have our

	textbook and all she does is she pretty much rewrites everything that's in the textbook in a power point and we write it down like why don't we just read it [Sara]: and then we do questions [Tanya]: if we read it and actually like learned stuff like [Ruth]: and then like when we're doing the questions, I'm always like this stuff wasn't in our notes, was this in our notes?...and you go back and [Tanya]: it's never in our notes so it'd be, make more sense to read the textbook and do more useful things to actually get it in our [Anna]: ... I just didn't like how we had to read it off the book and that's all we did I remember. I don't know I just didn't like that and last year this other teacher he was okay I guess but his notes were pointless cause they didn't really help, well to me they didn't ... [Karla]: yeah I'm good with the experiments and everything I just don't like just having to sit there reading out of the textbook like I'm more of a do, I learn better if I actually do it
Theme:	Knowledgeable teachers - explanations
Total # of girls responded / # of total occurrences:	17 / 42
Quotes	[Katie]: cause our teacher sucks at answering questions... I don't think she knows her subject at all which is weird cause she's a bio major but I don't think she knows most of what's happening. She's really boring, she, I don't know, she's really bad explaining and answering questions. She, I feel bad now... our science 8 and science 10 teacher was really good, Mr. ... Well he was kind of one of those teachers you're either gonna love or gonna hate. Just cause of the way he explains things but I really liked him. I thought the way he explained really worked for me and his notes and everything made sense to me [Sara]: and like her background she said's in biology so she knows what she's doing she's just isn't experienced in it so she isn't very very good at it [Tanya]: but he taught science, math and science I think last year but he's taught at bigger schools in Lethbridge and stuff so he's experienced and when he came in and

started teaching I actually started learning more just the way he taught I guess
[Anna]: yeah, my mark actually went up when he came

[Ruth]: I think it's easier to learn from them when they know what they're teaching like I had Mr. ... last year for Science 10 and he teaches chemistry and physics and I learned those really well but my lowest mark was in biology because he's not a biology teacher
[Tanya]: It's easier when you're teacher has been teaching for that long and they have a routine

[Alicia]: He did a lot with like environmental science before he was a teacher
[Cathy]: He put a lot of like in the class
[Alicia]: she had the same teacher
[Cathy]: yeah, he didn't do so much with the English and the Social but he did a lot with the class in science stuff so it really kinda emphasized it so it was actually much more cooler than learning about everything else and after that you just kind of wanted to go with it. I found it much more interesting the way he did it.

[Jenny]: she like describes everything good and she's like just good at like teaching things

[Marie]: for me sometimes, well when I first started out in the year, I didn't really, I've had this teacher before and we've, I know what he's like but he teached a different thing, like he teached art, and so when he taught science he only taught us like a little bit in elementary school so we didn't really think that he'd be teaching it full time and he said that as a person he didn't really know it so he was gonna learn it on the way, like as we were learning it so we'd be like: well he's on the same page as us. But he, it seemed like he knew it already, like in one day he was full extent knew what everything was and he wanted us to like, he wanted us to take things and just right off the bat have them and then I just don't really, I didn't really like that, and so I didn't really want to do any of the stuff, I kind of dreaded it, going to class knowing that he's going to go faster and everybody in the class is complaining about how it's

	[Linda]: yeah, like last year we had the most amazing science teacher. Like she is very strict and not many people liked her but if you just listened to her she could easily just explain this to you, like we read a little bit and then she'd explain it to us so we got it and she'd draw pictures for us on the board and she'd explain it with like experiments and examples. It's like I totally get this and I went in and I got, did really good on all our tests [Marie]: now I'd say, I'd say he has a little bit of a better understanding but not to the extend that we would like, like I know he can't be what we like or anything but do what we like but when he, when he tried to learn, he told us he was learning, we were like okay we're gonna be learning along together and then we'd be able to be like oh no, this is right, this is right and then be able to use our brains but then he just went ahead, studied it all and knows it all now where we are like well we thought you were learning along with us [Linda]: well, I think, he does, on most things he does but there's this one thing I was super stuck on for a super long time, it had something to do with buoyancy and density, I think it was mostly buoyancy, and I asked him a question and he had no clue and he had to sit down with me and we had to come up what we thought it was, and then finally when he did come up with a definition it was so complicated that it took me like, asking, I had to ask people like eleven times after that okay, well can you try to simply what he said, they're like we don't know how to simply what he said [Cindy]: he's really nice and everything sometimes he like, it's kinda hard sometimes because he doesn't know how to explain it like so you get it but most of the time he does, he just needs to I think he needs to read over his stuff a little bit more and he even says that himself because it takes him a couple of tries to get what he's trying to say, so it's just kinda hard to get what he's saying if he can't explain it like as well as he needs to [Karla]: when we had him in Grade 6 he was better because he, we were younger and I think it was easier science but now that we're in Grade 8 I think it's a little bit harder for him so he just needs to like keep reading about it and figure how he's going to explain things

