

Girls, STEM, and Children's Books:

A Review of the Literature Concerning Girls' Interest, Motivation and Ability in STEM, Complemented
by a Mixed Methods Content Analysis of Award Winning Informational Children's Books

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INTRODUCTION AND THESIS GOALS

So what makes a good story? You know, the kind of story that grabs your attention, convinces you that the impossible is within your reach if you simply but try – the kind of story that gives you hope and heart, and makes you want to reach for the stars, but most of all the kind of story that removes the limitations that others have built around you.

This is an attempt to find out.

The goal is simple, to find what makes an engaging science story for girls, fictional or not, and not necessarily the best learning book about a science subject, but rather, a book that undoes much of the damage that stereotypes and other social messages can do; the kind of messages that kill a girl's interest in physics and engineering and make her doubt her own abilities or accomplishments.

Therefore, the goal is simple, but the way to that goal is complex.

WHY IS THIS IMPORTANT?

Congressional hearings have declared that the United States' future is dependent upon technology education, including increasing the number of women involved science and technology (Encouraging the participation of female students in the STEM fields, 2009) and that science, technology, engineering and math (STEM) fields are vital to the future of the United States (*Report to the president: Prepare and inspire: K-12 education in science, technology, engineering, and math (STEM) for America's future*, 2010).

Yet despite this recognition of the problem and push for more women in STEM, including governmental programs to increase girls' and women's interest in STEM (*New formulas for America's workforce: Girls in science and engineering*, 2003; *Encouraging girls in math and science: IES practice guide*, 2007; *Report to the president: Prepare and inspire: K-12 education in science, technology, engineering, and math (STEM) for America's future*, 2010), or even various educational efforts and

research into the problem and its solution, there is still a serious lack of women in STEM, most particularly in physics, engineering and computer science (1 in 5 scientists are women, about 25% overall in engineering/science) (*Encouraging girls in math and science: IES practice guide, 2007*; Encouraging the participation of female students in the STEM fields, 2009).

The lack of women in the science pipeline (Hanson, 1996), a way of describing the talent pool from which future scientists will be drawn, has been called a *leaky pipeline* (Blickenstaff, 2005) in which girls lose interest by middle school or late high school, or women in college decide against technology careers, even if such a career was originally their goal when they started college, or finally, if they do pursue such careers, leave these jobs after college (Encouraging the participation of female students in the STEM fields, 2009).

This thesis will examine current research on this leaky pipeline and investigate one type of solution – a type of intervention that uses the ubiquitous children's picture book – to help sustain girls' interest through the first critical hurdle for girls in STEM, namely the K-5 years leading up to the middle school dropout point.

Since this thesis will be attempting to take an interdisciplinary approach to not only understanding this overall problem, which I believe to be a systemic problem, but also in understanding one specific type of intervention to this problem, this thesis has admittedly ambitious goals as a result.

The first goal is an expansive literature review, covering research from several fields. This includes research on the STEM problem itself, and the role of stereotypes in socialization, as well as various media effects research including television, interactive media and children's storybooks. It will also look at the current understanding in quality science books for children, and even extend into the use of persuasion and the role of the monomyth in building an effective and engaging story.

The second goal cannot be achieved by this thesis alone, but that said, I believe it is still important to note it. The second goal is to eventually draw from this research a set of tailored guidelines

for creating engaging, effective, K-5 science storytelling focused on increasing girls' interest and motivation in STEM fields, as well as giving them strong narratives to use when confronted with damaging stereotypical attitudes. Such narratives would be specifically designed to be easily memorable and to help keep girls' STEM interest and motivation strong, and their self-esteem and self-confidence high.

These narratives would also encourage girls (and all readers) to see any role, not just science and engineering roles, as inherently gender neutral. The goal here is not to fall back on the idea that simply having female role models will solve the problem but rather to encourage girls to see all roles through a gender neutral lens, one that states, when girls do see a male in a role, they will not automatically (and erroneously) assume that only males are allowed, but instead, will simply assume that, in this particular instance, a male *happened* to be in the role.

This second goal also includes a sub-goal of making parents and teachers aware of their own strong effects (both positive and negative) upon girls' STEM interests and motivation. This secondary message is to be accomplished through the same science storytelling narratives. However, these guidelines are an eventual goal and possibly one that can only be achieved by group effort, and also likely require further content analysis and results synthesis (popular book qualities synthesized to good science book qualities and counter-stereotyping messages). A worthwhile goal, I believe, but sadly, beyond the scope of this thesis.

The third goal is part of this thesis and helps aid in the success of the eventual second goal. Namely, it is to add, in a very small, limited way, to the current content analysis research efforts examining gender bias (lack of gender balance) in children's books, specifically those books to which school children have greater likelihood of being exposed. These books include award winning Orbis Pictus and Sibert informational books – which actually have as a requirement that the book winners should not be biased (gender, ethnicity, socioeconomic).

However, it is noted that this content analysis will be very limited in scope compared with much of the existing research. It will be single coder (myself) and look at very basic, yet easily reproducible items, such as gendered titles (coming from a European-American education and culture, with its associated potential biases) and ratios of males to females in pictures. In addition to this basic review, the analysis will use the information previously learned from the literature review to try to interpret potential meanings and effects of the images when viewed by a child.

To sum up, goals one and three are steps along the way in achieving goal two, but even so, goal one, in particular, is an attempt to nail down specific attributes that can be quantified rather than just saying more qualitative, interpretative phrases like "engaging narrative" or "eye-catching" or "quality science." The ability to quantify engagement, interest, and/or motivation – primarily gleaned from the literature review – will hopefully lead to further research and content analyses of other science corpora, and this research will help refine a set of specific guidelines and suggestions for girls' STEM science books, whether informational or storybook in type, or static book or interactive eBook in delivery, so that authors can more consistently and effectively create a narrative that is both engaging and scientifically relevant, with all the qualities deemed important for a quality science book yet still with a strong, engaging narrative expressly aimed at increasing girls' interest and perseverance in STEM – not to mention their own sense of self-efficacy. However, as already said, the guidelines are a long-term goal. This is merely a first step.

Finally, an unlisted goal would be, of course, to generally encourage further research and experimentation into effective, science-oriented storytelling narratives for girls as well as improvements in increasing gender balance and decreasing all kinds of stereotypes in children's books and other media.

LITERATURE REVIEW

LITERATURE REVIEW PART I: THE ISSUE OF KEEPING GIRLS IN STEM

The current understanding of this leaky science pipeline – in which girls and women drop out of either the pursuit of STEM careers or actual STEM careers once they get there – is manifold in nature. There are multiple, interacting, potential reasons. These include related factors such as lack of role models, cultural conditioning through media, stereotypes, and teacher bias (including unconscious or conscious attitudes and beliefs that declare girls as less able than boys and therefore, leading to differences in teaching or encouragement). Yet the reasons also include effects from such factors. These other factors include lack of confidence, lack of support at home, in the classroom, or from other authority figures, and lack of peer group support. Additionally, research has observed ineffective teaching methodologies that may again favor boys over girls, as well as lack of resources available to tackle the STEM issue, and finally, the perception that science isn't fun. (*New formulas for America's workforce: Girls in science and engineering, 2003; Encouraging girls in math and science: IES practice guide, 2007; Encouraging the participation of female students in the STEM fields, 2009; Blickenstaff, 2005; Chipman, 2005; Hall, 2007; Hanson, 1996; Heilman & Haynes, 2005; Heilman & Okimoto, 2007; Matson, DeLoach, & Pauly, 2004; Murphy & Whitelegg, 2006; Sadker, Sadker & Zittleman, 2009*).

Research also notes that barriers to entry into STEM fields by women and other underrepresented groups, factors that contribute to decreasing interest, often begin at an early age (Encouraging the participation of female students in the STEM fields, 2009; Sadker, Sadker & Zittleman, 2009).

This review looks at the problem, its possible causes, and suggested solutions, with specific emphasis on the use of one intervention, namely children's picture books. However, an in-depth look into the problem and what are perceived by researchers to be contributing factors to this problem is first necessary. From this exploration, an understanding of how interventions may be helpful can be more

easily determined, as well as explain why children's books may be a key way to help counteract the many forces at work deterring girls from STEM careers.

In particular, the idea of interest and motivation will be examined, looking at how gendered role models and other stereotypical attitudes diminish interest and motivation, with the result being that a chain reaction of diminishing interest and ability occurs. In other words, as interest and motivation decrease, girls spend less time engaged with math and science. They take fewer classes in math and science, read about these areas less, and become less involved in general. This, in turn, leads them to have less ability and competency beliefs than boys, resulting in girls having less interest and motivation in regard to math and science – and so on. Breaking this cycle, I believe, is critical to increasing girls' interest in and pursuit of STEM fields.

So the key issue is the following: why do they lose interest and motivation?

To understand this issue better, we will first look at the most basic question. Are girls, in general if not in all cases, just less *intrinsically* apt at math and science when compared to boys?

NATURE VERSUS NURTURE – DOES GENDER PLAY A ROLE?

"Putative sex differences in cognitive abilities continue to be advanced as the preferred explanation for sex differences in career participation, even though large sex differences in other variables would seem to be more plausible," notes Susan Chipman (2005, p. 18). She goes on to say that despite the continuing and growing pile of research to the contrary, that "people *do not want to believe* that girls and women can be good at mathematics" (p. 18) and that this includes researchers who, intentionally or not, have tended to distort their results in the direction of their stereotyped expectations. The result, notes Chipman, looking at the extensive work of Fennema (as cited in Chipman, 2005) studying this researcher-bias, is that even small, mean differences between the sexes have been generalized into highly dichotomized stereotypes, and any significant differences favoring females have been typically reported in less positive ways than if the differences had been found to favor males.

In fact, the issue that boys may be more inclined toward math and science, or more able, has been previously debunked by other researchers and instead research has shown that girls and boys have equal interest and achievement scores in grade school (*Encouraging girls in math and science: IES practice guide, 2007*; Encouraging the participation of female students in the STEM fields, 2009; Shakeshaft, 1995). Additionally, many measures of math achievement actually favor females over males (as cited in Chipman, 2005) and what is thought of as a sex difference in mathematics is very likely just a difference in the amount of math learning over time (as cited in Chipman, 2005).

Mathematics assessment is often measured and used as a benchmark for future science achievement, since it is a key component to success in any science career.

In addition, Elizabeth Spelke, a professor of psychology at Harvard, in 2005, analyzed one of the most cited experiments from 2000 that claimed to show that males had intrinsic abilities needed for later mathematics and mechanics – abilities which females did not have – as well as other claims about gender differences as the reason why men were more likely to be in science and math (Spelke, 2005). This experiment used infants and as such avoided socialization issues. She found the Connellan et al. experiment (as cited by Spelke, 2005) riddled with problems, including a lack of repeatability to the results, lack of exploration for other factors, and a strong potential for experimenter bias. Any one of these types of errors might potentially invalidate the experiment.

Spelke (2005) also countered this one experiment with an overwhelming amount of research over thirty years showing "no evidence for a male advantage in perceiving, learning, or reasoning about objects, their motions, and their mechanical interactions" (p. 952) and declared that this is the first of many unfounded myths about sex differences. She even found evidence that often the opposite is true when studying infants, because female infants develop more rapidly than male infants. That difference in natural progression in infant development, itself, makes any such studies less reliable (as cited by Spelke, 2005).

Second, Spelke (2005) did a meta-analysis of other recent work claiming biological math achievement superiority of males over females, namely cognitive differences between the sexes, and found that most experiments revealed little to no significant differences or mixed results in cognitive abilities related to mathematics and scientific reasoning (as cited by Spelke, 2005). Adding to the complexity of cognitive development assessment, she noted that research conducted over the years by others has indicated that since differences emerged after infancy, "it is difficult to tease apart the biological and social factors that produce them" (Spelke, 2005, p. 953).

Spelke (2005) continued her analysis to other areas of test assessment, calling into question whether tests such as the SAT-M (the quantitative portion of the Scholastic Assessment, formerly Aptitude, Test) have been altered over the years to give males an mathematical score advantage (such as removing an entire section that girls consistently scored better on than boys.) Scores on the SAT, she showed, were used as evidence in claims that males were better at mathematics and the claim that there were more males with "extreme mathematical talent" (p. 955). Such criticisms of the SAT and other assessment tests are echoed by other researchers (as cited by Hall, 2007; Sadker, Sadker, & Zittleman, 2009). However, Spelke noted extensive research that showed males and females, both domestically and internationally, had equal proficiency in math classes, both at the average level, and the advanced level with mathematically talented students (as cited by Spelke, 2005). Spelke (2005) concludes her expansive analysis convinced that biological differences play little to no role in general achievement of men and women.

So if there is little natural difference in aptitude, what happens? Is it lack of interest? The key dropout points in the pipeline seem to lend credence that something other than genetics is at fault, but perhaps girls' level of interest is the basic issue.

After all, why would girls and women drop out at specific points along this pipeline? It implies that girls and women did have an interest at some point, and their successful grades proved it. Or did they simply get good grades because they had the ability and then dropped out once they didn't have to

perform in those subjects anymore? If so, why drop out at specific points? Why do some girls stay in the pipeline longer? The key dropout periods happen "at the beginning of middle school, towards the end of high school, throughout college and graduate school, and in their [women's] professional lives"(Encouraging the participation of female students in the STEM fields, 2009, p8).

Interestingly, Spelke (2005) even notes that historical records have shown that preferences for one field, such as physics, over another field, such as accounting, have varied extensively over time – showing no direct correlation with intrinsic mathematical ability for either gender. Aptitude at math does not directly lead, for men or women, to a career in science or engineering. According to Spelke, "We must look beyond cognitive ability to other aspects of human biology and society for insights into this phenomenon." (p. 956).

James P. Byrnes, a professor researching cognitive processes, would agree, adding that a more comprehensive and rigorous model of achievement, aptitude and motivation is needed, because, says Byrnes, with that better understanding, gender-based differences would also emerge, helping with the creation of "highly effective forms of intervention" (Byrnes, 2005, p. 73).

BYRNES' THREE CONDITIONS MODEL OF ACHIEVEMENT (3C)

Byrnes (2005), in his extensive survey of the gender research, would counter Spelke's (2005) SAT-M claim, though not her assessment that genetic differences between males and females are not the determining factor in mathematical ability. Byrnes also found the genetic claims lacking but additionally found problems with claims of gender bias as the predominate reason why there is a gender gap in STEM, though here, he acknowledges that there is a large amount of research supporting the idea that societal beliefs and values, especially stereotypes, affect the interests and beliefs of children – leading girls to feel that they are not good at math, or welcome there, while encouraging boys to believe the opposite (as cited by Byrnes, 2005).

Like Spelke (2005) and other researchers (as cited by Byrnes, 2005; as cited by Hall, 2007; as cited by Sadker, Sadker, & Zittleman, 2009), he noted that girls routinely get better grades than boys in math and science, but do worse on assessment tests. However, this leads Byrnes to question why girls would put such effort into learning math and science, if social gender bias and stereotyping pressures really are the most important factors working against girls. Yet he also noted research showing "that girls think math is more difficult than boys and value it less" (p. 82) which seems to show that societal beliefs do have some effect, but he still wonders why girls would try so hard to get good grades if that were the case?

Byrnes (2005) calls his model the Three Conditions Model of Achievement, where the path to high achievement requires that 1) children are given consistent opportunities to enhance their skills, 2) they have the motivation to take these opportunities and 3) they have the aptitude (ability) to take advantage of these opportunities. Gender is not an issue, and the theory focuses instead on the idea that individual aptitudes can vary from child to child. The heart of the issue is concerned with whether students are encouraged to learn and with their increasing progress (and therefore increasing aptitude) over time (as cited by Halpern, Wai & Saw, 2005). This is a key difference between Byrnes model and models that focus on either gender or social conditions, or even models that assume an integrative psychobiosocial approach.

Like Byrnes (2005), Halpern, Wai and Saw's psychobiosocial model (Halpern, Wai & Saw, 2005) is a more integrative model and one that attempts to show a relationship between potentially different cognitive abilities between males and females (over time) and their environments, which influence their attitudes, beliefs and choices. It is a relationship where biological/cognitive states influence social conditions and psychological states, which influence biological/cognitive and psychological states, which influence biological/cognitive states and social conditions (and round and round). It is an ambitious integrative attempt, but as Byrnes does point out, has serious problems when international comparisons are made – gender (cognitive/biological) issues are not consistent across cultures and are not strongly

correlated with math and science assessment scores (as cited by Byrnes, 2005), making Halpern and her colleagues' ideas about actual biological differences – affecting performance, methods of problem solving, and choices (to some degree) – problematic.

For example, Byrnes cited research showing that precocious 13 year old boys did better on the SAT than precocious 13 year old girls, despite no explicit gender bias beliefs reported by the children or their parents (as cited by Byrnes, 2005). This might lead one to believe that there is a genetic difference. However, Byrnes cited countering research (as cited by Byrnes, 2005) suggesting that self-selection and implicit beliefs, which were not measured, might be more influential than explicit beliefs. Implicit beliefs are beliefs which can operate on an unconscious level so that a person might act according to sex type stereotypes despite conscious denials that such stereotypes have no effect on them (Halpern, Wai & Saw, 2005).

Therefore, to understand how cultural/societal beliefs might be involved, Byrnes (2005) also looked internationally during his research. That research revealed that in at least some Asian countries, namely Japan and China, which are often known for a heavy gender bias against women, Japanese and Chinese students of both sexes performed higher than American students. In fact, he cited a study that found, on the SAT-M, that Japanese and Chinese students did not show the gender gap so apparent in American students (as cited by Byrnes, 2005). Byrnes felt that the performance of these students shows that not only is there no genetic-mathematical difference between the sexes, but that despite strong cultural/social gender biases, the performances of the students were still unaffected.

However, Byrnes (2005) did note that one study across 19 countries did show a strong correlation between societal gender bias and 8th grade mathematics scores (as cited by Byrnes, 2005). So what made Japan and China different? Byrnes suggests that motivation and opportunity to gain aptitude in STEM areas may be the key. Motivation and opportunity would also go further, according to Byrne, in explaining the effects of cultural/social factors, such as stereotypes and beliefs, since such influences would not only include messages that teach girls that math is difficult, but may also lead society and

teachers to expect less from girls, encourage them less, and work with them less, thus reducing their opportunities to learn math earlier and more continuously, which also leads to less motivation and less aptitude over time.

MOTIVATION AND ACHIEVEMENT – AFFECTING FACTORS (STEREOTYPES, EXPECTATIONS, TEACHING)

If we assume Byrnes' (2005) 3C theory as a base, then neither genetics nor intrinsic ability are the primary reasons why students, including girls, either succeed or fail, nor is the girls' STEM issue simply a cultural matter – a matter of gender bias. If Byrnes is correct, then even though there may be some intrinsic advantages to some children, both girls and boys, as they grow and develop, the greater factors have to do with continuous encouragement leading to internally developed motivation and consistent opportunity. These factors include the effects of cultural/social issues, such as gender bias but also cultural values regarding education and individual effort. However, what other evidence is there, beyond a basic aptitude/ability to learn, that motivation and opportunity are the real keys to achievement over time, and how might social/cultural values including sex role stereotypes play into that?