Theme:	Identifying with role models
Total # of girls responded / # of total occurrences:	7 / 7
Quotes	[Steph]: mine's a hockey player because she's really smart and she's just pushed her way through to get what she wants so she's just been my role model for a few years now [Alicia]: like I have a friend, you know the new ... clinic that opened up in ...? She is one of the head nurses there. [Donna]: I just like horses and we have a friend we and she went to BC for horse therapist and she says she just loves it so I said why not me [Linda]: Terry Jean Popawitch from So You Think You Can Dance Canada who won. She's not like an educational role model but it's just cause I enjoy dancing and that's all I spend my time doing outside of school, that and piano [MH]: Is she someone that you could see yourself being in a few years? [Linda]: if I kept working as hard as I do in my dance classes then yes [Marie]: yes I do, there's this, I used to have her as a dance teacher, she lives in our town right now, her name is .... and she used to be, I think it's called Alberta's Ballerina, where she had her own like her own studio named after her, she had her, she was a very famous teacher and dancer. She had, she used to have like concerts, well like where she would have plays and she did Romeo and Juliet and things like that and I just really liked her as a role model because she showed me that you can pursue your dream if you knew that you could and you believed that you could. But also thinking that, the things that you do, that you do well, you do those things because you want to try them, you want to show the world your talent so

Theme:	Role models overcoming barriers
Total # of girls responded / # of total occurrences:	5 / 7
Quotes	[Steph]: she's really athletic and she, I actually got to meet her and talk her and she just told me, she grew up in this tiny town like we do and she pushed her way to

be on the Olympic team and she's only 24 and she's already been in the Olympics two times and she's crazy good at everything and I don't know she wants to then she's kinda like me she really likes animals and when she's done with hockey she wants to open a vet clinic kinda thing and work with that, she's just been my role model

[Alicia]: I've seen family influence science though like my friend who works at the clinic, her son was diagnosed with brain cancer a couple years ago and it really made her work that much harder to help with cancer research.??? It can actually help you with it in some ???

[Cathy]: but then there's some of them who you see and there's so much that they did and from the time that they did it and the how much they had to overcome like say religion or something was a huge thing
[Alicia]: Galileo
[Cathy]: yeah, that's who I was gonna say, where everything is supposed to be the same and then he goes and he just basically says everything opposite to what everybody has already believed, to be able to do that was pretty big on his part

[Linda]: because she, the first year she tried out for So You Think You Can Dance Canada she didn't make it past the top 40 and it was just so cool to see how she went to schools like in Canada like to Vancouver and went and studied more dance for a year and has tried her hardest and then she ended up winning the next year. She went back even though she knew it was, it was a hard thing to do and she got, she got injured, like her ribs had all been cracked and broken but she'd still keep going 'til the very, very end.

Talking about Einstein but meaning Hawking
[Marie]: showing others that you know like you know that this dream is almost impossible just because of how you act or are and how you look and how things are going in your life and how you've been treated and everything. And I think that, yeah, I think it's inspirational because he's just the most, he's the best person I would think of.