STEREOTYPES – SCIENCE IS THE DOMAIN OF MEN

Some people, as David Sadker and his colleagues (2009) like to point out, assume the gender bias/imbalance problem has already been solved (as cited by Sadker, Sadker & Zittleman, 2009). Far from it, Sadker's group responds, and they are quick to add that stereotypes and gender bias hurt not just the girls but the boys as well; creating a hostile and demeaning atmosphere that hurts anyone who doesn't conform, especially girls and minorities of both sexes.

Research over the last thirty years has consistency shown that while girls get better grades in math and science compared with boys, they still score lower on assessment tests (as cited by Chipman, 2005; as cited by Byrnes, 2005; Jacobs, Davis-Kean, Bleeker, Eccles and Malanchuk, 2005, as cited by Hall, 2007; Ma & Xu, 2004; Sadker, Sadker & Zittleman, 2009) as well as report lower levels of self-confidence in their math and science abilities (as cited by Chipman, 2005; as cited by Byrnes, 2005; Jacobs, Davis-

Kean, Bleeker, Eccles and Malanchuk, 2005, as cited by Hall, 2007; Ma & Xu, 2004; Pomerantz, Rydell Altermatt, & Saxon, 2002; Sadker, Sadker & Zittleman, 2009). The Draw-A-Scientist-Test (DAST), a benchmark test used to measure perceptions about gender roles in science since the 1980s, still shows girls and boys viewing scientists, and therefore science, as a primarily male domain (as cited by Hall, 2007; as cited by Sadker, Sadker & Zittleman, 2009) and the older the students, the more stereotypical the results (as cited by Sadker, Sadker & Zittleman, 2009).

In fact, according to the data, girls and women still don't believe that they are welcome in science (Hall, 2007; Hanson, 1996; Sadker, Sadker & Zittleman, 2009) and they may be right. For despite improving conditions, data shows that they still earn less than men (Hall, 2007; Hanson, 1996; Sadker, Sadker & Zittleman, 2009), from an average of 1/3 less to even greater disparities for African or Latino-American women, even when the degrees come from the same selective universities (Sadker, Sadker & Zittleman, 2009). Additionally, they are perceived as less competent or penalized for being female (Hall, 2007; Hanson, 1996; Heilman & Haynes, 2005; Heilman & Okimoto, 2007; Sadker, Sadker & Zittleman, 2009) and even today most careers are still typically gender segregated (Sadker, Sadker & Zittleman, 2009) with women still highly underrepresented in science and engineering (*Encouraging girls in math and science: IES practice guide, 2007*; Encouraging the participation of female students in the STEM fields, 2009; Hall, 2007; Hanson, 1996; Sadker, Sadker & Zittleman, 2009). Furthermore, 62% of college women experience sexual harassment on campus, including harassment from professors (as cited by Hall, 2007). Also, they experience both overt and covert gender discrimination as well as academic and professional undermining from college peers, professors and later, from co-workers and managers (as cited by Hall, 2007; Hanson, 1996; Heilman & Haynes, 2005; Heilman & Okimoto, 2007). As well, child-care responsibilities still fall mainly on women's shoulders (Sadker, Sadker & Zittleman, 2009) leading to them having greater limitations based on child-care issues (as cited by Hall, 2007; Hanson, 1996), and women are still vastly underrepresented in political offices compared to other countries, putting them behind countries such as Sweden but also behind countries such as Rwanda and Zimbabwe (Sadker, Sadker & Zittleman, 2009).

Hall (2007), a chemistry baccalaureate turned science writer, not only experienced the pipeline in the sciences first-hand, but in her book, she compiled extensive research and first-hand accounts of the struggles and obstacles women face in the male-dominated world of science, from their earliest school days through college and into their experiences in the professional world. Hall documents the many ways this bias surfaces, including, among other things, being excluded by males in both clubs and in the lab, told by male advisors, teachers, peers and superiors that they are useless and just decorative, or told by peers and managers that they are only there because of affirmative action, as well as the following: assigned demeaning tasks such as secretary; paid less; promoted less; silenced in meetings; their ideas stolen and credit given to others; and often dismissed as less qualified even when their work is equivalent to or superior to their male counterparts (as cited by Hall, 2007).

In Hall's (2007) book, the first-person accounts are shocking but not without merit, as she observes that the findings of researchers confirm that overt and covert gender discrimination occurs on a far too regular, and accepted, basis. Hall notes an "often cited" (p. 87) 1997 Swedish study by Wenneras and Wold on the evaluation of postdoctoral fellowship applicants (as cited by Hall, 2007). Compared to the male applicants, the female applicants were rated lower in all three of the evaluation areas, despite equivalent quality and quantity. What they did find, reports Hall, was "the average female applicant had to be two and a half times as productive as the average male applicant to receive the same competence score" (p. 87).

Likewise, Heilman and Haynes (2005) found that unless the specific achievements of a female member of a female-male team were made salient, then participants tended to diminish or ignore the accomplishments of the female team member and instead attribute any successes to the male member.

Additionally, Hall (2007) calls out an interesting simulation by applied psychologist Richard Martell in 1996. The simulation showed that if men in an organization received even a slightly higher performance review (1%) than their female counterparts, then they quickly dominated the organization, and women, at best, could only achieve little more than one-third of the top spots (as cited by Hall, 2007).

It clearly demonstrated that even a slightly gender biased advantage, overt or covert, intended or unintended, could lead to large effects and a greater gender gap, over time.

Hall's (2007) book creates a strong argument, based on both research and anecdotal evidence, that gender bias is still a strong and debilitating factor in the sciences. An argument strongly echoed by other research (*Encouraging girls in math and science: IES practice guide, 2007*; Encouraging the participation of female students in the STEM fields, 2009; Hanson, 1996; Heilman & Haynes, 2005; Heilman & Okimoto, 2007; Sadker, Sadker & Zittleman, 2009).

STEREOTYPES AND THE CLASSROOM (TEACHER VALUES, BIAS AND EXPECTATIONS)

Likewise, longitudinal work by Sadker and Sadker has chronicled how little progress has been made in reducing gender bias in the classroom (Sadker, Sadker & Zittleman, 2009). The Sadker's book offers a unique perspective. Not only did the Sadkers, in 1994, take an expansive look at thirty years of progress or lack of it in regard to gender and diversity bias in our educational (and social) system, but their update of that same book fifteen years later, saw David Sadker and Karen Zittleman take a second look at all the areas previously investigated. In essence, their work reflects not only two very deep, very expansive longitudinal meta-analysis but also several longitudinal experiments looking specifically at many gender and diversity issues within the school system, and as a result our society as a whole. Even just summarizing all their findings within a literature review is impossible, but specific issues dealing with stereotypes and gender bias merit some discussion.

Sadker et al. (2009) found that teachers called on boys more than girls, gave more attention to boys, praised and acknowledged boys more, helped boys more, gave more specific praise to boys than girls, gave high or low achieving girls the same superficial, generic acknowledgement rather than praise for their work, praised white boys more than non-white boys but still paid more attention to non-white boys more than girls of any ethnicity, reprimanded girls for calling out answers but didn't reprimand boys for such behavior, reprimanded non-white boys and thought of them as troublemakers but did not think the same or act the same with white boys, recognized smart boys and prized them as students but did not

do the same for the smartest girls in the class, and often "more than half" (p. 80) gender-segregated their classrooms as well as giving boys more physical room and more teacher (versus assistant) time, contributing to female invisibility.

Along these same lines, is an interesting small case study of four middle school African-American girls, all strongly interested in science, done by Brickhouse, Lowery and Schultz (2000) when they were investigating the links between self-identity and science. They found that two of the girls, the ones that acted counter to the gender-role expectations of their teachers, were penalized and their performance and abilities downgraded. This is strikingly similar to the stereotyping behaviors between teachers and students that Sadker et al. observed (Sadker, Sadker & Zittleman book 2009), where some students, typically white boys, were preferred and encouraged while others were not, or even seen as troublemakers for similar behaviors.

Additionally, Sadker, Sadker and Zittleman (2009) also found that boys were allowed to take over the playground, the lunchroom, the sports activities and facilities, and the classroom, including using bullying behavior to exclude the girls – while the teachers and coaches either did nothing or encouraged the behavior. Girls were second-citizens but in early elementary school were typically too young to "truly understand and challenge their assignment as the lower-caste gender" (p. 79), yet one fifth of boys and girls were keenly aware of it as a disadvantage by "upper elementary and middle school" (p. 79) and aware that teachers and coaches didn't expect much from the girls.

When the Sadkers and colleagues (Sadker, Sadker & Zittleman, 2009) video-taped teacher-class interactions and pointed out these behaviors to the teachers, they noted that the teachers were shocked and dismayed at their behavior and its impact. The teachers were unaware of their actions in the classroom, if not the playground, especially as many thought they were being gender-fair.

Furthermore, Sadker, Sadker and Zittleman (2009) found other trends with teacher-student interactions, including giving girls less time to answer questions than they did for boys. Teachers also

gave highly gendered responses in other ways such as giving girls passive-oriented feedback on their appearance and how pretty they looked, while giving more action-oriented and educational feedback in similar situations with boys. The Sadkers related several incidents they observed including a teacher telling a little girl that her new dress was pretty and so was she, while telling a little boy, showing off his shiny, new belt buckle, that cowboys wore such belts and were "rough and tough and they rode horses. Did you know that?" (p. 75). They noted that for girls, the teachers spent much of their time talking about the girl being pretty, while they did the opposite with boys, typically telling boys about what they could do with it. They also found that girls were twice as likely to be praised for rules of form (such as straight margins or nice handwriting). Girls were being taught that appearance matters, the Sadkers said, and seem to have confirmed when they surveyed 400 middle school students. For the girls, they learned, the most important part of being female, the best part, was their appearance.

The work of the Sadkers (Sadker, Sadker & Zittleman, 2009) is expansive, looking at the issues in elementary school through to higher education, and the gender effects they found were pervasive and damaging, especially to the girls, but again, not limited to them but affecting all the children in various ways. The Sadkers emphasize that the issues are not simply about teaching but about society. It is U.S. society, they said, that is creating an environment where girls are being taught that they are second-class citizens who need to be pretty and not smart, and it is society that is teaching U.S. children that boys matter more than girls, to the detriment of both.

STEREOTYPES AND THE HOME (PARENTAL VALUES, BIAS AND EXPECTATIONS)

Jacobs, Davis-Kean, Bleeker, Eccles and Malanchuk (2005) in reviewing their own vast body of research into the effects of the parent-child relationship (using the Eccles' parent socialization model) indicated that they have continually found strong links between parental beliefs and its impact on children's achievement choices. In other words, rather than looking simply at parenting practices, they look specifically at how parents motivate their children's actions and values, such as why a child might choose math or science – or why a child might not, even if he or she feels competent in those domains.

Eccles and her colleagues examined and tested ideas of modern expectancy-value theories, that a child's values regarding particular goals (tasks) helps explain that child's preferences of study topic, in other words "the social-psychological influence on choice and persistence" (as cited by Jacobs, Davis-Kean, Bleeker, Eccles and Malanchuk, 2005, p. 247). According to their model, a child will make choices depending on perceived probability of success of each option and its relative value. These choices are assumed to be influenced by task-specific beliefs (self-perception of competency, short-term and long-term goals, and the task demands), which are in turn influenced by social and parental expectations and beliefs, as well as the child's own perceptions of previous experiences (Jacobs, Davis-Kean, Bleeker, Eccles and Malanchuk, 2005).

Eccles' and company found support for these task-based models, including within the field of mathematics, as well as evidence that parental expectations, attitudes, interpretations, and values, as well as a child's self-perception play a part, and that gender role stereotypes also play a part (even beyond the child's actual task-based ability) (as cited by Jacobs, Davis-Kean, Bleeker, Eccles and Malanchuk, 2005). It is also important to note that while the Eccles' model is fundamentally a causal one, it also acknowledges that there is a reciprocal relationship between parents and children. Parents' attitudes and beliefs can change over time as well, leading to different behaviors (such as new attitudes or expectations, or new opportunities) and parental attitudes can be influenced by their children's (Jacobs, Davis-Kean, Bleeker, Eccles and Malanchuk, 2005).

Children's internalized beliefs, therefore, are not simply a reflection of their parents' beliefs and values say Eccles' et al. (as cited by Jacobs, Davis-Kean, Bleeker, Eccles and Malanchuk, 2005), but they do emphasize that the role of those parental attitudes, beliefs and values – both explicit and implicit, intended or unintended – is critical to how children see themselves, their world and their choices in that world. These effects include gender roles and stereotypes. In fact, data from one of their longitudinal studies indicates that "participation in activities during elementary school is highly gender typed" (Jacobs, Davis-Kean, Bleeker, Eccles and Malanchuk, 2005, p. 253) and that it is not surprising that "this behavioral

instantiation of their social identities is related to children's intrinsic values" (p. 253). They also note that values regarding math ability and perception of math competence are also highly gendered, especially "at the youngest ages" (p. 254). Additionally, they find that counter to earlier research and theories, they and other researchers (as cited by Jacobs, Davis-Kean, Bleeker, Eccles and Malanchuk, 2005) have found, through short and long-term longitudinal studies, that the gender gap in math self-competency decreases with age and is gone by the end of high school. So by the end of high school, the question is no longer about actual competency (ability) in math but rather about interest and motivation to continue.

What Eccles' et al. (as cited by Jacobs, Davis-Kean, Bleeker, Eccles and Malanchuk, 2005) find instead, to explain the lack of girls' *interest* in STEM careers, is a gendered home environment, where parents "provide more math-supportive environments for their sons than for their daughters by purchasing more math/science toys for sons, spending more time on math/science with sons, and holding higher perceptions of their sons' than daughters' math abilities as well as gender-typed worldviews about natural talent in math." (p. 259). These studies as well as others (Ford, Brickhouse, Lottero-Perdue & Kittleson, 2005; Barrett Singer & Weinstein, 2000; Tenenbaum & Leaper, 2003) emphasize the importance of the middle childhood years for later math/science achievement scores and that parental attitudes and values regarding their daughters' competence in those areas directly impacts their later choices, even if their daughters are high math/science achievers (Jacobs, Davis-Kean, Bleeker, Eccles and Malanchuk, 2005).

STEREOTYPES AND ETHNICITY, STEREOTYPE THREAT, AND ACHIEVEMENT

Walters and Brown (2005) also looked at how ethnicity, not just gender, affects achievement and a young woman's self-belief about competency – though they did not explicitly look at parent expectations and beliefs. They also found though that ethnicity and identification with that ethnic as well as gendered identity did play a role, with the advantage going to Asian-American women and the greatest disadvantage to Latino-American women. African-American women, they noted, seemed unaffected, perhaps, say Walters and Brown, because they already had developed mechanisms that helped them

combat negative stereotypes and attitudes toward their ethnicity. These mechanisms help them foster greater self-reliance, allowing them to work more independently, and without peer group support.

Sadker et al. (Sadker, Sadker & Zittleman, 2009) noticed this effect as well. Latino girls, they noted, suffered the greatest self-esteem loss in the middle and high school years (a 38 point drop between elementary school and high school), when compared with other ethnicities, but African-American girls did not. In fact, with African-American females, their self-esteem improved by 50 percent, though it was not as high a confidence boost as African-American males experienced. To explain this, the Sadkers cite survey research by Hesse-Biber and colleagues, which showed a strong connection between self-esteem and both family support and racial identity, which seemed to mitigate the effects of gender and any academic issues – in other words, African-American girls saw their racial identity as more important than their gender (as cited by Sadker, Sadker & Zittleman, 2009).

Therefore, social/psychological factors affecting motivation and achievement should not be underestimated. In fact, many researchers have noted the effects that can occur simply by activating a stereotype. Halpern, Wai and Saw (2005) as well as Walters and Brown (2005) referenced an experiment pitting the positive stereotype of Asians being good at math against the negative gender stereotype of women not being good at math. When participants evaluating a female Asian-American college applicant were reminded that the student was Asian, they recalled a higher SAT-M score for her. When the gender stereotype was activated – they were reminded that she was female – a significantly lower SAT-M score was recalled (as cited by Walters & Brown, 2005; as cited by Halpern, Wai & Saw, 2005).

Moreover, Walters and Brown (2005) found in their extensive exploration of the summary and empirical research related to ethnicity and gender, that both types of stereotypes play a role in the math performance gap between the genders. Not only that, but ethnicity stereotypes can either magnify or diminish the effects, depending upon whether they counter or encourage the negative stereotype. They also note that even a positive stereotype can lead to performance declines as students are reminded of

others' higher expectations, which can, in turn, lead to them choking under the pressure (as cited by Walters & Brown, 2005).

Thus, find Walters and Brown (2005) stereotypes affect both self-confidence and interest, leading to low confidence and/or low interest female students to avoid math activities and stop taking math classes. This "stereotype threat", when activated, creates an environment where the performance of women not only materially declines in some cases (Walters & Brown, 2005), but also may contribute to a stereotyped environment where women's performance is also erroneously perceived as inferior to that of men (Heilman & Haynes, 2005).

Math anxiety (or test anxiety in general) is basically a state where the student performs lower because of their fears. If this math anxiety is being activated, at least in part, by stereotype reminders (including internalized beliefs about oneself), then what can be done to counter act it?

McGlone and Aronson (2007) performed an experiment where college-student participants were divided into three groups. The females in one group were warned about "stereotype threat" and given specific counter-stereotype narratives (positive coping messages) that they were instructed to recall before taking a quantitative sub-section of the Graduate Record Examination's practice general test. In another group, the females were also warned about the concept of stereotype threat, but were asked to try to suppress any negative stereotypes. They were not given any counter-stereotype coping messages. The control group was not given any counter-stereotype narratives or warned about stereotype threat. The results showed that the use of positive counter narratives such as a positive stereotype association did have an impact. Female students in the positive counter message group showed test scores that closed the gender gap when compared with the control group, while female student test scores in the group that was asked to simply suppress negative stereotypes actually widened the gap when compared with the control group. Therefore, at least in the short-term, positive reinforcements can have a positive effort on test results, just as knowledge of the stereotype threat phenomena can affect performance negatively.

But what about longer term results? Can such ideas be used to increase interest in STEM fields and help create long-term motivation?

Short-term reinforcements may help simply because they also help girls' self-confidence. Low self-confidence in math and science, even when the student gets good grades, has been found to be one factor in decreasing interest over time (as cited by Chipman, 2005; as cited by Byrnes, 2005; Jacobs, Davis-Kean, Bleeker, Eccles and Malanchuk, 2005, as cited by Hall, 2007; Ma & Xu, 2004; Pomerantz, Rydell Altermatt, & Saxon, 2002; Sadker, Sadker & Zittleman, 2009; Walters & Brown, 2005). A longitudinal study by Brainard and Carlin (1998) at the University of Washington looked at women in their engineering pipeline and at the effectiveness of the Women in Engineering (WIE) Initiative's retention interventions during the freshman and sophomore years.

Despite these interventions, which did give the University of Washington's engineering program better retention rates than found nationally, Brainard and Carlin (1998) still found "consistent patterns of persistence factors and barriers for these high-achieving women; most notably a significant drop in academic self-confidence during their freshman year in college." (p. 369). The persistence factors (over all four years) for staying in engineering included the following: previous enjoyment of high school math and science classes; continued enjoyment of those classes in college; the ability to work well independently; a positive relationship with an advisor (or mentor), as well as lesser influences such as support from their mothers, quality instruction, involvement in the society of women in engineering campus group (SWE) and participation in conferences, events and internships.

Brainard and Carlin (1998) also reported that it wasn't surprising to the researchers that the barriers the women encountered, that convinced them to leave the program, included "losing interest in science/engineering, being attracted by another field, or being discouraged by academic difficulties and a perception of low grades" (p. 374).

Yet, Brainard and Carlin (1998) pointed out that the barriers perceived by those who didn't leave but stayed were very similar, including "a fear of losing interest, intimidation, lack of self-confidence, poor advising, and not being accepted into their department" (p. 374). Lack of self-confidence, they believed, was not tied to GPA, since the GPAs of the women who left compared to those who stayed "show no difference in actual performance, measured by GPA" (p. 374). As a result, they found that self-confidence was a critical aspect and it was not a lack of ability that was causing the attrition rate. Brainard and Carlin finished by recommending added policy changes that would allow women to enter the engineering program in the sophomore year (instead of the junior year) to help keep women in the engineering pipeline.

So as Brainard and Carlin (1998) showed, even high-performing women, those who enjoyed their math and science classes, still felt barriers to entry or of being welcome in engineering departments and STEM fields, and even their self-confidence was affected. However, Brainard and Carlin's work also showed that continuous interventions by the engineering department were effective in keeping young women in the pipeline, and their work also showed that enjoyment of math and science in high school was a strong reason for pursuing engineering in college.

Since other longitudinal efforts (Sadker, Sadker & Zittleman, 2009; Simpkins, Davis-Kean & Eccles, 2006; as cited by Walters & Brown, 2005) have also shown that interest in high school is dependent upon interest in middle school and even in elementary school, a chain of sustained interest and motivation seems to be emerging, just as Byrnes 3C model (2005) indicated. Interest and motivation, when cultivated, does seem to lead to greater ability over time, leading to young girls who like math and science to become young women who like math and science and that also have the ability and the self-confidence necessary to continue to pursue STEM careers.

STEREOTYPES AND THE INTERNATIONAL STAGE (SOCIAL/CULTURAL BELIEFS, VALUES, EXPECTATIONS)

However, social/cultural attitudes, as Byrnes would remind us, regarding gendered stereotypes are not limited to the U.S., but are widespread across the world, including Asian countries (Byrnes, 2005). Yet, there are differences, too, hints Byrnes, which may in fact be key as to why Japanese and Chinese students, regardless of gender biased views, perform better, earlier, and with more consistency in math and science.

In fact, current researchers like Aunio, Aubrey, Godfrey, Pan and Liu (2008), along with older meta-analysis and research such as that done by Susan Holloway (1988), would point to cultural/social values in Asia that encourage education and give it high status. However, Corwyn and Bradley (2008), in studying Asian-Americans, would emphasize that it is not simply being Asian that matters, but rather a Confucian value system, since not all Asian-Americans show high appreciation for education or equal achievement. This Confucian value of education for education's sake may lead to implicit and explicit parental and teacher beliefs that are passed on to students of both genders (Corwyn & Bradley, 2008). Likewise, it may lead to greater emphasis on math and science in the classroom (Perry, VanderStoep, & Yu, 1993).

Additionally, Phillipson (2006) found another difference between typically Western and typically Eastern beliefs – that of effort over ability. In Hong Kong, Phillipson analyzed students from three, different primary schools, two Chinese (one lower socio-economic status, one middle/upper class) and one Western (middle/upper class), and discovered that parents of students from both of the Chinese schools believed that effort was the primary reason for success – not intrinsic ability – though there were differences in how middle/high versus low income students saw their successes. The middle/high income Chinese students were more likely to attribute their success to effort, more than the low income Chinese students, but both attributed their success more to effort than did the British students. The Western school parents believed that ability was the primary reason for success, not effort.

Phillipson (2006) concluded that these findings are in line with the higher expectations of Confucian cultures, where failures are not typically blamed on other attributes, such as ability, having a

bad day, or task difficulty. Phillipson also found failure by a Chinese student did not lead to the student feeling that their future would also be a failure – a better future and success would just take more effort. This belief is typically counter to the lower self-regard and lower expectations of future success that are often attributed to poor academically performing Western students, says Phillipson.

Yeung and Yeung (2008) found similar results when comparing Australian and Hong Kong 5th grade students' beliefs about the path to achievement being from effort rather than ability. As they expected, Hong Kong students significantly attributed their achievement to effort over ability, but yet also saw ability as a factor. While Australian students tended to see ability but not effort as the sole determining factor for their achievement. From this, Yeung and Yeung recommended that teachers emphasize effort, since it is a controllable factor by students, rather than the idea of intrinsic (uncontrollable) ability, and also that teachers should be careful to praise both ability and effort, and learn to assess effort (and not just competencies and proficiencies), as well as nurture the idea of effort from an early age to maintain and increase motivation. They also recommended that teachers learn to help maintain students' sense of gained ability in order to encourage self-concept, as well as to make sure that the weakest students in the class are not forgotten and neglected but encouraged in their efforts, gained abilities and learned strategies as well.

Likewise, in their survey of the current understanding of academic performance differences between the West and the East, Elliot and Phuong-Mai (2008) note that researchers have shown that "inappropriate levels of high confidence may result in complacency and reduce students' awareness of the need to work hard" (p. 36). They observed that Russian teachers tended to be more critical and challenging than their American counterparts, who tended to give praise unconditionally. Elliot and Phuong-Mai also found similar data indicating that American teachers tended to award higher grades and praise than did Japanese teachers, to the point of devaluing the entire process. The same traits were observed with parents' appraisal and treatment of their children (Elliot & Phuong-Mai, 2008; Hess, Chih-Mei, & McDevitt, 1987). While such comparisons, Elliot and Phuong-Mai (2008) say, must be taken with

caution, they also cite a large body of research that shows the positive self-perceptions of both American and British children and their parents "often bear little relationship to their actual performance" (p. 38).

Elliot and Phuong-Mai (2008) continue their extensive analysis of the current research citing example after example of Western students' and their parents' over-rating of their abilities and accomplishments (as cited by Elliot & Phuong-Mai, 2008). They finish their analysis with a grim assessment that U.S and English schools are not focused on academics or even learning, but are rather social institutions where popularity with peers and sporting achievements are the most important aspects – an emphasis that comes not just from the students, but also from their parents, the school administrators and their teachers to some degree. Like many researchers, they conclude with recommendations for improvement that include a greater focus and respect for education, learning and scholarship. This focus must come not just from school curriculum, they note, but also come from peer group support and family support, and also must include a stronger belief in discipline and effort.

So as Elliot and Phuong-Mai (2008) emphasize, it isn't a matter of simply mimicking Asian pedagogy, since many factors may be deeply embedded in the culture itself. This sentiment is echoed by Tan, McInerney, Liem and Tan (2008) who caution Western educators not to simply copy pedagogy from Eastern educational systems, but they should instead try to understand and factor in cultural considerations. The origins of various educational practices may not matter, say Tan et al., but what counts is "the manner in which it is being acted out, which means theories and practices should be adapted to the context where they are implemented." (p. 8). It is a matter of changing behavior and instilling "profound attitudinal and motivational factors" (Elliot & Phuong-Mai, 2008, p. 48) to create a better, overall learning environment.

MATH PERFORMANCE – GREATER EXPECTATIONS AND GREATER COVERAGE (TEACHING MATH)

This focus on the relationship between opportunity, motivation and aptitude/achievement given the effects of stereotypical beliefs on classroom teaching, as well as the expectations of parents and

teachers is echoed by many researchers (Barrett Singer & Weinstein, 2000; Brickhouse, Lowery, & Schultz, 2000; Ford, Brickhouse, Lottero-Perdue & Kittleson, 2005; Jacobs, Davis-Kean, Bleeker, Eccles, & Malanchuk; Hall, 2007; McGlone & Aronson, 2007; Sadker, Sadker & Zittleman, 2009; Simpkins, Davis-Kean, & Eccles, 2006; Tenenbaum & Leaper, 2003;). In fact, as indicated by research into Eastern pedagogies, some researchers (Perry, VanderStoep & Yu, 1993) have already shown that the way mathematics is taught may, in fact, lead to better mathematical ability; something that is not directly tied to particular cultural/value systems.

This was what was found by Perry, VanderStoep and Yu (1993), when they looked at the higher achievement accomplished by students from Asian countries when compared with U.S. students, during their investigation into 1st-grade mathematics instruction by Japanese and Chinese teachers.

Perry et al. (Perry, VanderStoep, & Yu, 1993) found that Japanese and Chinese teachers spent more time focusing on conceptual understanding and problem solving strategies, including the following: concrete real world examples relevant to the students' lives, greater teaching consistency and knowledge, more time spent on mathematics and challenging the students, and greater coverage of all math topics over time from first through fifth grade. The result of this deeper and more consistent focus on developing generalization across topics – including more coverage of mathematics concepts, teacher instruction consistency and ability, teacher expectations that students, even 1st graders, should be able to answer complex conceptual questions, and a focus on higher order thinking – which are all things that U.S. teachers did not do or expect, concludes Perry et al. is that it leads to significant increases in mathematics understanding, problem-solving abilities and competency. Students learned more than simply how to pass a test. Perry, VanderStoep and Yu concluded that such expectations and teaching methods could also be applied to other domains and would lead to improvements in U.S. education beyond increased mathematics abilities.

The way science and math is taught may be a critical factor to the continued pursuit of math and science, though of course, cultural expectations and stereotyping are also likely to affect how a student perceives his or her relationship with math and science.

This type of disengaged relationship was also noted by Lyons (2006) as well as other researchers (Miller, Slawinski Blessing, & Schwartz, 2006) when investigating students' views of science and their science classroom experiences. Lyons looked at the views of high school students from three studies done in Sweden, England and Australia. The students found science boring, the content not relevant to them, as well as the instruction disengaging with teachers not willing to answer questions when students wanted to discuss some concepts and get deeper into subjects.

Instead, according to the students, they were told to be quiet and to just accept the things without question (Lyons, 2006). Students' perceptions, according to Lyons, are that they are just passive recipients, learning information by rote and without any real understanding of it, with everything being right or wrong, and also that science is without any creativity – with no room for them to contribute, unlike other subject areas. This frustrated students and increased the perception that science was difficult, irrelevant and boring, even with students that liked science and pursued science interests outside of school.

Lyons (2006) also noted that such a passive-learning environment, where much of the content is rushed through without chance for discussion or application, is also similar to the learning environment in many Asian countries, such as Japan and Korea, in at least some sense countering the claim by Perry et al. (Perry, VanderStoep, & Yu, 1993) that simply the way math and science is taught, and not other cultural and social values, is the way to fix the problem.

Other complaints included a teaching focus on test taking, where students never saw lab activities in their classroom until after the administration of the required progress assessment exams (Lyons, 2006). The class activities up until that point were solely focused on potential exam questions and

test taking strategies. While passing such assessments is considered an important marker for the quality of school education, Lyons called into question whether students are really learning or just being coached to pass such assessment exams, with the result that students feel forced to take math and science, further discouraging a positive experience with it. As Lyons finds, in line with other research he notes, negative engagements with math and science decrease a students' motivation to continue pursuing science and math and increases their beliefs that science is difficult, and not for them.

Girls particularly feel more disengaged and dissatisfied than boys with their experiences with and perceptions of science (Miller, Slawinski Blessing & Schwartz, 2006; Sadker, Sadker & Zittleman, 2009) and it is interesting to note that students rated physics as the most difficult in the hierarchy of science, and biology as the easiest (Lyons, 2006). Interesting, because Miller et al. (Miller, Slawinski Blessing, & Schwartz, 2006) found that girls, when they did plan a science major, were more likely to either take science because they had to for a healthcare related field, or because they were planning to go into biology fields, which is the one area in STEM that has seen significant increases in participation (*New formulas for America's workforce: Girls in science and engineering, 2003*). The students' views reflected very gendered views about the sciences, even if they were not particularly aware of them as such (Miller, Slawinski Blessing, & Schwartz, 2006), and indicated which science areas are becoming more appropriate for women and which ones still are masculine (Sadker, Sadker & Zittleman, 2009).

Still, such decreased motivation, negative experiences and decreased likelihood to take more math and science, is exactly in line with Byrnes' (Byrnes, 2005) 3C model and as such, would lead to fewer girls in the science pipeline.

However, such blanket comparisons between classroom teaching styles and cultural values must be treated cautiously, as East-West researchers have already mentioned (Elliot & Phuong-Mai, 2008; Tan, McInerney, Liem & Tan, 2008). What works in one culture may not easily transplant into a different culture, nor are higher expectations without potential negative consequences, as already noted by Walters and Brown (2005) when talking about the negative aspects of a positive stereotype, where

students feel more pressure to succeed, possibly doing worse on tests as a result, and/or might feel like failures if they don't meet the stereotypical expectations.

Along these same lines, Tan and Yates (2011), did, in fact, find high levels of stress among Singapore secondary and college students. They were looking at a more negative aspect of Confucian cultural nations as a result of the high expectations for achievement by students' parents and teachers. The resulting stress, they note, is positively correlated with achievement success but also with mental health problems. Tan and Yates, too, concluded that parents and teachers do have a strong effect on the beliefs and attitudes of students, but also cautioned that those effects must be considered in their entirety.

It seems that much can be learned regarding how cultural values, and therefore cultural emphasis, can be used to encourage or discourage student achievement and long-term success, but this is not the same as simply blindly copying the pedagogy of one nation over another. Cultural, social, and psychological effects are complex and what works in a society with strong Confucian ideals about the importance of education may not readily transplant to a culture more focused (and familiar) with the idea of individual freedoms and a belief in intrinsic ability over external effort.

However, international comparisons do offer a window for both evaluation and learning about how to improve our educational system and how to help keep girls (and boys) in the science pipeline. Such international results also offer further proof that Byrnes' (2005) 3C model – a model that focuses on increasing aptitude through consistent motivation and opportunities to learn – offers a viable approach to the problem. In fact, interventions to keep girls in the science pipeline parallel this line of thought.

MOTIVATION AND OPPORTUNITY – INTERVENTIONS TO KEEP GIRLS IN THE PIPELINE

The National Science Foundation (NSF) has summarized years of intervention studies that have shown not only that girls' interest and abilities are equivalent to boys, but also that girls' interest can be increased through various intervention techniques and changes in teaching methodologies and teacher

attitudes (*New formulas for America's workforce: Girls in science and engineering, 2003*). Yet despite this, the dropout rate has continued and the pipeline continues to leak (Hall, 2007; Hanson, 1996; Sadker, Sadker & Zittleman, 2009).

All the reasons that decrease girls' and women's interest in entering and/or staying in STEM fields mentioned earlier hold some merit and demonstrate that the problem is a systemic one, thereby showing that any complete solution must also be manifold in design. There are many aspects to the problem and the solution must attack the problem on many levels and via many techniques (*New formulas for America's workforce: Girls in science and engineering, 2003*; Barmby, Kind, & Jones, 2008; Blickenstaff, 2005; Farmer, 2007; Murphy & Whitelegg, 2006; Shakeshaft, 1995).

Furthermore, researchers have demonstrated that various interventions can and do work, even at the K-6 level and especially using role models in some way to breakdown stereotypes and increase interest (*New formulas for America's workforce: Girls in science and engineering, 2003*; Bennett, Lubben, & Hogarth, 2007; Buck, Plano Clark, Leslie-Pelecky, Lu, & Cerda-Lizarraga, 2007; Epstein Jayaratne, Thomas, & Trautmann, 2003; Hoh, 2009; Häussler & Hoffmann, 2002; Jenson & Brushwood Rose, 2003; Jenson, de Castell, & Bryson, 2003; Jenson, de Castell, & Fisher, 2007; Jones, Howe, & Rua, 2000; Matson, DeLoach, & Pauly, 2004; Murphy & Whitelegg, 2006; Nhundu, 2007; Reed Rhoads, Walden, & Winter, 2004; Rogers & Portsmore, 2004; Taylor, Jenson, & de Castell, 2007).

These interventions include science book reading clubs (Bergsman, 2010), after school science clubs (Agosto, 2004; Farmer, 2007; Reed Rhoads, Walden, & Winter, 2004), robots (Matson, DeLoach, & Pauly, 2004; Rogers & Portsmore, 2004), special seminars and events (Agosto, 2004; Epstein Jayaratne, Thomas, & Trautmann, 2003; Rook, 1996), talks from or presence of role models (Buck, Plano Clark, Leslie-Pelecky, Lu, & Cerda-Lizarraga, 2007; Cohoon, 2001; *Encouraging girls in math and science: IES practice guide, 2007*; Epstein Jayaratne, Thomas, & Trautmann, 2003; Hoh, 2009; Nhundu, 2007), introducing even the youngest students to physics and engineering concepts (Bennett, Lubben, & Hogarth, 2007; Mantzicopoulos & Patrick, 2010; Rogers & Portsmore, 2004), finding ways to engage girls more with

computers and computer games (Inkpen, Booth, Klawe, & Upitis, 1995; Jenson, de Castell, & Bryson, 2003; Jenson, de Castell, & Fisher, 2007; Farmer, 2007; Taylor, Jenson, & de Castell, 2007), getting parents involved (Agosto, 2004; Rook, 1996; Simpkins, Davis-Kean & Eccles, 2006), especially mothers (Rook, 1996), or perhaps especially fathers (Gilbert & Calvert, 2003), as well as the use of biographies as role models (Nhundu, 2007), and also include introducing science earlier in the classroom with a more multimodal, relevant, interesting approach that includes context based and hands-on experiments (Bennett, Lubben, & Hogarth, 2007; *Encouraging girls in math and science: IES practice guide, 2007*; Häussler & Hoffmann, 2002; Huebner, 2009; Shakeshaft, 1995) as well as the use of more engaging but quality trade books over textbooks (Freeman & Goetz Person, 1998; Leal, 1993; Leung, 2008; Mantzicopoulos & Patrick, 2010; McCrudden, Schraw & Kambe, 2005; Murphy & Whitelegg, 2006; Palmer & Stewart, 2002; Rice, 2002; Sunanon Webster, 2009) or finally, just all of the above (*New formulas for America's workforce: Girls in science and engineering, 2003*).

But how long do such interventions work, since most are of a short-term nature?