Theme:	Role models success
Total # of girls responded / # of total occurrences:	4 / 4
Quotes	[Alicia]: well the one does x-rays and stuff so she knows a lot about I guess Physics or whatever would be involved with that. She's talked to me about it because I did a project on it last year and I got some information from her. But she was pretty helpful though she knew way more about it than I guess any of the websites. She could explain it way better because she used it every day. [Cindy]: I would talk to someone very successful and they would lead me in the right path. I'm not sure, I think my teacher now would lead me in his own path

Theme:	Parental and peer support
Total # of girls responded / # of total occurrences:	16 / 21
Quotes	[Steph]: yeah they would definitely be okay with it, they would never tell me not to do it [Katie]: yeah my parents would probably be really like happy about it [Yvonne]: yeah, I don't know if my dad would for me, he'd probably be like, I don't know like one time when I was talking to him about like schooling and stuff like what I want to do, he tells me there's too many engineers so I shouldn't be one, like, fine, but I guess it could go back to like how a guy can be more successful in something like that than a woman, [Yvonne]: they'd probably call me a nerd and be like oh [Tanya]: yeah, I don't really talk about it with my friends like I know my dad wants me to, he just always says like you always have wanted to go into forensic science and I think that would be a good thing for you like he thinks it's like positive and supports me [Sara]: yeah, like my friends would never say anything negative to it or anything like they wouldn't be like you're a nerd but it's just not, they don't really care, you know it's not like a [Donna]: they'd probably say good for you you want to do that and that's I don't know [Jenny]: yeah they seemed really supportive

	[Jenny]: they'd be happy for one of us to do that [Donna]: they know that guys can't just do everything so if you had a daughter and then a son then they can be like ok so their kinda equal. But then the daughter achieves more than the son their kinda sometimes more supportive on the daughter because they're like k you're my girl and you're doing all this that girls don't really do... [Marie]: I think my mom would be happy for me because I want to pursue my dream, I believe I can, I think she would be excited that I shared that I know what I want to be when I'm older, that I have a future, that what I want to be is something that I will be happy to do, something that she may not agree with but she knows that I will be happy and that I'm pursuing something that makes me most interested and most excited about [Linda]: ... some might laugh and some might really support it, some might think that's really cool so [MH]: and those that would laugh, why do you think they would laugh [Linda]: because they think of scientists like geeks and weird and out there and they just think of them as waste of time really so... they just think why on earth would you pick that [Karla]: well when I was younger I always told them I was gonna be a scientist, I don't know why, I just I really liked science when I was younger and so they were kinda of proud of me...
Theme:	References to parents
Total # of girls responded / # of total occurrences:	10 / 21
Quotes	[Steph]: my mom kinda does, she kinda uses bio a bit... she works at ... she's like, she's I don't really know, she does a lot cause she has to take a whole bunch of training courses about, she has to identify the different everything like in the fields and soil, and everything. So she kinda uses bio I guess in a way, kinda not [Sara]: my mom is a lab tech... she said it's a good job but she wouldn't recommend it to me cause she said there's not much branching out you can do from it

	[Emma]: my dad he works at a farm, so they work a lot with the drugs for animals [Donna]: yeah my mom and dad do that too
Theme:	Women in media
Total # of girls responded / # of total occurrences:	16 / 29
Quotes	[Yvonne]: on TV you always see the guys that are the smart ones... and you see these dumb blondes trying to do science [Yvonne]: when I think about it like just thinking if I was to make a movie for myself I would always have the guy with the glasses in the coat doing like, pouring the chemical into something and then I'd see a girl try it and explode [Steph]: that's just the stereotype, that's how it's just it's always been like that even when you see movies from the 80s you and before that it's the guys always in the glasses and the labcoat and the girls are always all dressed up and ditsy [Katie]: I don't know, on TV there's usually like the really hot science girl but then there's the [Yvonne]: and then there's the really like one with like the mole like on her nose or something [Sara]: stereotyping girls or that the guys they're always smarter. Like the Big Bang Theory, I really like that show, but all the guys are super smart and nerdy and then the only main girl in it is a bimbo but I still like the show [Ruth]: it's really funny. There was Sheldon's girlfriend for a while there but she was really creepy [Sara]: yeah but they're kind of like creepy and nerdy and I don't know [Sara]: I think in that show it's a negative image but like on Mythbusters there's the one, like I think it's just not as common that is to see them like really smart guys. It's like in Mythbusters the one girl like ??? she's a positive image but in Big Bang Theory those girls are kind of creepy [Sara]: the girls are positive in that one (CSI) [MH]: is that a good image of women in science