One longitudinal study done by Simpkins, Davis-Kean and Eccles (2006) attempted to determine if long-term effects on motivation and interest would result from interventions in grade school. Simpkins et al. looked at the outside science activities and interests of 5th graders as well as their self-competency beliefs in 6th grade and in 10th grade. She found that while both boys and girls performed equally well in math and science in 5th grade, in 6th grade, boys had a higher self-competency belief in math than did girls. She also found that participating in out-of-school science activities in 5th grade increased the youths' self-competency beliefs in both 6th and 10th grades, particularly for the boys. There was also high stability in those beliefs between 6th and 10th grade. Also, self-beliefs and grades were not positively correlated in the 6th grade for boys, meaning their self-competency beliefs were not influenced by their actual grades, but by the 10th grade, they were. For girls, their grades in 6th grade did lead to their current and later beliefs in high school about the importance of math and science and their interest in it.

As a result of this analysis, Simpkins, Davis-Kean and Eccles, (2006) conclude that strong self-beliefs and activities in math and science in the 5th grade likely lead to stronger self-beliefs and interest during the next five years, which also lead to taking more math and science courses and excelling at them, which again lead to higher achievement (and self-belief) in math and science. Simpkins et al. continue by mentioning that their work confirms earlier findings of Eccles' and her colleagues. However, Simpkins et al.'s work includes out-of-school activities and their results "lend support for Erikson's theory of the link between children's activity involvement experiences during middle childhood and their subsequent beliefs" (p. 80). Also, the stability of self-concepts from 6th to 10th grades, leads them to recommend continuous interventions, since a single intervention is "not likely to have lasting effects" (p. 82).

Simpkins et al. (Simpkins, Davis-Kean & Eccles, 2006) also find that instead of girls' values predicting their interest and pursuit of math and science, rather their findings suggest that self-concepts regarding ability play the more important role – which they say, may reflect historical changes regarding college entrance requirements (i.e. the need for more advanced coursework and higher grade averages), or simply be tied to their participants, who were all European-American students. As a result, they recommend that future studies investigate both self-concepts and values across racially/ethnically diverse groups.

Therefore, long-term influences of short-term interventions are still unclear and clearly more longitudinal studies would be needed to clarify the relationship between values, self-concepts, ethnicity, and the effect of other factors on girls' STEM interests.

However, given this lack of clarity in long-term results of interventions, short-term interventions may not be enough to counteract all the forces discouraging girls' and women's sustained interest in STEM. As a result, repeated interventions may be required. (*New formulas for America's workforce: Girls in science and engineering, 2003*; Barmby et al., 2008; Murphy & Whitelegg, 2006)

In essence, while short-term interventions help, and may have long-term effects, given the systemic nature of the problem, changing teaching methodologies across grade levels may offer the best, most pervasive, and consistent solution, but even this may be undone if societal factors and pressures continue to convince girls that STEM is not relevant to them, that math is hard, science is for boys, and girls have specific gender roles that do not include, much less reward, roles in STEM (*New formulas for America's workforce: Girls in science and engineering*, 2003; Blickenstaff, 2005; Farmer, 2007; Hamilton, Anderson, Broaddus, & Young, 2006; Jenson & Brushwood Rose, 2003; Kenway & Gough, 1998; McCrudden, Schraw, & Kambe, 2005; Murphy & Whitelegg, 2006; Nhundu, 2007; Shakeshaft, 1995; Taylor et al., 2007; Tsao, 2008).

However, that is no reason to give up, especially knowing the critical need for future scientists, technologists and engineers. So what about books? Books are a consistent and continuing resource in all schools, all libraries and all classrooms. Teachers use books to teach reading as well as history, science, math and other critical knowledge domains. So can books be used as a reliable, pervasive tool to counter negative stereotypes and promote interest in STEM?

LITERATURE REVIEW PART II: PICTURE BOOKS AS INTERVENTION

VISUAL PERSUASION AND EDUCATION (COMICS, PICTURE BOOKS, VISUAL MEDIA)

As already demonstrated by McGlone and Aronson (2007), counter-stereotype messages can be used to reduce stereotype threat in performance situations. Clearly, a strong narrative can have strong effects, as Sadker and Sadker and many others note (Bergsman, 2010; Beck, Nelson-Faulkner, & Pierce, 2000; Camp, 2000; Cary, 2004; Crawford & Zygouris-Coe, 2008; Evans, 2009; Freeman, & Goetz Person, 1998; Harmon & Gonzalez, 2003; Kakalios, 2005; Leal, 1993; Leung, 2008; Mantzicopoulos & Patrick, 2010; McCrudden, Schraw & Kambe, 2005; Murphy & Whitelegg, 2006; Nhundu, 2007; Palmer & Stewart, 2002; Parker & Lepper, 1992; Rice, 2002; Roser & Keehn, 2002; Saul & Dieckman, 2005; Sunanon Webster, 2009; Thomas, 1983) when looking at the gender messages that children receive via visual media.

Also, the advertising industry has a long history with understanding the mechanisms of persuasion (Cialdini, 2001; Harris, 1999; Sparks, 2002). Additionally, there has been a long history of research into various communication forms using a variety of measurement methods (Krippendorf & Bock, 2009; Harris, 1999; Riffe, Lacy, & Fico, 2005; Sparks, 2002) with special emphasis on the effects of communication media on children, especially advertising and violent media (Harris, 1999; Sparks, 2002).

Yet, while the concerns are often about the negative impact of media, these same mechanisms have also been researched and harnessed to have a positive, prosocial impact (Cialdini, 2001; Fisch, 2004; Harris, 1999; Sparks, 2002). From *Sesame Street* to the use of comics in the classroom, educators, researchers, authors and publishers have sought ways to engage young viewer/readers' interest and use media to encourage the learning of a variety of things, as well as to teach positive social values, beliefs and behaviors (Baumgartner & Morris, 2008; Bitz, 2009; Bitz, 2010; Cary, 2004; Fisch, 2004; Hong Xu, Sawyer Perkins, & Zunich, 2005; Kakalios, 2005; Lodi, 1989; Thomas, 1983; Thompson, 2008;).

Additionally, it is well known that humor, a form of entertainment, has been a strong persuasive force in politics and political campaigns, including giving comedians great influence with voters and their preferences for one candidate or issue over another (Baumgartner & Morris, 2008; Krippendorf & Bock, 2009). Political cartoons would also fall into this category as would cartoon strips, such as *Little Orphan Annie*, which when analyzed, appeared to have strong political leanings (Shannon, 2009). However, the art and genre of cartoon art has other uses as well. Lodi (1989), for example, used comics as part of an anti-drug campaign to teach adults and children about the dangers of narcotics, claiming successful results. Drechsler (2008) wrote a comic novel that dealt with her own experiences with molestation and abuse at the hands of her father. Bitz (2009, 2010), Cary (2004) and Thompson (2008), have also reported greater student interest and engagement when comics and/or manga (Japanese comics) activities were introduced into schools. Finally, Kakalios (2005) has used and continues to promote the teaching of physics by engaging student interest by using student knowledge of comic superheroes, and detailing how the physics of superheroes works.

However, it should be stressed that, after a review of the last four decades of humor use in the classroom, Banas, Dunbar, Rodriguez and Liu (2011) found that for humor to be a beneficial experience in the classroom, it must be positive, non-aggressive humor. Positive, non-aggressive humor is "associated with a more interesting and relaxed learning environment, higher instructor evaluations, greater perceived motivation to learn, and enjoyment of the course" (p. 137). By contrast, the opposite effect was found with negative, aggressive humor aimed at students, creating "a more anxious and uncomfortable environment for learning, lower evaluations of instructors, increased student distraction and less enjoyment of class" (p. 137). Additionally, they found that "there is substantial empirical evidence that humor can enhance recall and aid learning" (p. 137). Banas et al. suggest further research is needed in many areas, including a more systematic, empirical and repeatable examination of humor in the classroom, as well as research that examines cultural/subcultural normative effects, as some cultures may see humor as inappropriate in a learning situation.

Still, why would such approaches work? In each case, an entertaining media form was used to engage the interest of an audience, and to influence that audience in some way. The entertainment/art form was not the same in each case, but the underlying mechanism was the same, i.e. to engage interest and, though not stated explicitly, to engage intrinsic motivation in order to bring about some sort of desired behavior (learning about the evils of narcotics, teaching about abuse, learning physics, influencing voting behavior and preferences). Increasing engagement and greater interest with a subject is also, not coincidentally, the goal of intervention techniques for girls with STEM fields. A definition of engagement – what is engaging – seems to be in order.

WHAT IS ENGAGEMENT? – INTEREST AND INTRINSIC MOTIVATION

For the purposes of this thesis, I will define engagement in the following way. Engagement means that there is personal interest and intrinsic motivation with the subject in question. The resulting behavior from this engagement would be to learn more about the subject and recall relevant information related to the subject. This leads to three sub-issues: 1) what does interesting mean and how can interest be generated, 2) what is intrinsic motivation and how is it generated and sustained, and 3) finally, how is engagement, in other words, interest and intrinsic motivation, connected to learning?

Interest and motivation and their relation to learning have been the subject of cognitive psychologists, educators and other researchers for decades. In fact, in 1987, the interestingness of children's reading material was the focus of Anderson, Shirey, Wilson and Fielding, who conducted quantitative, repeatable experiments to determine just what was meant by interest, how it related to attention and learning, and how to make sentences more interesting. It should be noted that the fact that they conducted quantifiable, repeatable experiments, rather than using qualitative methods, is significant, since as a result, their work can be repeated according to the rules of scientific method. Therefore, while the results are still open to interpretation, the data gathering mechanism is less so, at least when compared with the qualitative methods (observational, anecdotal, etc.)

They also evaluated other work, both experimental and theoretical, related to interest. Anderson et al. defined interest (in children's reading material) as "the capacity of material to evoke an emotional response in children" (Anderson, Shirey, Wilson & Fielding, 1987, p. 287). The children these researchers were referring to were third, fourth and six graders. Their findings were mixed, but they did show that the idea that interest's role was to create/increase attention (not learning) and that increased attention would in turn, lead to increased learning was in fact, false. Interest had a direct link to both attention and learning, but attention was not a required middle step in the process. The mixed results though, those of what exactly causes interest, was far more interesting.

In their first experiments with third and fourth graders, Anderson et al. (1987) looked at a variety of conditions (reading alone, reading in groups by turn, listening, reading a computer screen) and found the effects of interest were strong in all cases. However, they did not find many interacting factors. For example, it did not matter if the child read silently, was active or passive in the reading, dealt with questions from the teacher, or was a fluent versus non-fluent reader. However, they did find that in all cases, gender mattered. Children found sentences more interesting if the subject was the same readily identifiable sex as the reader. Identifiable sex was important as image-provoking (interesting) sentences where the subject was not readily identifiable as a boy or girl did not invoke much interest in the children. They did note that some stereotyping of roles was involved in the sentences used in the experiment, so possibly the subject matter rather than simply the gender of the sentence subject, had something to do with interest as well.

Yet, Anderson et al. (1987) dug further and looked at what had been hypothesized as four key attributes of interestingness, namely 1) character identification (sex, age, race, religion, occupation, life situation, temperament, etc.), 2) novelty (not ordinary happenings), 3) life theme (the subject matter is one with which the reader is already interested in), and 4) activity level (intense action or feeling, rather than more passive states or scenes, are more interesting). This time they looked solely at third graders, and were surprised to find little correlation at all. They did not find any gender correlations, but did find a

slight preference for sentences with adults rather than child characters. They did not strongly sex-type the sentences in this experiment, which also therefore, decreased any stereotyping of roles. What did account for 47% and 21% of the variance was novelty of concept and centrality of the theme to third graders (i.e. did they relate to the theme of the story).

I must note that if gender does have nothing to do with interest, then that would imply that science programs with male protagonists should still be interesting to girls (or programs interesting to boys with a female protagonist) as long as the program is novel and the content relevant. However, given the mixed results found by Anderson et al (1987), not to mention the research on stereotypes, role models and intervention methods to encourage girls in science (see part one of this literature review), it does seem that this is not the full story. Anderson et al. (1987) seemed to think so to, and looked further into this issue.

When Anderson et al. (1987) looked at other research, they noted that the "structural affect" theory of stories by Brewer and Lichtenstein has been proved out by empirical evidence (as cited by Anderson, Shirey, Wilson & Fielding, 1987). The basic idea is that stories are a subclass of narrative. The primary purpose of a story is to entertain, and a story can only be considered entertaining if it has an arousing effect. In other words, people will remember a story only if it produces an emotional response. This was the basis of Anderson and his associates work as well – interest produces an emotional effect.

To further their investigation into the nature of interestingness, Anderson et al. (1987) looked at the results of similar work done by Jose and Brewer in 1984. Jose and Brewer were evaluating a developmental model related to interest and suspense stories. They also tested factors like character identification, identification *and* level of perceived suspense, liking of the story's outcome – as related to the character (bad/good) and the ending (happy/unhappy) – and found that overall story liking "increases with greater identification, greater suspense, and greater liking of the outcome." (as cited by Anderson, Shirey, Wilson & Fielding, 1987, p. 295) The model was tested against second, fourth and sixth graders.

Jose and Brewer determined that the nature of the character (good or bad) was of overriding importance to children, especially younger children. The children identified nice characters as more like themselves and liked those stories better. Other matches between the character and the child reader, namely age or gender, did not matter to the younger children. It only became important for the six graders. Likewise, the second graders only liked the stories with nice characters and happy endings. Increased suspense in the story, shown to increase with increased character identification, did not result in greater story liking by the second graders. However, increased suspense did increase story liking for the older children (fourth and six graders) (as cited by Anderson, Shirey, Wilson & Fielding, 1987).

Finally, Anderson et al. (1987) cited the research of into how (then current) basal reader stories as well as social studies and science textbooks fared when rated for interest and attributes found related to interest (emotional response, identification/inside view of character, suspense/conflict, engaged vs. detached observer point of view) and found that basal reader and textbooks did not rate high at all. These books were not interesting. Trade books, by contrast, were high in such criteria and were confirmed to be popular with the children. Furthermore, researchers of that time noted that not just children but also adults preferred material with "more interpersonal and internal conflict, greater inside view, and more engaged narrative" (as cited by Anderson, Shirey, Wilson & Fielding, 1987, p. 296) and also that adult interest, especially the adult who read the material to child, is likely communicated to that child – as is their disinterest – and that effect should not be underrated (as cited by Anderson, Shirey, Wilson & Fielding, 1987).

Anderson et al. (1987) finish their exploration into interest with the (then current) trend in textbooks of placing interesting asides into the text, with the idea that these unnecessary and often distracting informational bits, will attract attention and that this attention will then translate to the rest of the text and the learning of the desired information. Anderson, Mason and Shirey investigated this idea and found no effect whatsoever. These irrelevant asides did not increase learning (as cited by Anderson, Shirey, Wilson & Fielding, 1987). This work on the effect of irrelevant information, also referred to as

seductive information or seductive text, in a text has been explored by many other researchers as well, with the overall conclusion that irrelevant facts (as asides or in other formats, including too fast a pace or too many fades/dissolves/wipes in a television program) not only have no effect on learning of the rest of the information, but in fact, distract the reader from learning the actual, desired material (Garner, Alexander, Gillingham, Kulikowich, & Brown, 1991; Wade, 1990). Trying to force interest in boring material through interesting factoids is not useful and in fact, may detract from learning and attention (Anderson, Shirey, Wilson & Fielding, 1987; Garner, Alexander, Gillingham, Kulikowich, & Brown, 1991; Wade, 1990).

The second part of engagement as defined here is intrinsic motivation. This is not to say that interest doesn't play a part in increasing motivation, or the reverse – for example, to read a book about a subject the reader is interested in, or to read a book about a subject and become more interested in it as a result – but rather that what causes interest is not necessarily the same as what causes intrinsic motivation (Malone & Lepper, 1987). Or, in other words, intrinsic motivation is the desire to perform some *action* for internal reasons and without external pressure to do so. Intrinsic motivation is what creates the "will to learn" (p.223) and is the motive that "finds both its source and its reward in its own exercise" (p. 223). Malone and Lepper state that learning only becomes a problem and school "boring and unpleasant drudgery" (p. 223) when the only motivating factors are to win external rewards or to avoid punishments, i.e. such as getting good grades, getting a high-paying job, or the reverse, in other words, embarrassment at failing, or losing privileges of some kind as a punishment for failure.

To this end, Malone and Lepper (1987) sought to understand how to design intrinsically motivating instructional environments and confirmed that previous research by many researchers had already shown intrinsic motivation (instead of extrinsic incentives) often led to "greater interest in the activity or the instructional content of the activity" (p. 229). They also noted that the motivational attributes they compiled could just as easily be applied to the design of good novels, though not as a replacement for the creative process. They concluded their research with the idea that the taxonomy

they discovered in their research could be used as "a way of guiding and sharpening intuitions and aesthetic sensitivity, not a way of replacing them" (p. 249).

So what exactly did Malone and Lepper (1987) discover regarding intrinsic motivation, also referred to as endogenous motivation, or even referred to as activities that are "*fun, interesting, captivating, enjoyable*"(p. 229)? Malone and Lepper used both surveys of *liked* computer games (by elementary school students of varying grades) and experiments using a modified/unmodified game (using grade school children of some kind in all cases, with all fifth graders in at least one experiment) to create and refine their conclusions, namely that the taxonomy of intrinsic motivations for learning include four classes of "individual" motivations (challenge, fantasy, curiosity, control) and three classes of "interpersonal" motivations (cooperation, competition, recognition). The full taxonomy and its implications are more complex than can easily be discussed here. A complete listing of these classes and their components is listed in Table I (containing the original table from Malone's and Lepper's paper) and the reader is referred to Malone's and Lepper's paper for a full understanding of the table contents and its impact and uses.

TABLE I: MALONE AND LEPPER FINDINGS FOR MOTIVATION

Table 10.4

Heuristics for Designing Intrinsically Motivating Instructional Environments

I. INDIVIDUAL MOTIVATIONS

A. Challenge:

The activity should provide a continuously optimal (intermediate) level of difficulty for the learner.