	[Sara]: yeah, they're just as good as the guys in that one [Tanya]: yeah, they're just as good, like they do the same jobs and some of them have like specific things that they're really good at and other people work, they're all kind of separated and then there's some guys and girls that do the same jobs and they're equal at it like not one is better than the other [Alicia]: they only have girls on there cause they look good [Cathy]: yeah, but for the main ones if you watch a documentary or something it's always a guy [Alicia]: the ones we watched in class even there is no girls [Linda]: it depends, some days I watch Mythbusters and they have to go most of the time to a scientific formula to figure out how to bust the myth and a lot of times yes there is women scientists that are there to help them [Marie]: I've seen on Discovery Channel, where women are normally in every single TV show that I've watched. I am, I think they're more of a, but sometimes they're not just the scientists, the in charge kind of person, they're more of the side, agrees with the real person who's helping
Theme:	Idea of what day to day job is like
Total # of girls responded / # of total occurrences:	5 / 6
Quotes	[Yvonne]: I don't really know much about other engineering and stuff like that but when I think of it, I think that guys can get further in it like become more successful doing it than women can [MH]: do you think that CSI is a realistic portrayal of what it means to be a woman in a forensic science career? [Tanya]: yeah, it's showing what you're going to have to go through like that it's not fake [Sara]: I think in that aspect but I don't think everyone working in a lab is gonna be that good looking all the time or like looking, I think like the looking, like what they're doing aspect probably, but what they look like probably not [Tanya]: what they have to investigate it's all realistic

	and everything but it's not gonna be as easy as they make it look on TV shows, like they find things so fast, but it'll be around that [Marie]: ...I think that I would be able to pursue a dream like that if I had more of a understanding of how it's like to be a scientist. I'd think I'd have to know more about how the, how they work, how they think, how they have to [Linda]: how they think their brain works [Marie]: yeah how do they go through their days...
Theme:	Men are experts, women assistants
Total # of girls responded / # of total occurrences:	8 / 10
Quotes	[Cathy]: I always see them as they're kind of not the main person, like the dentist or not the main dentist [Alicia]: they're the assistant [Cathy]: they're the assistant, and then doctor they're the nurse they're not the actual doctor, they're never [Alicia]: yeah, in like a perfect world it would be equal, but when you see it in real life a lot of time they aren't [Cathy]: the main big person I guess [Beth]: the head honcho [Alicia]: less authority [Donna]: there's doctors that are males like mostly all the doctors here are males, all of them and then the assistants are girls [Jenny]: oh yeah, like the nurses [Donna]: yeah and like the desk person is a girl and it's kinda mostly the guys k they have their own thing they wanna do, the girls they're just like k I don't want to get into that so they think that they just can be secretary or something [Jenny]: right now so many place in ... it's the male is the head man person and then the females are the paperwork or the nurses like that kind of thing [Donna]: assistants they're not like I've haven't [Jenny]: yeah, they're not the big man out there [Donna]: I haven't really seen a real doctor that's a girl

Theme:	Lack of women (in textbooks and curriculum)
Total # of girls responded / # of total occurrences:	7 / 13
Quotes	[Beth]: have you noticed in the media most of them are guys [Alicia]: yeah, that's what I was getting at, Dr. Suzuki, Bill Nye [Cathy]:,but for the main ones if you watch a documentary or something it's always a guy [Alicia]: the ones we watched in class even there is no girls [Cathy]: in the textbooks though what we knew all the guys most of them because of textbooks and there's never ever any women in them

Theme:	Participation in extra-curricular science activities
Total # of girls responded / # of total occurrences:	12 / 16
Quotes	[Tanya]: it just seems really interesting to me. I've always been interested in forensic science and I always look things up on the computer about it and watch the shows with people doing forensic science [Anna]: oh, ah, there was this science fair I remember when I was in Grade 6 I think it was and you had to like build something like just anything and I did like a little ball thing that just dropped and stuffed and it turned on a fan and I don't know it was pretty cool [Alicia]: We went to Operation Minerva ... [Cathy]: Well you really got to go like you got to take like a bio class in the university so you really got to see like how [Alicia]: ours was DNA [Cathy]: yeah and you got to play with like DNA and you got to [Alicia]: watch it like unravel [Cathy]: yeah, and you got to see your spit and stuff, it was pretty cool [Alicia]: you got to wear the big white suit things for when we did the sheep's blood and the gel stuff [Cathy]: it was pretty cool, you got to experience something different that you wouldn't be able to in the classroom