1. Goals – The activity should either (a) present clear, fixed goals or (b) provide an environment in which it is easy for students to generate goals for themselves at an appropriate level of difficulty

The activity should provide short-term, as well as long-term, goals

2. Uncertain Outcomes – Uncertainty of outcome may be produced using:

(a) Variable difficulty levels

(b) Multiple levels of goals

(c) Hidden information, selectively revealed

(d) Randomness

3. Performance Feedback – Performance feedback should be frequent, clear, constructive, and encouraging

4. Self-Esteem – The activity should employ graded difficulty levels and positive feedback techniques to promote feelings of competence

The activity should employ personally meaningful goals that have instrumental, fantasy, or social relevance for the learner

B. Curiosity:

The activity should provide an optimal (moderate) level of informational complexity or discrepancy from the learner's current state of knowledge and information

1. Sensory Curiosity – Sensory curiosity may be enhanced by variability in audio and visual effects

The activity should promote interactive exchange with the learner

2. Cognitive Curiosity – Curiosity may be prompted by instructional techniques that cause learner's to be surprised and intrigued by paradoxes, incompleteness, or potential simplifications

Cognitive curiosity will be enhanced when activities deal with topics in which the learner is already interested

C. Control:

The activity should promote feelings of self-determination and control on the part of the learner

1. Contingency – The activity should provide a responsive learning environment

2. Choice – The activity should provide and emphasize moderately high levels of choice over various aspects of the learning environment

Personalization of the activity may enhance perceptions of choice

3. Power – The activity should permit the learner to produce powerful effects

D. Fantasy:

The activity may promote intrinsic motivation through the use of fantasy involvement

1. Emotional Aspects – Fantasies should be designed to appeal to the emotional needs of learners

Fantasies should encourage identification with imagined characters or contexts

2. Cognitive Aspects – Fantasies should provide appropriate metaphors or analogies for the material presented for learning

3. Endogeneity – Fantasies should have an integral, endogenous, relationship to the material to be learned

II. INTERPERSONAL MOTIVATIONS

A. Cooperation:

The appeal of the activity may be enhanced by enlisting the motivation to cooperate with others

Endogenous cooperative motivation may be produced by segmenting the activity into inherently interdependent parts

B. Competition:

The appeal of the activity may be enhanced by enlisting the motivation to compete with others

Endogenous competitive motivation may be produced by creating an activity in which competitors' actions affect each other

C. Recognition:

The appeal of the activity may be increased if the learner's efforts receive social recognition

Endogenous recognition motivation may be produced by activities that provide natural channels for students' efforts to be appreciated by others

(Malone & Lepper, 1987, pp. 248-249)

Important points, as related to engagement, interest and media, from Malone and Lepper's (1987) efforts involve how intrinsic motivation is tied to interest as well as sensory and cognitive curiosity. Curiosity, according to Malone and Lepper, is "the most direct intrinsic motivation for learning" (p. 235). Theories, they note, have tied curiosity stimulation to an optimal level of informational complexity or incongruity, and Malone and Lepper treat curiosity as similar but different from the idea of challenge (as cited by Malone & Lepper, 1987).

In this way, according to the ideas of Malone and Lepper (1987) (and the researchers and theories they are referencing), curiosity can be generated from *sensory* information (attention attracting variations or changes in light, sound or other stimuli such as those that might be found in colorful images in books, computer animations, interaction with media, or camera techniques) or from a *cognitive* need to understand one's environment in order to create better internal knowledge structures. An example of cognitive curiosity might be the need to understand an apparent inconsistency, like "plants require sunlight to live, but that fungi are plants that live in the dark" (p. 237) or even simply by being familiar with the subject being discussed, similar to the ideas of character identification or life theme in Anderson's, Shirey's, Wilson's and Fielding's (1987) ideas regarding interestingness. In both types of curiosity, it seems logical that an emotional response of some kind is generated, i.e. interest.

As a final note about intrinsic motivation, particularly relevant to this thesis since it deals with picture books, is the idea of the use of fantasy to contribute to intrinsic motivation. Malone and Lepper (1987) cite evidence that the use of fantasy (an environment that evokes mental images of places or social situations not present) can not only fulfill emotional needs but can also help provide metaphors that help the learner understand or relate novel or new information to past knowledge. Learners might then apply this knowledge to real-world situations, or use it understand more abstract information, for example, using physical objects to understand the concept of fractions or numbering systems. Fantasies may even improve recall of the learned material, since the participant may have adopted a particular role in learning the material or learned to associate vivid images with the learned material, in both cases further

enhancing recall because of that novel or emotionally-incited response (as cited by Malone & Lepper, 1987; Parker & Lepper, 1992).

It is important to note that Malone and Lepper (1987) used computer games, rather than books, film, television or any other form of media, in their experiments. Computer games offer many of the benefits of other media but also offer direct interaction with the media itself, which may help increase interest and motivation. In fact, research into interactive media has been shown to increase a child's interest and potentially their learning and recall (Calvert, Strong, Jacobs, Conger, 2007; Gentile et al., 2009; Korat & Or, 2010; Lee, Heeter & LaRose, 2010; Parker & Lepper, 1992; Tung & Deng, 2006). However, as noted by one study by Ricci and Beal (2002), interaction, itself, may not be the key to interest or motivation. Ricci and Beal examined the influence of interactive media on first grade children's story memory. They tested four presentation modes: audio only, audiovisual (television-like), audiovisual with interaction on the screen, and audiovisual but only allowed to observe other children interacting with the screen. They found that children had better recall and comprehension with the audiovisual modes versus the audio only mode, but no differences were found between the audiovisual modes. Additionally, with the interaction mode, itself, the amount of interaction did not matter in regard to story recall.

Now, I note that one study does not make a conclusion about the effectiveness of direct interaction versus non-interaction viewing of a program. However, it does imply that engagement (interest and motivation) is likely not the same as direct interaction with a computer screen. Therefore, highly engaging media need not be limited to computer programs. This also may help to explain why educational television shows, such as *Sesame Street*, do engage children and help them learn. Less interactive, more passive (or perceived as passive) forms of media can still engage effectively with an audience.

In fact, such ideas about the presentation of vivid, interesting, curiosity-rousing yet still relevant information and its usefulness for learning sounds remarkably similar to the ideas and media presented by educational television, especially internationally respected educational television (edutainment) shows

like *Sesame Street*. So how exactly do such shows accomplish this? What makes them engaging and do children really learn from television?

ENGAGEMENT AND LESSONS LEARNED FROM CHILDREN'S TELEVISION

Shalom Fisch (2004) is a children's media effects researcher and author of *Children's Learning from Educational Television: Sesame Street and Beyond*. In his book, he investigated and compiled the research to date (as of 2004) involved with educational television and its impact on children, as well as explored possible theoretical models to explain how children mentally process and learn from educational television.

In order to understand the role of educational/informational television, Fisch (2004) reminds the reader that the Children's Television Act of 1990 defined educational/informational programming very broadly but that it must further positive development of the child in some way, including cognitive/intellectual development or the child's emotional/social needs. He also points out that other researchers have designated that educational television is informal education, as it takes place "outside of school, involves experiences that are not part of a school curriculum, and often must compete with other activities to gain children's attention and engagement" (as cited by Fisch, 2004, p. 9).

This broad definition, according to Fisch (2004), highlights two important aspects of educational television that 1) they must be highly appealing to children, else children will not watch and 2) episodes must stand on their own, since episodes may not be viewed sequentially. As a result, educational television episodes are not structured the same way formal classroom lessons are structured, nor can they be. Fisch also points out that informal education is not intended to replace formal education but instead supplement it in several important ways: 1) expose children to topics they might not be exposed to otherwise (or expose them to such topics earlier than they would be exposed to in a formal setting); 2) "provide compelling experiences that coax children into spending additional time exploring concepts that they are learning about in school" (p. 10); 3) encourage positive attitudes toward school subjects and 4) motivate children to actively engage in learning (informal or formal).

Therefore, as Fisch (2004) points out, the goals of educational television parallel the original and continuing intent of *Sesame Street*, which began in 1969 and pioneered the idea and effectiveness of educational television. However, counter to general beliefs, *Sesame Street's* mission was broader than simply closing the educational gap between privileged and underprivileged children, states Fisch. Rather, "the intent was to provide educational experiences for all viewers, but to pay special attention to the needs of underprivileged children" (p. 17) and therefore, the original curriculum goals were "in five areas: social, moral, and affective development; language and reading; mathematics and numerical skills; reasoning and problem solving; and perception. In the decades that followed, the curriculum would expand to cover topics ranging from science to health to race relations." (p. 17). What made *Sesame Street* special, says Fisch, is the research that the show's producers put into it, working with educational researchers in order to design a production model that continues to show useful, even impressive results.

Sesame Street does, in fact, have an impressive record though not without some criticisms, says Fisch (2004), primarily regarding evaluation methodologies and ethical considerations – that research is based on researcher needs and that the data gathered is used to control children. Fisch dismisses these criticisms, either as outdated with improved evaluative measures, or as unrealistic (child-designed research is useful in only some cases) or simply as overblown (television must be entertaining as a necessity, but that does not imply it controls children). Still, such fears about the influence of television have been the focus of much research, especially on the effects of violent television (Harris, 1999; Sparks, 2002). However, as Fisch notes, with *Sesame Street* and other educational television shows, even critics acknowledge that the goal is a noble one. Therefore, improving evaluative measures is helpful since what really matters is finding out if educational television works.

As such, according to Fisch's (2004) compilation, *Sesame Street* delivers on its educational and socializing promise, with children showing improvement in all of the content areas covered by *Sesame Street*, whether the exposure was short-term or long-term. Long-term exposure was the most effective. A 2001 longitudinal study showed that these improved skills and positive attitudes toward learning

extended all the way into high school (as cited by Fisch, 2004). Not only were grade points higher for those teenagers that had watched *Sesame Street* as preschoolers, especially for boys, but also those teens "used books more often, showed higher academic self-esteem, and placed a higher value on academic performance" (p. 23). Fisch notes also that preschoolers in this study that watched high amounts of violent television, by contrast, had lower grades and higher aggression (as cited by Fisch, 2004).

Fisch (2004) emphasizes that the successful results of *Sesame Street* have been duplicated with international versions of the show, suitably localized for each culture. Fisch concludes that long-term effects found with *Sesame Street* viewing may be due in part to an early learning model that encourages positive behaviors helpful in regard to learning, increasing interest and motivation, and helping children learn pre-academic skills, particularly language and literacy. Contrary to criticisms and fears of television, cites Fisch, the research indicates that *Sesame Street* has actually increased a child's ability to focus and learn language skills (as cited by Fisch, 2004).

How does *Sesame Street* do it, asks Fisch (2004)? Fisch notes some of the key factors in *Sesame Street's* success are 1) its appeal (humor, visual action/movement, appealing characters that are nice, funny, smart, helpful), 2) clear, child-centered presentations that are direct, simple and concrete, instead of abstract, non-linear, inferential narratives, and these presentations are set in settings a child is familiar with so that they can relate new information to prior knowledge, 3) music and sound effects but as such, both must be carefully integrated with the visual movement, and 4) repetition and reinforcement to enhance comprehension and the ability to recognize different segments "that address the same underlying educational content" (p. 33) often by using a unifying clue that ties the different segments together (such as this segment brought to you by the letter "C").

When Fisch (2004) looked at the research associated with other educational programs, such as *The Magic School Bus*, *Cro*, *3-2-1 Contact* and *Bill Nye the Science Guy*, he found similar results and similar tactics, one of the most important being that the educational material must be tightly integrated with the plot of the show, in other words integral to the narrative itself. Without that tight, integral coupling,

children were more likely to be distracted by irrelevant points in the narrative (including irrelevant visual details like an actor's face or a too bright color) and view the educational content as less appealing and less valuable as a result. In fact, when it comes to science and mathematics, Fisch found research indicating similar increases in interest and motivation as had been found with research into other topics (language, social skills, etc.), but with some added constraints for dealing with science content (as cited by Fisch, 2004).

Science programs are different than other educational programs in that the genre chosen is highly important, states Fisch (2004). Each genre, (mystery stories, humorous cartoons, realistic), has its own strengths and weaknesses, even within the genre itself. As Fisch points out, in *Cro*, a prehistoric animated series about a caveman and his friends, the physics animation in *Cro* must be realistic (rather than the fantastical, more common cartoon animation techniques such as squash and stretch) since physics, machines, and science are the focal points in the story, nor can *Cro* suddenly break the narrative and start explaining the physics in a detailed manner. However, in *The Magic School Bus* a fantasy element is preserved through the use of a magical school bus, yet the places visited (other planets, inside the human body, etc.) must be realistic, factually based environments and also, since the guide is a teacher, the information can be presented (spoken/lectured) with a detailed explanation. According to the research found by Fisch, the elements and presentation of the story content, and explanations for the science content, must be considered carefully given the presentation (genre) format.

Therefore, Fisch (2004) noted that for science programs the following considerations were important: 1) presentation of content (the effects of the genre and setting); 2) matching topics to genres, which basically points out that some genres can more easily deliver the content than others, such as animations being able to show complex machines that would be prohibitively expensive to do with a documentary-style program, which in turn is more capable of showing real-life situations and detailed explanations; and 3) industry considerations and reach, meaning it is appropriate to think about how the television industry will react to the genre chosen. A well-done cartoon has a better chance of being

picked up by a major network and shown on its Saturday morning line-up than does a documentary or real-person style show.

To conclude his research on science programming per se, Fisch (2004) also compiled a list of effective characteristics for science and technology television shows. The list is shown in Table II (in its entirety, including the television shows Fisch referenced, and the chapters he referenced from his book). This table is a small portion of Fisch's overall work and research, so the interested reader is referred to Fisch's book in order to fully appreciate his work and its impact and use in improving and understanding children's education television.

TABLE II: FISCH'S EFFECTIVE SCIENCE/TECH TV CHARACTERISTICS
Characteristics that Contribute to Effective TV Science and Technology Programs

- Focusing on concrete, visual phenomena or devices, as opposed to abstract principles (*Cro, Les Débrouillards, Scholastic's The Magic School Bus*)
- Using unusual or action-filled, rather than static, visuals (*3-2-1 Contact*)
- Choosing topics that are inherently interesting to children and relevant to their lives (*Les Débrouillards*)
- Presenting content via age-appropriate language and at levels of difficulty that are tailored to children's knowledge and developmental level (*Les Débrouillards*)
- Enhancing appeal through age-appropriate humor (*3-2-1 Contact, Les Débrouillards*)
- Including characters whom viewers see as competent and intelligent, and with whom they can identify – particularly characters who are slightly older than the target audience (*3-2-1 Contact, Les Débrouillards*)
- Embedding science content in a dramatic narrative (*3-2-1 Contact, Les Débrouillards*)
- Making educational content integral, rather than tangential, to the narrative plotline – a notion that is similar to "content on the plotline" in *Ghostwriter* (chap. 4, this volume) or "distance" in the theoretical model proposed in chapter 10 (*Scholastic's The Magic School Bus, Cro*)
- Focusing an individual episode or segment tightly on conveying a small number of ideas (*Scholastic's The Magic School Bus*)
- Repeating concepts across an episode or segment (*Scholastic's The Magic School Bus*)
- Drawing explicit connections among conceptually related segments (*3-2-1 Contact*)
- Balancing straightforward delivery of science content with a process of discovery (*Les Débrouillards*)
- Embedding content in a context of problem solving in which characters continually revisit and refine their solutions to make them more effective (*Cro*)
- Presenting experiments in ways that children can replicate at home (*Les Débrouillards*)

(Fisch, 2004, pp. 93-94)

Fisch's (2004) evaluation of children's educational television is quite expansive, from delving deep into the research on each type of educational program (science, social, reading, etc.) to possible theories explaining how the learning process works in this and potentially other mediums. These theories will not be discussed here except to say that first, Fisch finds that none are adequate for a full explanation of the processes he observes with children and educational television learning, but models such as the early learning model, the capacity model, as well as the transfer of learning ideas concept, and various aspects related to the social factors involved, all contribute to a theoretical understanding that is still evolving.

Second, Fisch (2004) saw value to the use of narrative (storytelling); that it was a "particularly conducive medium for learning" (p. 179) and cites a great deal of research emphasizing a narrative form's ability to teach, to help with recall and mental construction of events, and with social learning aspects. Other important factors he mentions stress the need for identification with the characters and the need to have an emotional response (negative or positive) to the material, but *not too great* an emotional response. Too great an emotional response can in fact, according to research by Brosius and Bruner, cause disengagement, as well as decreased long-term learning and comprehension (as cited by Fisch, 2004). This type of too strong emotional response can also cause the same effect as irrelevant material; it distracts. Moderate emotional response is best, notes Fisch, but concedes that emotional response strengths will vary viewer to viewer. Likewise, Fisch notes research showing that children's preconceptions, including misperceptions or stereotypes, may impede their comprehension of material if that material is counter to those preconceptions or strong stereotypical beliefs. "Thus, learning from educational television is a function not only of the material in the television program itself, but also of all of the other material stored in a child's memory as well." (p. 187).

This has serious implications for moderating a child's behavior and beliefs towards more prosocial behaviors, since, as Fisch (2004) points out, children are learning from a variety of sources.

However, for academic subjects, such inhibitory factors might be minimized if the children are exposed to the new information *before* the age at which such attitudes about those subjects are formed, thus avoiding conflicts with preconceptions or misconceptions about the subjects. Also, says Fisch, as posited by the early learning model, exposing children to educational television at an early age may have a cascading effect that follows them even into high school, despite other societal factors (family, peers, other media, etc.) which may "mediate, facilitate, or negate the effects of educational television" (p. 192).

In addition to Fisch's (2004) own expansive review of the current thinking and research into educational television, Long, Steinke, Applegate, Knight Lapinski, Johnson and Ghosh (2010) in 2008 looked in particular at the portrayal of female scientists on television. Long et al. noted the strong, socializing effects of television, especially on middle-school girls, and therefore, examined 14 popular television shows in four genres (cartoon, drama, educational, comedy) in regard to their portrayal of male and female scientists. They discovered that gender-stereotyped behavior was not typical, and that scientists in general were portrayed as intelligent – though males were more likely to be portrayed as independent, and as more violent. This, they noted, was different than other studies that they found, so either scientist portrayals were changing or these particular shows were more equitable and less stereotypical than the ones chosen for other studies.

However, Long et al. (2010) also noted that male scientists significantly outnumbered female scientists and were also in more scenes. Males particularly dominated commercial (non-National Science Foundation funded) television shows by more than 2 to 1, but in NSF supported (educational) shows, there was greater balance – but still with male portrayals slightly higher. Long et al. found support that the continuing view of science is that it is for men, or in particular, unmarried, intelligent Caucasian men without children who hold a high-status science position. The female portrayal, similarly, was of an intelligent, unmarried, Caucasian, high-status holding scientist, which Long et al. noted, still might be seen as a deterrent to girls interested in science, since both male and female scientist portrayals emphasized

the lack of a personal life. Long et al. note that their findings are consistent with current and past findings both on television and in film.

However, the research does show that educational television does have an impact if it is engaging, and that engagement is not tied explicitly to direct interaction such as with interactive media. This leads us to the engagement mechanisms present in books.

ENGAGEMENT AND VISUAL LITERACY – READALOUD LESSONS AND PERITEXT

So how is engagement captured in picture books, or rather still images, which by their very nature lack some of the attention-getting and demonstrative advantages of television and interactive media, such as motion and sound? How can still images create just as deep a connection as interactive media, but without the same "sensory curiosity" (Malone & Lepper, 1987) abilities? And how is the reader to understand the meaning of the images or text of the picture book without those more easily understandable animated clues that television or interactive media use? In other words, how is meaning created, interpreted and reacted to, much less used to create interest or intrinsic motivation?

To say that traditional (non-electronic) picture books are limited to just the effects of the words or pictures on a reader, or if read, to that of a passive listener, forgets to take into account at least one form of direct interaction that does occur with some picture books, that of the "readaloud." The processes involved in children's readalouds is the focus of Lawrence Sipe (2008), a long-time researcher into children's understanding of picture books and how these processes can be used by teachers to help create better learning environments for children that increase their literary understanding beyond simply comprehension.