	[Jenny]: well once we had a really sick cow and the vet came out and like he's always like asking me to like hold stuff for him and...it was fun but it was weird [MH]: would you like to participate in one if you got the opportunity [Marie]: I'd love to have the [Linda]: I have like my grandma sent me an email of this really cool experiment and I'm like dude I could totally win with that so [Cindy]: I watch TV and do experiments at home and [Karla]: I do like, I always buy like little science kits and stuff just to test things out cause I like to
Theme:	Teachers as role models
Total # of girls responded / # of total occurrences:	2 / 2
Quotes	[Jenny]: kind of, like our teacher right now and she's also our volleyball coach. I kind of look up to her [MH]: okay, do you have a role model? Do you have a person that you look up to that kind of inspires you that you say, you know that person really motivates me to wanna do that or to wanna do better? [Karla]: my science teacher kind of [MH]: yeah, your current science teacher? [Karla]: yeah [MH]: can you tell me a little bit about why your current science teacher? [Karla]: he always encourages you to do your best so even if you're like not doing very good or whatever he takes extra time to help you and encourages you to do your best and everything and so
Theme:	Family-work balance
Total # of girls responded / # of total occurrences:	12 / 13
Quotes	[Katie]: yeah mine are more stuff from home, stuff that I can do with my kids [Ruth]: one of the reasons that I wanna do like diagnostic medical sonography is there is less on call kind of stuff and night shifts that kind of thing it's more like I choose what I wanted to do because it's not as

	[Sara]: if I was to become a doctor something like that and you're doing night shifts and just being like you see on the TV shows, like it's hard to balance being at work all the time but then you still you're family wants you to be there so a lot of times it's hard to work it out [Alicia]: I don't want a family [Cathy]: maybe after everything is like going good and you're done with your schooling [Alicia]: after you've like reached your [Cathy]: you have like a good job Cathy]: and you're good to go then maybe possibly but not like say we graduate a couple years later we have kids then we go and it's just so much hassle so [MH]: do you ever worry about trying to balance a science career and a family? [Karla]: yeah [Cindy]: also another depends on the hours and if you're on call and [MH]: so if you chose a profession like that where you were on call, would that worry you, is that something that [Cindy]: yes I wanna get to spend enough time with my family
Theme:	Rural girls leaving
Total # of girls responded / # of total occurrences:	7 / 7
Quotes	[Ruth]: I would come back if they had the program I wanted to do like here [Sara]: no, I'm planning on leaving as soon as I graduate and never coming back [Cindy]: yeah, I'll probably leave ... [Karla]: it's cause I don't, like I like ... and everything, I just think I'd get more opportunities if I went to like, if I went somewhere else
Theme:	Need for science in rural community
Total # of girls responded / # of total occurrences:	15 / 24
Quotes	[MH]: you think science is important to your community? [Yvonne]: I don't think it has a super big effect to it but it does

[Katie]: yeah, I don't know, just being a farming community there is like a little bit but not

[Steph]: depends... if guys decided to stay here and farm and stuff than they use science more I think

[Ruth]: someone has to have science skills to have a well rounded community so yeah it's important to have them but not necessarily you have to have them

[Beth]: I think it would almost be looked down upon just cause everyone wants everyone like you grew up here so you should stay here and marry some other person of the same religion and stay here and have children to look after the house. It's almost kind of
[Alicia]: It's quite honestly like that, like you should stay in the community

[Beth]: chemistry is the only thing that will ever kinda come up
[Alicia]: I guess it's agriculture science though
[Beth]: well that's kinda what I'm getting at
[Alicia]: I mean there is a lot of that stuff and the research centre and
[Beth]: agricultural science I find is a lot of just chemistry and stuff. But they really try and avoid like the bio end of things cause there's so much things that contradict their religion with bio so their always like lets steer away
[Cathy]: and most of the really religious people are the ones who are the big farmers
[Beth]: they don't really view science as an important thing
[Alicia]: even though everything they do, like their
[Beth]: is involved in science

[Donna]: cause everybody here lives on a feedlot or in town or whatever like with dealing with drugs you have to know what things will work and won't work on the specific animal

[MH]: do you think science is important for your community though?
[Cindy]: yes
[MH]: how so?
[Cindy]: it helps change almost everything

	[Karla]: the environment [Cindy]: the environment, the economy, yeah, I can't think of anymore [MH]: so do you think you more people in your community that have a strong science education? [Karla]: I don't think so, I think a lot of people like I think most people just have it like common sense to do and to not do things but so I think we're ok, like ...'s ok but I guess it wouldn't really matter if more science people came in
Theme:	Science is fun/ interesting "What do you think about science?"
Total # of girls responded / # of total occurrences:	13 / 19
Quotes	[Yvonne]: it's fun and boring at the same time [Katie]: I like parts of science, I just don't like other parts [Anna]: well, it's not that I don't like it, it's just that it's hard, I don't know, it's interesting [Tanya]:yeah, it's fun and it's interesting but it's hard if you don't understand but once you understand it's a lot easier and it's easier to like know what you're doing I guess [Cathy]: I love it! [Alicia]: Favourite subject. [Beth]: I like it. Good at it. [Emma]: I don't know I just found it interesting [Donna]: like it's not boring like [Jenny]: it's my favourite subject [Marie]: I think it's fun and exciting to learn about new things that are, that some other scientists learn about and it's kind of, it kind of tells you about what the world is like when you get out there after you're done high school and everything [Cindy]: it's pretty interesting. I would like to learn more about it

Theme:	Pedagogic dynamics
Total # of girls responded / # of total occurrences:	15 / 38
Quotes	[Steph]: yeah, he's not one of those teachers that just sits there and is so boring and make you want to fall asleep, he's new and tries to keep us into it and everything. He tries to make sure everybody is included so we learn at the same time [Yvonne]: I think the thing that helps he does a lot of out of school stuff like he's a volleyball coach and the slow pitch coach and so he's not like some science teacher, I don't know how to explain like he's [Steph]: yeah, I see him every day outside of school [Ruth]: or like when your teacher says one thing and then tells you to do something different or, that kind of thing. When you don't like your teacher it's also very stressful [Ruth]: when I don't understand it you look to your neighbour or your teacher. Sometimes your teacher is like well what do you think it is and you're like I don't know what it is that's why I'm here [Tanya]: I don't know what it is that why I'm askin [Ruth]: and they're just trying to get you to learn but it's like [Sara]: just show me [Ruth]: yeah if you show it to me then I'll be able to do it but you haven't shown it to me before so how am I supposed to know this and like you can try it but if you've tried it 6 times and it doesn't work then why can't he just show it to you [Alicia]: They're pretty fun discussions sometimes... gets really heated, like debates [Donna]: and she takes steps at it like not just say k this is this learn about it, she'll go through it and takes steps with you [Jenny]: she'll make sure you learn the concept before she moves on [Jenny]: she includes everybody in the class so that it's not just one person always getting the answer, it's everybody [Donna]: yeah, and she makes us have these little

quizzes on every Thursday to make us understand the little things a little more and then she, and then when you get a 100% you get a candy which encourages you to do better
[Emma]: and you get put into a draw for Hurricane tickets or MovieMill tickets

[Jenny]: well Mr. ..., he wasn’t really bad but he just gave us information and expected us to just get it right there, so it was hard
[Donna]: and then he’d kind of read or write too fast and then you’re just like k what do I do here so you go that and that and then you’re just like I still don’t get it and he’s just like k, move on
[Jenny]: he just weaves in and expects you to get it

[Marie]: well he gets off track. He’s told us that before but when you say the littlest thing he’s off track, he goes to another world it feels like and then we spend half of the class doing that and he’s off talking about something that is not related to the science
[Linda]: and then gets mad ‘cause we have nothing done
[Marie]: yeah he gets mad ‘cause we have nothing done and he feels like we did it on purpose when we just asked, we asked just to understand, he’s a friend to us pretty much

[Marie]: she made us websites, well not made us but found websites for us to go and
[Linda]: study
[Marie]: yeah and study, like she had this one website where you had your test on there and it had to do with the same things that you’re learning about so you could go on there