Sipe's (2008) theory is set within a social constructivist paradigm, where people create reality by consensus; reality is not simply out there, but interpreted and shaped consciously by groups of people. Therefore, meaning-making and interpretation play critical roles in how we see the world and behave in society. Sipe's theory is that children respond in five different ways to picture book readalouds:

analytically (deconstructing narrative meaning), intertextually (relating the text to other texts or products), personally (connecting the text to their own lives), transparently (complete immersion) and performatively (manipulating the story to fit their own goals). These interactions show that they are active participants in the process of meaning-making and interpretation of stories even while the stories are in the process of being read.

Sipe (2008), as he notes himself, like many other major researchers in this field, believes in the power and influence of picture books and that "the arts are critically important in young children's school experiences, and that, rightly approached, picturebook readalouds can contribute to the thoughtful, foundational (and critical) views of life that art has the potential to enable" (p. 6). He believes that picture books expand children's ideas about themselves and their world, and are not simply for teaching basic comprehension or reading skills. Picture books teach children advanced cognitive skills, perspectives on real life, and an ability to think critically about issues, not to mention the ability to "imagine other, more just and equitable alternatives" (p. 7) to the current world they live in.

Sipe's (2008) own new theory will not be expanded upon in depth in this thesis. However, it is important to note that Sipe's focus is on the "readaloud," the reading of picture books to young children and how such activities can encourage a deeper understanding of the text, beyond simply comprehension and other reading skills. Sipe advocates a highly interactive reading session where children actively engage during the reading itself, as he believes that this immediate sort of interaction, when encouraged, increases interest, interaction and a deeper understanding of books – meaning making – all set within a socially constructed context influenced by personal experiences, family, culture, and especially the teacher/reader's own beliefs and values. He also notes the importance of the peritext, those parts of the book that are not text, but rather the images, cover art, endpages and even the act of turning the pages. All these things convey meaning, again within a social construct, and as far as Sipe is concerned, are highly underrated in their importance and influence, especially "the role of aesthetic response" (p. 243) and he encourages greater empirical research into the peritext aspects of picture books, for "the experience of

'story' may be one of the most powerful ways we have of imposing order and meaning on the world" (p. 247) and that "narrative is a crucial factor in the formation of identity"(p. 247).

I note that since STEM intervention-oriented research has also stressed the importance of interaction and engagement, Sipe's (2008) focus on high interaction, its impact on identity formation, cognitive processes such as meaning-making, and the ability to imagine new worlds and ideas – even within the context of a readaloud – rings a familiar chord. It is also important to note that Sipe emphasizes the importance of the peritext and its impact on the reader, just as Nodelman (1988, 2010) and others (Arizpe, 2009; Arizpe, 2010; Colomer, 2010; Christensen, 2010; Mjør, 2010; Nikolajeva, 2010) also emphasize the image and other non-textual elements, from the individual impact of each element to the impact of all elements in a book as a synergistic unit.

These non-textual elements are actually important factors in gaining a child's attention when children are allowed free choice of books and if the reaction is positive, helps peak their interest in reading the book, where a negative reaction to the peritext, from the inclusion of too many title pages to the depiction of something the children see as offensive (slaves), can convince a child to discard the book (Reuter, 2007).

While Sipe (2008) believes in the importance of the picture book, especially in the peritext of the book and believes the visual side of picture books need rigorous empirical analysis, his focus is on the interactivity that can be generated and harnessed by teachers during a readaloud. So what about the visual impact of picture books? What research has been done or theories promoted in understanding the power of images and other elements in peritext?

ENGAGEMENT AND VISUAL LITERACY – BARTHES' SEMIOTIC CODES AND SCHEMATA MODELS

In fact, I did find several theories related to visual literacy and the acquisition of literacy – whether visual or textual, shallow or deep – even if empirical (repeatable, falsifiable) experiments are not as plentiful as theories (or at least found during this thesis.) Many of the analyses often fall into a

qualitative analyses category such as observational, interview, or case study data gathering (asking a child what they think X or Y means, or observing how children respond or interact with material) (Arizpe, 2009; Evans, 1998; Evans, 2009; Evans, 2009; Nikolajeva, 2010; Pantaleo, 2009; Parkes, 1998; Sipe, 2008; Styles & Noble, 2009), and as such are more open to varied interpretation than quantitative analyses, as well as potentially creating falsifiable and repeatability issues. The work done in the 1980s on interest (Anderson, Shirey, Wilson & Fielding, 1987) and motivation (Malone & Lepper, 1987), by contrast, focused on quantitatively-based experiments, as has other research more recently (Reuter, 2007) especially research involved with interactive media, such as computer games (Calvert, Strong, Jacobs, Conger, 2007; Gentile et al., 2009; Korat & Or, 2010; Lee, Heeter & LaRose, 2010; Parker & Lepper, 1992; Tung & Deng, 2006).

In addition, content analysis, a qualitative/quantitative blend, has been performed on several corpuses of picture books and those results will be discussed in the content analysis section of this thesis.

Therefore, the theoretical side will now be further discussed – namely, visual literacy and multimodal communication and how such relate to the impact and effect of picture books. Visual literacy is the ability, quite simply, to understand what the images mean and is based on "encoding and decoding signs" (Nikolajeva, 2010, p. 28). Furthermore, the viewer must be able to make the connection between the signifier, the iconic sign, and what it represents. This includes the ability to generalize, meaning that even though a number of images may be used to mean the same signified referent, the viewer is expected to understand that such images are referring to the same thing or idea, such as any model of car still being perceived as the object "car." Viewers are also expected to understand that while the images are two dimensional in form, they represent a three dimensional world, and that more true-to-life images (such as photographs or highly photo-realistic drawings) are more realistic, while abstract or distorted images are recognized as more fictional. These abilities are just the basic levels of visual literacy, and without them, deeper levels of understanding, of meaning-making, cannot occur. (Nikolajeva, 2010)

Roland Barthes' work on reader-oriented semiotics, *S/Z*, is often cited as a way to understand the layers of meaning within both textual and non-textual narratives. Barthes' model is broken up into five

layers of codes: the proairetic, the hermeneutic, the semic, the symbolic, and the referential code. The proairetic code pertains to the ability to understand plot, that a narrative has temporal and causal components. In other words, that one event follows another and is caused by previous events. This is also called the anticipatory code since it creates anticipation and retrospection on the part of the reader. The reader anticipates events, including a conflict and a resolution, and this code also helps the reader make inferences about the connectedness of past, present and future events in the story. (as cited by Nikolajeva, 2010)

Nikolajeva (2010), who specifically seeks to apply Barthes' semiotics to picture books, states that the "most essential code in reading a picturebook is its sequential nature" (p. 29) and that images in a picture book are connected, not separate works of art. This is in agreement with Sipe's (2008) own understanding of how the peritext and text work synergistically to create their impact on the reader, that the narrative begins with the cover page and that even turning a page creates a sense of anticipation in the narrative itself.

The hermeneutic code is related to a deeper understanding of what the story means, and involves interpretation and awareness that there are deeper levels of meaning beyond being able to follow the sequential plot (as cited by Nikolajeva, 2010). In picture books, according to Nikolajeva (2010) but also in agreement with Nodelman (2010), image takes precedence over text, and both image and text are required to understand the actual meaning being implied. In fact, says Nikolajeva, "images can both amplify and seriously subvert the messages and values of the verbal text" (Nikolajeva, 2010, p. 32), that the "verbal and visual plots can be mutually redundant, complementary or contradictory; they may even be independent of each other" (p. 32), or there may be several visual plots, or the level of complexity of either the visual or the textual components need not be the same. She points out that an image can create a setting or particular mood, which contributes to the overall impression. All of these aspects and more make interpretation a complex task, or even a task with multiple even infinite potential outcomes.

The semic code refers to the ability to understand the characters in narratives as signs rather than as literal living people (as cited by Nikolajeva, 2010). Nikolajeva (2010) expands Barthes' model on this level, since she believes that the semic code should apply more broadly, to all fictional elements, rather than just fictional characters. Nikolajeva feels this is important in the study of picture books, or even all narratives, because "fiction is a construction, a constructed set of selected events and characters, deliberately created by the author" (p. 34) to communicate with the reader and evoke a specific effect. Moreover, "accuracy of detail, whether verbal or visual, does not automatically make literary space less fictional" (p. 34) since it is, in fact, a construction even if it creates the illusion of reality. This idea is reflective of Nodelman (1987), who also states that even non-fiction is actually fiction, since it is a construction, using specifically chosen elements to create a specific effect.

I note that the semic code is also the level where iconic signs (mimetic meanings) are found, or in other words, stereotypes, since stereotypes are iconic signs, easily recognizable for what they generalize and characterize (girl, boy, dog, cat), though the types of iconic signs and what they signify are directed by the deepest layer, the referential code, which points to cultural context.

Likewise, below Barthes' semic code is the symbolic code (as cited by Nikolajeva, 2010). Unlike iconic signs, symbolic codes are arbitrary in their meaning and depend upon decoding agreements between the sender and the receiver, such as dark forests meaning danger, or rainbows implying the concept of hope, says Nikolajeva. Obviously, as stated by Nikolajeva, symbolic meanings can be vague, contradictory and highly context dependent, making this level extremely difficult to decode. Also, the referential code level undoubtedly plays a role in how the symbolic codes are interpreted, not to mention semic or even potentially all the other levels since narrative expectations can change by culture or time period (as cited by Nikolajeva, 2010). With the referential code, again Nikolajeva expands it from Barthes' original in order to better, in her opinion, apply it to picture books and literary texts. According to Nikolajeva, referential codes should also include socio-historical understanding, not just a current cultural understanding. This also includes ideology (including covert ideology, i.e. implicit but not stated directly

in the text) inherent to the time and place when the book was written, or to what period the book is referring, and that again, she states, as with all the levels, means that the verbal and visual narratives need not agree, provoking counter messages, irony or other effects.

Barthes' model is not the only model used by picture book researchers. Picture book researchers such as Ingeborg Mjør (2010) also use schemata models (as part of cognition), the implied reader, and connotation to frame thinking about literacy, both textual and visual. The implied reader is the idea that the reader is assumed to already have certain knowledge about the world, "a set of competences and interests" (p. 179), from the ability to understand narrative form, as a base, to more advanced levels such as the ability to recognize and decode signs and symbols, and interpret their meanings. As noted by Mjør, parents, when reading to their children, may perceive that the child does not have the implied reader skills that the parent believes is necessary, and as a result the parent will use various strategies to overcome this deficit and explain to (teach) the child what the text *means*. Mjør states these strategies can be described via schemata modeling (a cognitive process) and connotation. I note that this could also apply equally well to any reader who is reading to someone else, including teachers.

In schemata modeling, according to Mjør (2010), also referred to as cultural or mental models by media researcher Bradd Shore (as cited by Mjør, 2010), we create structures of information, in other words, models, and these mental models are related to real world models in order to create meaning. As Mjør states, "when our brains can match external patterns with those already stored in memory, we experience *meaning*" (p. 180). Meaning is both a "discovery of the world and a kind of recognition of what we already have in mind" (p. 180), according to Shore (as cited by Mjør, 2010). Mjør uses a schemata model typology that includes "classifications, scripts, scenes, stories, and also emotion and gender models" (p. 180) where such concepts are flexible, overlapping and include "aspects of emotions, the body and the unconscious" (p. 180).

According to Mjør (2010), stereotypes are a vital type of classification, scripts are sequential everyday actions and show how to behave, scenes organize and tell us what to expect in certain places

(like a park or a restaurant), and story schemata are about narrative structure, telling us how stories are formed. Mjør did not discuss his view of gender or emotion models, except to say that "we relate to gender through models" (p. 181) and we are taught via cultural models how to feel and express feelings through particular body postures or facial features. He also notes that in his research, children already have specific mental schemata and models by the age of two, obtained through fiction as well as real life experiences.

Mjør (2010) also uses the concept of connotation. Denotation refers to the core meaning of a sign, such as the word white implying the quality, the color white, which all whites have in common. Connotation refers to additional, secondary, emotive meanings of a sign, such as white implying purity. Connotations can be individualistic and variable, as opposed to the idea that denotations are shared, common meanings. In connotation, Mjør also references Barthes in discussing meaning-making, particularly connotation as applied to visual imagery and the culturally shared aspects of connotative meaning, namely myths, also defined as broad concepts of ideology, says Mjør, such as "frenchness," or "militariness." As stated by Mjør, one aspect of "the collective character of connotations is that they function extremely well in the globalized mass culture, for example in advertising" (p. 181). Connotators can be of form (photogenia) or content (poses and objects). Parents, adults and the mass media teach children how to interpret these connotators, i.e. their meanings, such as the pose or poses that imply dizziness, hunger, or self-confidence. According to Mjør, "meanings like this influence how we experience what a picture actually communicates" (p. 182).

I find that schemata modeling, like Barthes' semic or even symbolic and referential codes, has direct ties with the impact of stereotypes and role models on society, since such schema are shorthand mechanisms used to quickly categorize and classify, and as Mjør (2010) says, that stereotypes are "a vital dimension of classification, they affect how we relate to information, especially our first reactions" (p. 180). As such, I believe that schemata modeling, connotators, and iconic signs should be considered in

discussions on intervention programs to encourage girls to engage positively with science and technology, and as such, to break stereotypical attitudes and beliefs.

ENGAGEMENT AND VISUAL LITERACY – CULTURAL CONNOTATORS AND STEREOTYPES

Stereotypes, as semiotic icons or cultural connotators, were definitely in evidence when Mjør (2010) examined the children's book *Apan fin* (1999) (the pretty monkey), noting that the book's lack of recognizable signs (i.e. iconic images/semic codes in Barthes' model) led to confusion about the monkey character's sex (female), especially since the more typical iconic meaning of a monkey, according to Mjør (and the referential codes that Mjør was using), was that a monkey is associated with masculinity. However, the gender ambiguity did not faze the children, who did not care. Mjør notes that it was the parent readers that had issues with the lack of recognizable gender signs since they were more familiar with the "semiotics of gender" (p. 188).

Similarly, Mjør (2010) noted that the bad dog in the story was not interpreted as such by the children, since their typical associations with dogs, both real and fictional, were positive associations. The dog stereotype in Swedish literature is positive. Also, in the story, the dog was interpreted to be a mongrel since the visual connotators in the story – how the dog was drawn – depicted what readers thought of when thinking of the stereotype of a mongrel dog, Mjør adds, though the dog was not ever explicitly declared as such. The discomfort with the negative, bad dog concept was also reflected with the parent readers, who Mjør found, under-communicated the badness of the dog, either quickly glossing over the point or changing the text to something different, like "big" dog.

Likewise, lack of the (implied reader) cultural awareness needed for a given picture book (the referential code level in Barthes' model) was investigated and demonstrated by Evelyn Arizpe (2009, 2010), who looked at research related to the ways children of different cultural and ethnic backgrounds react to children's picture books. She cited several examples where differing cultural backgrounds led to different ways of interpreting narratives, from focusing more on the text than the pictures, to outright rejection of homework and taking picture books home since, in that particular case, the Chinese student

was raised in a culture where picture books were a reward given after one had learned to read, not a mechanism for learning to read (Arizpe, 2010).

Arizpe (2010) also cited her own work and others that showed that the author's purpose (the implied reader) of a book was often lost on children from differing cultural backgrounds. For example, she cited one case where, instead of seeing aspects of the book as simply aesthetic choices or meant to be humorous, the children saw them as shocking and upsetting. Those aspects included "scribbles, torn paper and other desecrations" (p. 80) as well as feces, vomit or even admissions by the author of his/her own naughty behavior as a child. However, she did note that often the children eventually got the humor and were able to make connections between the texts and their own life experiences, but this was accomplished through discussion and dialogue with teachers and other children, essentially jointly negotiating the meaning of the texts. Yet, this didn't change the fact that the immigrant and minority children she worked with "took the moral of the texts and their educational potential very seriously" (p. 80) and were very concerned with discerning what part of the texts were 'true' and what parts were 'fiction.' Arizpe saw this as a good starting point for further research into the interplay of "different literacies and cultural affects" (p. 81) and the creation of "metaliterary awareness of verbal and visual texts and how this awareness might be developed further" (p. 81).

In fact, in support of Arizpe's findings regarding the importance of cultural awareness, both Teresa Colomer (2010) and Nina Christensen (2010) looked at how cultural values are encoded into children's picture books, indoctrinating children into their society (hierarchy, dominant values, educational goals, tools to accomplish those goals) as well as educating them on what is expected of them (attitudes, behaviors). Christensen traced how three different picture books from three different time periods reflected the current ideology of that period (the Christian paradigm, the Enlightenment, and the secularized modern view), or as Christensen put it, the role of the picture book was to teach the child "the organization of the world" (p. 55). Interestingly, Christensen notes that all three books, despite quite different ideologies, used the same mechanism for teaching the child reader about that ideology, namely

the use of vice versus virtue, but also noted that again, the books used complex visual codes and the child was "definitely expected to be a skilled reader of images" (p. 66).

Colomer's (2010) focus was related to Christensen's (2010) observations and dealt with how changing trends in society and in picture books offer challenges to literary criticism. In particular, that literary criticism of children's literature needs to reevaluate and address current trends, particularly, the need to address postmodern trends in regard to what is helpful as well as what forms (in current children's literature forms) might actually impede a child's educational process. Colomer believes that today's (and yesterday's) children's picture books are more concerned with what adults think childhood should be like, their own "nostalgia and desires" (p. 50), an idea that is also reflected by Nodelman (2010). She also states that literary criticism needs to address 1) appropriate themes for today's real children, such as depression, 2) the need for coherent narrative forms, 3) the limits of children's cognitive abilities and just how much complexity they can handle and 4) the value of an image that clearly conveys information as compared to a more complex, confusing one, even if the latter image is considered more artistic in value. Colomer's work in this regard was focused on what questions still need to be asked, rather than providing any definite answers.

Children may have more knowledge than adults give them credit for about the world, as Nodelman contends (1987, 2010), but they may not have the knowledge required for a book that assumes different cultural knowledge than their own, or they might misinterpret iconic images because they do not conform to the iconic signs that they are expecting based on their own current knowledge (Arizpe, 2010; Mjør, 2010). I think that the implication for narratives seeking to dislodge stereotypes, such as "math being hard," or "girls don't do science," is that breaking through these types of knowledge (semic, symbolic, referential, connotators, models.) may meet with heavy resistance, including perhaps disinterest and disengagement. I believe that a possible way around this problem might be to use stereotypes to break other stereotypes. For example, one could start with a stereotypical image of a girl (or girl animal), the recognized iconic sign/connotator, but then have the girl do something that is

counter-stereotypical, like skateboarding, physics, or even cutting her hair into what is considered a boy icon hairstyle. Also, I believe persuasion techniques as well as fictional (entertainment) techniques might also be critical in keeping interest engaged while the stereotypes are broken or, if you will, redefined.