[Karla]: last year I had a teacher and she choose favourites so it was hard to work with her. Like she knew a lot about her science, it’s just she choose favourites so it was, personally I wasn’t one of her favourites and so it’s just hard to learn cause you were scared to ask her things but this year is a lot better cause he doesn’t choose favourites, he just likes everybody equally so... she would get mad at me and then like on my vocab when we had to define words, I would go up and ask her a question and she’d say just figure it out yourself so it’d take me a while to do that so yeah

	[Karla]: science for sure, ever since Grade 7, like last, my favourite subject was science all the way from Grade 2 to Grade 6 and then last year it just kinda changed cause of that teacher
Theme:	Classroom management
Total # of girls responded / # of total occurrences:	6 / 10
Quotes	[Beth]: I didn't like my Grade 5 and 6 science teacher. She hated me. She kicked me out in the hall 90% of the class time. [Alicia]: When I was in Grade 9 or Grade 8 she did that to me as well [Beth]: She just hated me overall. I was like never in the classroom. It was a little annoying. [Donna]: she makes science class like fun like when she marks she has this little squishy thing she calls it and she throws it around so then we go up to the board and answer a question which kinda makes it fun [Donna]: she kinda sometimes she says k guys gotta put up your hand [Jenny]: she encourages them to put up their hand but then if they don't do it then she just kinda just ignores them until someone puts their hand up [Marie]: and he like, it's like where, the kid, the boy that causes his stress, when he goes out he turns into a whole different person, our teacher, and he just makes us feel like you need to know this, if you don't know this then you're not gonna succeed in life and it's like well how are we supposed to succeed in life if you're not teaching us the proper curriculum and everything. And then he's like well, you should know this and it makes me feel like he, he doesn't really want us to be there when he's stressed. He wants to be alone and then when he teaches us he's like this short little thing and then it's like okay go and do this like 10 page of things and you don't know what to do. And then that's where it just turns into chaos where everybody just doesn't do the work cause they don't know what to do and everybody is asking questions and he's freaking out and it's just, it's kinda unstructured

Theme:	Desire to help
Total # of girls responded / # of total occurrences:	8 / 10
Quotes	[Sara]: I think in a medical aspect that working on humans health it's important cause it helps us get, learn more with bio and stuff about the human body so we can cure things like cancer and stuff like that [Ruth]: I wanted to help people and I want do something in the medical field but I was looking for something with the hours. I've always been really fascinated by the sound waves and x-ray and nuclear medicine [Holly]: yeah, pretty much me I love animals if I could I'd help every animal in the world that was sick [Emma]: and if I don't pursue with my nurse dream I want to be like helping in a old folks home

Theme:	Visualizing
Total # of girls responded / # of total occurrences:	9 / 16
Quotes	[Yvonne]: on TV you always see the guys that are the smart ones... and you see these dumb blondes trying to do science [Yvonne]: maybe engineering... that'd be cool, I can see that possible in my future maybe [Sara]: I have to visualize it and draw like if I can draw a picture for it I'll draw a picture cause I need to see things but I like doing it and stuff like that [Alicia]: kind of, like the one I know that works at the clinic I guess. I can see myself doing something like that [Marie]: I think I would be able to it's just it wouldn't really bring out the interests that I have now for the careers that I'd like to pursue in my future but knowing having that thought in my head, I think that I would be able to pursue a dream like that if I had more of a understanding of how it's like to be a scientist. [Karla]: I don't know I just really can't see myself just doing that. I don't know why

Appendix E: Survey Questions Relating to Interview Themes

	Theme	Survey Question Number	Figure & Table Number
1	Science as a Masculine Discipline	37, 38, 42-45	Table 1
	○ Women are just as capable to do science as men	42	Figure 1
	○ Men more likely to be successful	38	Figure 2
	○ Macho image		
	○ Women's work less recognized	37	Figure 3
	○ Women's rights recent		
	○ Brain differences – guys natural ability	42	Figure 1
	○ Girls have to work hard to succeed in science	43-45	Figure 4
2	Stereotypes of women in science	1-4, 18	Table 3
	○ Typical jobs – nursing, vet...less typical doctor	1, 2, 4	Table 2, Figure 5
	○ Women do more explaining while guys just show off		
	○ Descriptors for women in science	3	Table 4, Figure 6 & 7
	○ Teachers as women in science	12, 18	Table 5, Figure 8 & 9
3	Connecting science education to life	19, 20, 46	Table 6, Figure 10
	○ Real stories	19	Table 6
	○ Using creativity	5	Figure 11
	○ Helping		
	○ Upper level science only useful for job; looks good on transcript	40	Figure 12