Overall, the research done by or referenced by established experts in the field, such as Arizpe (2009, 2010), Colomer (2010), Christensen (2010), Mjør (2010), Nikolajeva (2010), Nodelman (1987, 1988, 2008, 2010) and others does imply that the construction of a counter-stereotype-oriented picture book requires careful thought and planning. So, even if semiotics, schemata and connotators are used to help create counter-stereotypes, what form of picture is most appropriate for encouraging science?

ENGAGEMENT AND THE EDUCATIONAL PICTURE BOOK (INFORMATIONAL OR STORYBOOK?)

Recent developments in picture book research have shifted from the historical emergence of picture books, as well as the idea of picture books as either an art form or educational tool but not both, to instead a focus on the complex aesthetic and cognitive processes involved in reading picture books, processes that can enhance or interfere with each other and therefore, the reader's process of interpretation and comprehension (Colomer, Kümmerling-Meibauer, & Silva-Díaz, 2010). In other words, picture books are both art form and educational tool, reflecting layers of meaning, and with the ability to "communicate on many levels and leave a deep imprint on a child's consciousness"(p. 1).

Perry Nodelman (1987), an authority on children's literature and particularly children's picture books, says that all books are essentially fiction, even non-fiction books, since all are specifically constructed by the author and/or illustrator to "represent a specific limited view of reality rather than anything like an absolutely objective reality in itself" (Nodelman, 1987, p. 161) and always expresses "the conscious and unconscious prejudices of its writer" (p. 161) and that writer's (and/or illustrator's) reality. This includes, he says, even those books written by scientists since a claim of objectivity also distorts reality, "by leaving out the distortions of subjectivity" (p. 161), or rather that scientists have biases whether they appreciate or not.

I duly note, from my own background in science and science jobs, that such subjectivity mentioned by Nodelman (1987) is part of the biases of any scientist, biases which the scientific method seeks to minimize but which scientists also acknowledge is never totally eliminated. It is why empirical, quantitative evidence is often desired over qualitative evidence, and likely why Sipe (2008) also desires it in order to more fully understand children's mental processes. Still, even in quantitative work, there is bias, even if just from the way experiments are designed, much less how the data is interpreted, so it always present. Recognizing that fact is important, I believe, and why cultural contexts should not be underrated in their effects.

Nodelman's (1987) views here are what researchers such as Colomer (2010) and Christensen (2010) have referred to as ideology or cultural values – as well as a particular set of assumptions about the reader of the book, the implied reader. Again, the implied reader is assumed to already have certain knowledge about the world, from the ability to understand narrative form in that culture, to the ability to recognize iconic signs (Barthes' semic code but potentially all the code levels in the Barthes model) and their meanings. Nodelman (1987) also contends that by trying to make learning fun, adults are sending a hidden message that learning isn't fun, since as he contends, "too many adults believe that facts about the real world are basically uninteresting, and that learning about them is basically boring" (p. 161). To this end, he was commenting on the issue of using fiction to engage children with education.

To be clear, Nodelman (1987) states that he doesn't want to imply that having fictional elements in non-fiction isn't fun, or imply that such elements detract from the educational. He merely wants to point out that it only proves the point that the line between fiction and non-fiction is non-existent. He also notes that the fears many adults have that children will confuse fiction with reality do not seem to hold water in his opinion, as he has never observed children that believe that talking, polyester clad *Sesame Street* characters are actually real, and would therefore identify with them in order to absorb the non-fictional material the creature was teaching. Nor does he see issues with teachers dressing up as such characters, as they might do in order to assume the characters supposedly identified-with authority

with the children. Children are not that gullible, he says, "they do not so much identify *with* such creatures as identify them *as* fictional and basically harmless" (p. 161).

What is needed, Nodelman (1987) contends, is for adults to teach children the difference, in other words, that non-fictional books do not represent pure reality and that the child should learn critical evaluation skills as a result – and that, unlike non-fictional works which contain some reality, fictional works are not reality at all. In doing this, he says, children can then simply, in regard to fictional elements, "acknowledge and enjoy its unreality" (p. 161). Nodelman is actually in favor of non-fiction books that are less obviously fictional and in fact, more factual, with fewer distortions of reality. He contends that such distortions can not only be seen with historical and biographical texts in their rendering of those subjects, but also with the implicit beliefs in what are supposed to be objective scientific works. He wants non-fictional books that are not "simplistic interpretations of factual information" (p. 161) since hiding the true complexity of the real world is lying to children – and given the media that children are already exposed to on a daily basis, they "are not likely to have reached the conclusion that books can and do describe the world which we actually perceive with our own senses" (p. 160).

I note that having fictional, entertaining elements in educational media does actually work (as cited by Fisch, 2004) and the research on interest (Anderson, Shirey, Wilson, & Fielding, 1987) and intrinsic motivation (Malone & Lepper, 1987) also supports its use, assuming the narrative and the educational content are well-designed and tightly integrated. However, Nodelman's (1987) points about distortions and biases in supposedly accurate non-fiction, as well as the acknowledgement that non-fiction, like fiction, is a constructed work, is well taken, as are his observations about the lack of gullibility in children, and the mismatch between what a child really experiences and what adults seem to think a child knows and experiences.

In fact, Nodelman (2010) states that typically the picture book reflects an adult's view of what childhood should be like, or rather what the adult wishes childhood and children to be like, not the true reality of childhood and children. Namely, he says, the child is "being invited to understand him or herself

as adults see and understand him or her" (p. 17) and that children's books teach "children how to be childlike, in terms of adult-authorized ideas of childlike-ness" (p. 19). This idea is also reflected by Colomer (2010).

The effect of this is that the pictures in picture books and their text are often, Nodelman (2010) says, at odds as a result, with the pictures reflecting a more realistic, complex, "sophisticated adult view of things" (p. 17) that is being ignored or withheld purposely in the simplified childlike text. The perspective used in the pictures also reflects the adult viewer, where the child protagonist in a picture book is typically seen (drawn) from a distance, and therefore seen by an invisible (adult) observer. This hidden adult (Nodelman, 2008, 2010) viewpoint is the one in which the child-reader is placed simply by reading the book. In other words, the child is forced to take the perspective of an adult.

Furthermore, Nodelman (2010) states that the images in picture books are self-defining but that the text associated with the images are, in fact, defined by the image – not the other way around. As Nodelman states, "a picture works to claim the world it purports to depict – to be realistic. To say a picture looks like the objects it depicts is to accept the idea that the real things do look like that" (p. 16) and that as such, pictures create their own truths. Pictures, says Nodelman, "claim words" (p. 16), and "claim them in the name of specific and surprisingly complex views not just of what the words mean, but of what reality is and means in general" (p. 17). Therefore, picture books, according to Nodelman, place child-readers within a complex web of interacting ideologies, not just of the author or the illustrator, but also of editors, publishers, librarians, teachers and parents.

These later views of the self-defining image seem to be an expansion of Nodelman's (1988) previous picture book theory, where he states that picture books are multimodal communication forms, unique in that the text and the images (the peritext) work together to give a complete meaning to story, that each is incomplete without the other, but the two never merge as in other multimodal forms. This interplay is very unique and complex, he notes, requiring many competencies in many areas to understand a picture book – even, a simple baby book is far more complex than most people realize

drawing on many assumed competencies, such as the idea of "book" itself, or linear narrative such as that which is automatically implied in an alphabet book where the letters are not random but in sequential order.

Nodelman (1988) acknowledges that his picture book theory draws heavily from semiotics and reader-response theories, as well as many others, including knowledge gained from cognitive psychology. Therefore, his work is focused on the idea that not only are the text and peritext interconnected and work together – to portray movement, create suspense, as well as to create/show continuity, or even irony when the two are in opposition – but that, along with other media forms, they teach children about the world, how to interact properly in that world, and even to see the world in new ways, yet always from a particular cultural context and worldview. Also, he states that the competencies that children need in order to understand picture books are very expansive and complex – children must be taught how to make meaning from both text and peritext; they do not just know these things automatically. Their meaning-making is socially constructed and guided by their society.

I believe these ideas, particularly the idea that non-fiction, like fiction, is just as deliberately constructed to create an artificial reality, has serious implications for informational books, which are often treated as if they are more factual, more pure, and more reflective of truth than fictional books. It would imply that the line between non-fiction and fiction is hardly the hard division that is often portrayed in discussions of the two forms, and therefore, the use of fictional techniques in non-fiction or rather education, especially to encourage interest, intrinsic motivation and learning, may not be as controversial as some opponents to the practice believe, as long as such techniques are carefully thought out and implemented (to avoid distortion or distraction).

In recent years, there has been considerable controversy over the merit of narrative non-fiction, also referred to as informational storybooks as compared with non-fiction without any fictional elements (informational books) (Bloom, 2003; Camp, 2000; Freedman, 1992; Hirth, 2002; Leal, 1993; Leal, 1995; Palmer & Stewart, 2003; Saul & Dieckman, 2005; Zarnowski, 1995). Programs and books such as *The*

Magic School Bus and *Sesame Street* fall into this category, as well as historical fiction or any fiction that incorporates factual information or settings. The concern from some opponents, or just those with a general interest, is that a mixing of fictional and non-fictional elements may confuse children (Zarnowski, 1995) or that children may fail to realize that there is a point-of-view or bias in such texts (Bloom, 2003; Freedman, 1992; Scanlon & Buckingham, 2002). Other opponents say that the learning aspects will be lost, as children focus on irrelevant information because it is more emotionally engaging, and therefore will not be able to recall the important facts to be learned (Garner, Alexander, Gillingham, Kulikowich, & Brown, 1991; Wade, 1990).

Proponents, while acknowledging that irrelevant information is a concern (Anderson, Shirey, Wilson, & Fielding, 1987; Fisch, 2005; Garner, Alexander, Gillingham, Kulikowich, & Brown, 1991; Wade, 1990), state that children do not confuse reality with fantasy (Nodelman, 1987; Parker & Lepper, 1992; Tunnell, 1994), that fantasy – or just a sense of *being there* – is actually good, not just for engagement but also for creativity and learning (Beck, Nelson-Faulkner, & Pierce, 2000; Crawford & Zygouris-Coe, 2008; Fisch, 2005; Parker & Lepper, 1992; Rycik & Rosler, 2009; Tunnell, 1994). In fact, as long as children are helped to understand the difference between the fictional and non-fictional elements (and the potential bias in the work) then exposure to quality, informational fiction may heighten their interest and spur them to see out more detailed information from other sources (as well as other points of view) (Beck, Nelson-Faulkner, & Pierce, 2000; Crawford & Zygouris-Coe, 2008; Harmon & Gonzalez, 2003; Power, 2003; Roser & Keehn, 2002; Rycik & Rosler, 2009).

Proponents also contend that the success of shows like *Sesame Street* and *The Magic School Bus* and their impact on increased reading and comprehension, as well as increased knowledge of and interest in science, speak for themselves (Fisch, 2005). The main point is that as long as the program is thoughtfully and carefully constructed, eliminating irrelevant facts that distract the reader/viewer, and remains focused on teaching the important information in innovative and entertaining ways, then the reader/viewer becomes highly engaged (high interest) with the relevant information (Anderson, Shirey,

Wilson, & Fielding, 1987; Fisch, 2005; Tunnell, 1994). High engagement and interest are recognized as key components in learning and recall (Anderson, Shirey, Wilson, & Fielding, 1987; Fisch, 2005; Malone & Lepper, 1987; Parker & Lepper, 1992).

So then, a picture book is a complex, fictional interplay of text and peritext, which requires many culturally-situated competencies in order to be understood. Such books can be engaging even if they lack some of the multimodal abilities of other media forms like television. Also, these books, like other media, also educate children about the world and their role in that world, including how they should behave and think in that world. Therefore, all narratives are educational in some way, and if Nodelman (1987) is correct, the line between fiction and non-fiction is a highly suspect one, but if the narrative is carefully constructed, its educational usefulness can be powerful, regardless of the book's status of fiction or non-fiction.

Therefore, in regard to girls in particular, what kind of narrative might engage them? According to theorists about engagement, children are supposed to be able to identify with the protagonist and want to emulate the protagonist's actions (Anderson, Shirey, Wilson, & Fielding, 1987; Fisch, 2005; Malone & Lepper, 1987; Parker & Lepper, 1992). Yet, for stories also trying to encourage girls into STEM fields, many stereotypes must be battled as well and the girl reader's worldview changed as a result. Girls need a hero they can believe in and emulate.

ENGAGEMENT AND THE FEMALE HERO

Every child needs to be a hero, not a heroine. So what is the difference and what does such a concept have to do with storytelling, particularly for girls' interest in STEM fields? The focus of this thesis is to first understand the problems facing encouraging girls and women into STEM fields. However, the focus then shifts toward creating theory-based guidelines for creating effective, engaging children's books that focus on empowering girls against negative stereotypes, and also simultaneously engage their interest and intrinsic motivation toward science, engineering and mathematics.

So far, the path to that goal has proven to have had many layers and potential obstacles, from the need to create interest and intrinsic motivation via various potential techniques, to the need to understand the schemata models and semiotic codes at work, to even the need to take into account the implied reader, both the adult and the child. Yet even this information is not enough, for the explicit goal is aimed at girls, not at all children, and a secondary goal is to break old stereotypes while encouraging new ones – new ways of seeing and organizing the world, new iconic images that work on the semic, symbolic and referential code levels, and yet to still tie these ideas into research about quality informational/educational books. As a result, tools are needed, ones that are explicitly designed to reach 1) girls and 2) persuade the reader/viewer to adopt a new attitude or behavior. That is exactly what Pearson and Pope (1976, 1981) contribute with their work on the female hero and how that female hero's journey is different than the culturally designed idea of the heroine.

Pearson and Pope (1976, 1981) have done in-depth literary analyses into British and American literary portrayals of women. From this they articulate the effects of patriarchal society as well as demonstrate that the neglected female hero does, in fact, exist, and furthermore, the female hero's journey is similar to the archetypical hero stages, i.e. the monomyth with its departure, initiation and return stages, with includes several elements in each stage, including the call to adventure, supernatural intervention, first threshold, chaos entry, reconciliation, etc. as described by Joseph Campbell and others (Pearson & Pope, 1981). However, Pearson and Pope state that there are important differences as well. These differences are specific to the female hero's (or the minority subculture hero's) need to deal with and break out of a male-dominated society and stereotypical cultural expectations arising from that male-worldview (Pearson & Pope, 1976).

According to Pearson and Pope (1976), women "become our own best jailers when we internalize societal and parental messages" (Pearson & Pope, 1976, p. 2) and freedom from that "depends on an understanding of the psychological elements and cultural assumptions" (p. 2) which cause women

to accept such internalizations and then to treat other women, or allow themselves to be treated by men, according to such damaging stereotypes.

Pearson and Pope (1976) look at historical literature which they freely admit has only survived because it was valued by men (or mostly men), noting that subculture writings often do not survive because they are not valued by the dominant (male) culture. Additionally, subcultures often internalize the values of the dominant culture, further reducing the likelihood of finding pure examples of the subculture. Instead, what is left to be analyzed often has a dual perspective, both dominant and subculture, but often the subculture message is diluted. However, even so, a "closer reading of even the most traditional works often demonstrates that literature is more interesting and complicated than cultural myths or stereotypes" (p. 3) perpetuated by those in power, since the realistic literature of the times, by both men and women, often explore the negative effects of cultural myths about women. They cite several examples of such works including Gustave Flaubert's *Madame Bovary* and Robert Browning's *The Ring and the Book*.

Pearson and Pope (1976, 1981) spend entire books analyzing this subject, but in sum, in their book, *Who Am I This Time?*, Pearson and Pope (1976) define six types of women in two categories: heroine and hero. The heroine category are the traditional, stereotypical ones, namely "The Virgin," "The Mistress" and "The Helpmate" which are equivalent to Joseph Campbell's goddess, temptress and earth mother, which are present in the male hero's journey. The female hero category includes "The Sage," "The Artist" and "The Warrior." These roles are, in Campbell's male-centric version, roles reserved only for men. According to Pearson and Pope (1981), if women take on these roles and refuse to be mastered by men, they are portrayed as villains in the literature.

Campbell's focus on men and male-dominated stereotypes (and therefore his archetypes) has been criticized by Pearson and Pope as well as others (Goertz, 2010; Pearson & Pope, 1981; Perlich, 2010; Whitt, 2010). Many of these critics seek redefinition and expansion of his monomyth so that it is more inclusive of gender and subculture differences (Goertz, 2010; Pearson & Pope, 1981; Perlich, 2010; Whitt,

2010), especially his view that the hero is male and his goal is to dominate and master the world, while the female heroine's goal is to be the "mastered world" (Pearson & Pope, 1981, p. 4). Goertz (2010), in particular, also seeks a better understanding regarding variances by culture. Later in his career, in an interview with Bill Moyer (as cited by Whitt, 2010), Campbell did mention the gender issue, saying that for women, childbirth is equivalent to a heroic act, but many critics still see such framing as driven by a male-oriented worldview assumption (Whitt, 2010).

Pearson and Pope (1976) seek to define the hero more neutrally, and judge the hero by his or her actions in the world, even as they allow that women (or any subculture) face difficulties on the hero's path that are not shared by those that are part of the dominant culture – such as oppression by the dominant culture. In doing so, they clarify the relationship between myth/archetype/stereotype to cultural reality, saying that the roles that men limit women to are related to how men avoid responsibility for their own actions and desires. They "project onto women qualities they hate or deny in themselves or qualities they desire but feel they lack. In doing so, a man does not deal with these positive or negative qualities within him because the focal point of his response is not the female within but a real woman" (p. 6) and "although men have wielded political control for thousands of years, they often present themselves as having little effect on human history, while women...often are credited with causing all human events" (p. 6) to which Pearson and Pope reference fictional figures like Helen of Troy, Delilah and Eve.

According to Pearson's and Pope's (1976) research, women are either blamed for all the problems in the world, or all problems in the man, or they are often "totally absent or are treated sadistically" (p. 7). Women are often portrayed in a bi-polar way, either all good or completely evil. Pearson and Pope cite how these stereotypical views often affected real life, like in Victorian England where the upper-class, light-skinned woman was the stereotype of good, while the working-class or dark-skinned woman was evil. The result was that after the passage of the Contagious Diseases Act in the 1860s, upper-class women were left unmolested, but those in the lower classes were subject to arrest

and forced examination for venereal disease. Similarly, the values that a culture defines as positive are "generally seen as male; women therefore are defined as embodiments of the opposite, negative qualities" such as the implied meaning of manly as strong versus womanly as weak.

Trying to give a woman manly characteristics then, say Pearson and Pope (1976), like strength, assertiveness, or intelligence, was considered unnatural, or if such were applied in literature, these traits were often associated in a negative way, like the evil queen in Snow White. Yet the ideal for women, as defined by men, was also a justification to treat women (or another subculture) in particular ways. "When women are defined as passive, their passivity may be interpreted as frailty and moral weakness. Like slaves and children, women are portrayed as needing care and control because they are physically and/or morally weak. The ideal then becomes a justification for subjection" (p. 8). The culture is affected by these stereotypes, say Pearson and Pope, and when internalized by women, it also affects their psyche and behavior. Women try to emulate the positive ideals defined for them and avoid the negative. This assertion by Pearson and Pope has already been corroborated by researchers into the effects of stereotypes (see part one of this literature review).