4	Science education and science teachers	48-50	Table 7 & 8, Figure 15
	○ Good student image • frustration when not learning • fear of failure	16	Figure 13 & 14
	○ Doing experiments	49	Table 7, Figure 15
	○ Participation in extra-curricular science activities	35	Figure 16 & 17
	○ Knowledgeable teachers	13, 14, 17-20	Table 9, Figure 18 & 19
5	What is important about role models	7, 8	Table 10-12, Figure 20-23
	1. Being able to identify with role models or relate to them 2. Overcoming barriers or believing in their dreams 3. Success of the role model		
	○ Teachers as role models	6	Figure 24, 25
6	Parental and peer support	31-33	Table 13, Figure 26
	○ Importance of father's opinions		
7	Influence of media		Table 14
	○ Not many women/descriptors	9-11	Table 15, Figure 27 & 28
	○ Gives idea of what day to day aspect of job is like		
	○ Work-family balance	36	Figure 29
	○ Men are experts, women are assistants	10, 11	Figure 30 & 31
	○ Lack of women with science careers (in textbooks and curriculum)	39	Table 16, Figure 32 & 33

Appendix F: Students' Descriptors for Persons Who Use Science in Their Job

Table F.1

Descriptors Coding for Question 3

Type of descriptors	Value assigned
All of the descriptors were negative	1
Most of the descriptors were negative	2
Neutral or same number of negative and positive descriptors	3
Most of the descriptors were positive	4
All of the descriptors were positive	5

Note. Negative descriptors included: nerd, geek, repetitive;
Positive descriptors included: busy (as in job security).

Table F.2

Tallies for Students' Own Descriptors

Positive descriptors	Total tally	Girls tally	Negative descriptors	Total tally	Girls tally
alert	1	1	boring	3	2
amazing	1	1	computer freak	1	1
awesome	4	2	four eyes	1	1
bright, brilliant	3	2	freaky	1	1
can be cool	1	--	geek	2	1
civilised	1	--	head ache prone	1	1
class	1	--	homework nerd	1	1
committed	1	--	logical (overly so)	1	1
complex	1	1	mean	1	1
confident	1	1	no fun (at all!)	1	1
creative	3	3	odd at sometime	1	1
curious	1	1	unpredictable	1	1
dedicated	3	3	unrespected	1	1
detailed	1	--	very slow	1	1
determined	2	2			
educated	2	1			
exciting	3	2	**Non-categorized descriptors**	**Total tally**	**Girls tally**
genius	1	1	busy	4	3
good shoes	1	1	bff	1	--
hardworking	2	2	knowital	1	--
helpful	6	2	labcoat	2	2

important	4	2	long vocabulary	1	--
independent	1	--	math	1	1
innovative	1	1	never worried about falling	1	--
intellectual	1	1	plane	1	--
intelligent	12	7	smarty-pants	1	1
interactive	1	--	quirky	1	1
interesting	8	6	sceptical	1	1
knowledgeable	6	4			
new	1	1			
nice	1	--			
open	1	--			
organized, uses methods (very scheduled)	2	2			
outgoing	1	--			
paid well	1	1			
patient	2	--			
persistent	1	--			
personable	1	1			
powerful	1	--			
relatable	1	1			
respectable	2	1			
responsible	2	--			
serious	2	--			
strong	1	--			
strong willed	1	--			
successful	3	3			
“tecnicion”	1	--			
understandable	1	1			
unique	1	1			
useful	2	1			
wealthy	1	--			
well groomed	1	1			
well-rounded	1	1			
willing	1	--			

Appendix G: Other Factors Listed by Girls as Important in Their Career Choices

Factor	Tally
Being respected, treatment by others	2
Dress code	1
Good cafeteria	1
Good hours	1
Having a good job where you get to express yourself	1
Having fun	2
Includes my favourite things	1
Learning more yourself	1
People I trust	1
Socializing	1
Staying busy	1
Wanting to excel	1
Working alone	1
Working hard	1
Working with children, people	4