In addition, Pearson and Pope (1976) also note that adhering to the ideal defined by men is still damaging, since every heroine role has a darker side as well. The beautiful virgin is also portrayed as helpless, passive and trivial. The temptress is a whore needing to be punished. The goddess is frigid. The virgin turned wife becomes the drudge or the shrew; she is now considered shallow and unproductive once she is no longer the pure, sexually desired virgin, and is instead, a housewife. The older version of the virgin, the virgin that remains unmarried, becomes the old maid. In all cases, once she is no longer beautiful, each type of woman is to be cast off and is likely to be portrayed as poor, say Pearson and Pope. The heroine roles are dead ends for women seeking to become their own person. The hero roles, by contrast, say Pearson and Pope, do offer such fulfillment but do require fighting against dominant cultural values and restrictions.

According to Pearson and Pope (1976), the sage is wise, the artist transforms her world but only the warrior openly "refuses to be seen as a supporting character in a man's drama" (p. 9) and changes her world through direct action. As such, only the warrior category is likely to be recognized by men as a hero role, but according to Pearson and Pope, the other two roles demonstrate how female heroes differ from the dominant cultural male view of a hero, but only because this is how female heroes have evolved given the restrictions and limitations in a patriarchal society.

Pearson and Pope (1976) spend most of their time analyzing literature for these six role types of women, but they also note that the times are changing and that women's myths are being redefined somewhat such that women are being portrayed as "both mythically powerful and capable of active heroism in the world" (p. 11) allowing them to be considered intelligent, sexual, independent, aggressive, nurturing, loving and effective. In regards to these gradual changes (as seen in 1976 at least), Pearson and Pope hoped that these new views would lead to women leading fuller, richer lives, and that society would likewise change and adjust to a more balanced view of both women and men, their roles, and their rights.

More recent researchers have indeed noticed more female hero characters in modern literature and film (Goertz, 2010; Gorsevski, 2010; Perlich, 2010; Whitt, 2010), though as John Perlich (2010) notes, these female heroes are still more the exception than the rule. "Modern film, fiction, and television often include women as 'friends to provide aid' (Whitt, 2010) rather than heroes with stories of their own" (Perlich, 2010, p. 102) and he cites such heroines as Princess Leia from the *Star Wars* series, Hermione from the *Harry Potter* series, and Eowyn from the *The Lord of the Rings* series. All of these women are strong female characters, but all are secondary, helpful characters to the main hero and his story.

Since the warrior role is the most easily recognized, I believe it is the easiest to portray in children's picture books, since child readers benefit from directness over complexity (Colomer, 2010). However, I think including elements of the artist and sage roles, if relevant to the narrative, might also be beneficial, implying that the ideal to use in a girl-focused book might be a wise, artistic/transformational

warrior. However, Pearson and Pope (1976) clearly articulate the need to avoid heroine roles or stereotypes that perpetuate female ineffectiveness and disrespect, so, the girl protagonist, therefore, should not reflect the heroine types. Still, given the needs to include iconic signs to help the child reader recognize and identify with the protagonist (Mjør, 2010), some stereotypical aspects may be needed – as a way to persuade the reader that the protagonist character is one that can be identified with and is worthy to be emulated.

This means the transformative aspects of the female hero may be useful to help persuade the reader to shift from a stereotype to a new way of viewing the protagonist, and in fact, transformation is actually part of the hero's journey, so it makes sense in a narrative way as well. In fact, advertising is all about convincing consumers to think in certain ways (Cialdini, 2001; Harris, 1999; Sparks, 2002), so it may be useful to look at the basis of advertising, namely persuasion and influence.

ENGAGEMENT AND PERSUASION

In terms of tools to accurately and effectively influence and change attitudes, researchers like Cialdini (2001) work to understand persuasion and how persuasive techniques work, with specific thoughts on how these techniques might be used in all contexts, not just advertising or sales. After all, a persuasive, engaging, motivating, counter-stereotype girls' children's book is an attempt at persuasion, as are all books that educate children, since as Nodelman (1988) and others have already stated, these books teach children their role in society, that society's ideology, values and attitudes, and what expectations children can have about themselves within that cultural context. Persuasion is most definitely, even if it is implicit, part of that acculturation process.

Robert Cialdini (2001) is a highly respected professor of psychology and expert on the subject of influence. In his widely acclaimed book *Influence*, Cialdini details the current research and findings regarding the mechanisms of the influence process (persuasion, compliance and change.) Cialdini categorizes compliance strategies (ways to make you say "yes" – used by sales, advertising, public relations, fund-raising and other areas) into six basic categories: reciprocity, consistency, social proof,

liking, authority and scarcity. He discusses each of these in terms of their social function and how they are harnessed by a *compliance professional*. He also states that *material self-interest* (i.e. getting a good deal) is implicit in the process, so he does not treat the area of self-interest as a separate category.

According to Cialdini's (2001) research, part of persuasion involves a human tendency called fixed-action patterns, which can be quite complex sequences of behaviors but have the fundamental characteristic that they are automatic and virtually identical each time they are activated. The interesting aspect of these automatic reactions is that they are activated by a trigger feature, which can be a very simple, specific cue.

For example, Cialdini (2001) says, an animal acts to defend its territory when a rival intrudes. It isn't the rival itself that is the trigger, but some specific feature of the rival, like the colors of particular feathers. He notes that a male robin will attack another (a stuffed version in the experiment) if certain tail feathers are present, but will not attack if those tail feathers are missing. He also notes that an experiment by social psychologist Ellen Langer and her associates showed that people waiting for a copy machine allowed a young woman ahead of them, not because she was in a hurry, or only had a few pages to copy, but because she used the word "because" in the request. Without that trigger word, she wasn't allowed to cut in (as cited by Cialdini, 2001). As Cialdini put it, human beings simply "like to have reasons for what they do" (p. 4). The reason itself was less important than the trigger word that implied a reason.

This "automatic, stereotyped behavior" (Cialdini, 2001, p. 7) which is prevalent in much human action, says Cialdini, is necessary given the complex society in which humans live. To deal with our environment, we need shortcuts. Humans don't have the time to critically analyze all people, events and situations, so instead, he says, we use "stereotypes, our rules of thumb, to classify things according to a few key features and then to respond without thinking when one or another of these trigger features is present" (p. 7). These shortcuts are also referred to as "judgmental heuristics" (p. 8) and the ones related to persuasion are "those heuristics that tell us when to believe or do what we are told" (p. 8).

Cialdini (2001) also notes the dangers of this kind of mental shortcutting, saying "there is an unsettling tendency in our society to accept unthinkingly the statements and directions of individuals who appear to be authorities on the topic" but also notes that these triggers and behaviors are not necessarily always engaged, machine-like. Instead, when the subject is important to us, a single trigger is unlikely to cause an automatic response. People will respond in a controlled (not automatic), thoughtful fashion when they have both the desire and the ability to do so, but given that, Cialdini still cautions that modern life, with its hectic pace, mental fatigue, highly distractive nature, as well as emotional and information overload "is not allowing us to make fully thoughtful decisions, even on many personally relevant topics" (p. 9).

I note that this is why stereotypes are both useful and potentially damaging, but that we cannot get away from them. Whether we like it or not, as humans in a society, we will use stereotypes as shortcuts, so the key in terms of this thesis (girls and STEM), is to change girls' stereotypes about STEM and their own role in STEM from negative to positive stereotypes.

Cialdini's (2001) six categories of persuasion (compliance) are about recognizing and using these behavioral triggers. Each is relatively self-explanatory. Reciprocation is the idea that if you give something, even if the other party didn't ask for it, the other party will feel obligated to return the favor at some point in the future when you ask. The favor you do the other person doesn't even have to be big. Politicians use this type of persuasion all the time. The favor could also be a concession rather than some kind of gift. The second rule is consistency. Once we make a choice or take a stand, we feel personal and interpersonal pressures to behave consistently with that commitment. Cialdini cites research about horse betters as an example. After betting on a particular horse, the better showed more confidence and belief that the horse would win. He also cites the sad tale of a woman who stuck with her man despite that man breaking all of his promises to her. Why? She did it because she felt the need to be consistent and believe in her choice.

The third rule is social proof. It's the reason, Cialdini (2001) says, why canned laugh tracks are so popular in television, or why bartenders salt their tip jars, and why advertisers describe a product as fast selling and then describe several people who have bought and loved the product. "*We view a behavior as correct in a given situation to the degree we see others performing it*" (p. 100). Interestingly, this is related to copying behavior seen in the media. Cialdini cited some Robert O'Connor experiments from the early 70s that showed shy, withdrawn children. These children watched and then subsequently mimicked the behavior of normal social children playing in a film (as cited by Cialdini, 2001). Cialdini also cited other similar experimental evidence as well. Children learned to mimic the behaviors of other children. This effect was observed through watching live children or media. Cialdini cited other evidence, with adults, that also showed the same effect – watching others, especially large groups of other individuals, led to copying behavior, even if that behavior was to do nothing and not help an accident victim (as cited by Cialdini, 2001).

The fourth rule is the liking rule and is quite simple, as stated by Cialdini (2001). We want to be liked. It's the pressure of friendship and wanting social approval. Sales people try to first get the target to like them, make them feel like they are the person's friend. Additionally, invoking the idea of friendship works also, he says. For example, the sales person says the target's friend recommended them or that their friend likes the product. However, liking, Cialdini says, also involves other traits: physical attractiveness, similarity to the other person (dress, background, interests, age, religion, habits, etc.), compliments, familiarity (greater exposure increases liking), cooperation (mutual benefit, common goals), and positive associations (avoiding being associated with bad things/bad news but instead being associated with good things or good news, even including a good lunch or a winning sports team).

The fifth rule is authority (directed deference) according to Cialdini (2001). This rule is widely known. We tend to respect and believe in authority figures, as long as we recognize them as authority figures. Stanley Milgram exposed this effect quite dramatically in the 60s and early 70s, where a person gave another an electric shock, despite pleas by the victim for the pain to stop. The victim was just

playacting but the surprisingly result was that the majority of people, despite wanting to stop giving the shocks, complied with the authority figure in the room (as cited by Cialdini, 2001). Cialdini notes the most interesting thing about the authority rule is that all that is needed is the appearance of authority, not proof of authority. Several symbols, he says, trigger our authority behavior response including titles, clothes and other trappings of authority, such as jewelry, expensive clothing, cars, and even height (taller = more authority, more status). These symbols are culturally specific.

Finally, the sixth rule, according to Cialdini (2001), is scarcity. "*Opportunities seem more valuable to us when they are less available*" (p. 205). People are more afraid of losing something than gaining something, so prevention ads work better when designed to stress what might be lost, such as losing years of life if one continues to smoke. Also, time limits, limited quantities, and even censorship also indicate scarcity and invoke automatic responses. As Cialdini notes, this is also tied in with an automatic response to be contrary, i.e. told you can't do something, or can't have something, makes you want to do or get that thing desperately. Cialdini also says that both something that is recently scarce rather than scarce all along, as well as the need to compete for something, heightens the emotional arousal effect of scarcity, and thereby, according to Cialdini, makes it more difficult to cognitively fight the trigger urge.

I believe both the work of Cialdini (2001) and Pearson and Pope (1976, 1981) offer opportunities for the effective creation of children's books aimed at increasing girls' STEM interest, especially picture books since they are visual in nature and therefore images of behavior can be shown and hopefully mimicked. A narrative could be created that emphasized the female active hero who is also persuasively appealing. This will be discussed in the synthesis (guidelines) section of the thesis.

In sum, this expansive, interdisciplinary literature review not only shows that the issue with a lack of girls in STEM is a systemic one, but that children's picture books do offer a potentially viable intervention method, and that this is based on current visual literacy theory and children's education through media. (That said, it is also possible that children's books are not acting as an intervention against stereotypes, but rather as a vehicle for promoting them.) The final part of this thesis will add to

the body of knowledge already gained through content analyses of children's books, and do so through a mixed methods content analysis of award winning informational children's books, a genre of children's books typically not investigated when compared with other content analyses, which, as found during this thesis' literature review, focus on fictional works rather than informational/non-fictional works. The goal is to find out what messages informational children's books are sending to child readers.

CONTENT ANALYSIS

GENDER BIAS IN CHILDREN'S BOOKS – CURRENT CONTENT ANALYSIS FINDINGS

In order to evaluate the lessons gleaned from this expansive, interdisciplinary literature review – a review which implies that there should be no significant differences in learning between girls and boys, but does seem to indicate that stereotypes and cultural conditional may play a strong role in how children envision themselves – a content analysis of informational children's books was done. One of the primary questions involved was whether children's books are showing any imbalances, particularly gender bias or restrictive stereotypes. What exactly are children seeing and potentially internalizing as their models of behavior, in other words, their iconic signs and cultural values?

Again, this is important because if children learn their roles in society as well as many of their beliefs from media, including books, as so many researchers contend, then it is possible that gender bias and stereotypical roles in books contribute to the choices that girls (and boys) make later in life. Also, since one particular cultural conditioning mechanism that influences girls and boys about how to behave in society is reading books – from picture books to chapter books, whether fictional or non, or whether a textbook or informational trade book – then what exactly are books teaching children? Is there gender bias or gender role bias?

Shirley Ernst (1995) studied five years of Caldecott and Newbery Award winners in the 1990's and found heavy gender bias in which males were more prominent than females in these fictional stories. She also looked at 2000 titles in The Horn Book Guides in 92-93, and she found males outnumbering females by two to one, or even three to one when just looking at biographies (p. 71). When she looked at Caldecott and Newbery in-depth (1991-1994), she found similar results and that male roles and attributes were more positive and active than those given to female characters. With all characters total in the books, she found about 60% were male in Caldecott and that Newberry had similar statistics (p. 72). This

was in line with previous research into gender bias and stereotyping in books from the 1980's and 1970's, and continues to be the result typically found by other researchers today when looking at popular children's picture books and literature (Gooden & Gooden, 2001; Hamilton et al., 2006; Kolbe & La Voie, 1981; Tepper & Wright Cassidy, 1999; Tsao, 2008).

However, this does not imply there has been no progress toward gender equity in roles, presence and traits. In fact, Clark, Almeida, Gurka and Middleton (as cited by Stier Adler & Clarke, 2003) examined Caldecott winners and runner-ups from 1997 to 2001 to determine if female characters had become more visible and all characters less stereotyped. They found that while the most significant improvements happened during the 1980s, the late 1990s also showed improvements, even if there was a slight backward trend in some areas when compared with the advances in the 1980s. However, based on their data, with 31.6% of their corpus of books having a central female character and a 2.3 to 1 male to female ratio (p. 381), females still had not achieved visual equity. (They did find that female non-human characters now outnumbered male non-human characters in stories, but the authors largely attributed that change to the sheer number of illustrations in one particular book). On a highly positive note though, Clark et al. did find among this corpus, a much more even distribution of positive, strong traits, showing significant progress on anti-stereotypical characterizations.

In sum, it is important to keep all data, good and bad, in perspective. Ernst (1995), in fact, noted that the world is full of books of all types, so selecting a narrow range to analyze does not necessarily imply something normative for the general case. However, Ernst also noted that award winning books are much more likely to be in school libraries and therefore it is more likely that these award winning books, considered books to be of the highest quality, will be some of the books exposed to children during their education. Therefore, if these quality fiction books are still gender biased, however improved, then school children are indeed being exposed to a gender biased view of the world and their own choice of role in that world.

WHY EXAMINE INFORMATIONAL (NON-FICTION) CHILDREN'S BOOKS?

So, if Caldecott and Newbery winners, which are fictional works, are potentially showing young readers a gender biased view of the world, and similar but varying results have been found with popular children's books and literature, what then might quality non-fiction (informational) books be telling young readers? Informational books are books intended to show and teach about real life events or science. These books are supposedly free of seductive or distracting information (Garner, Alexander, Gillingham, Kulikowich, & Brown, 1991; Wade, 1990) that misdirects the reader away from the intended lesson. However, are such books teaching young readers that certain roles are denied to them? Is that the lesson being learned, intentional or not? Given the fact that, according to the research (Encouraging the participation of female students in the STEM fields, 2009), middle school is the first primary turning point for science interest, where many girls turn away from STEM oriented careers, it then makes sense to look at aspects of K-8 education that may affect STEM interest, including books. Caldecott and Newbery would also be included in this, since role models and attributes are gained from many sources, but in particular, informational texts, by their very nature, play an important part in science and math development and interest.

METHODOLOGY

INFORMATIONAL AWARD WINNERS AS CORPORA SELECTED

So to add to the already extensive content analyses of fictional award winners and popular children's books, this research explored two sets of informational (non-fiction) award winning books, namely, Sibert award winners and Orbis Pictus award winners.

First, the Robert F. Sibert Informational Book Award was established by and is administered by the Association for Library Service to Children (ALSC). It was established in 2001 and is awarded annually to the author(s) and illustrator(s) of the most distinguished informational book published in the English language during the preceding year (Sibert Award website). Second, the National Council of Teachers of English (NCTE) Orbis Pictus Award for Outstanding Nonfiction for Children was established in 1990 to promote and recognize excellence in writing of nonfiction for children (Orbis Pictus Award website).

Eleven years of Sibert winners (2001 – 2011) and twelve years of Orbis Pictus winners (2000 – 2011) were examined, using titles, book cover images, images within the books, and either associate story text or caption text for each image. The examination was not as in-depth as Ernst since it did not try to categorize the text of each book, but rather focused on the images being displayed as well as some basic related text for that particular image.

APPLYING PICTURE BOOK THEORY – PICTORIAL ANALYSIS IMPORTANCE

A mixed methods image content analysis was chosen for two reasons: 1) to understand how the artwork defines the possible message(s) being conveyed, and 2) to get a feel for what even a small child might perceive, a child that could not read the text but certainly could look at the pictures and make inferences as a result.

Researchers have stressed that children do make inferences even from picture books, so they do learn from what they see, not just what they hear or read (Carr, Buchanan, Wentz, Weiss, & Brant, 2001; Chatton, 2001; Galda & Short, 1993; Richards & Anderson, 2003). However, without proper context this "simply looking at the pictures" may lead to incorrect evaluations of what those pictures mean (Beach, 1995; Nauman, 1999; Richards & Anderson, 2003). Additionally, this inference ability includes learning physics as well as computer and engineering concepts, even when in kindergarten (Leung, 2008; Rogers & Portsmouth, 2004). Therefore, even a child that is not the intended audience of the book might be attracted to one of these informational books in a library (or classroom) for a number of "aesthetic relevance" reasons (Reuter, 2007). For example, the child might simply like the cover and therefore look at the pages.

Also, choosing to look at Sibert and Orbis Pictus award winners relates to claims that informational trade books in general tend to be more fun, more focused on in-depth topics, and are easier to understand than standard school textbooks, and that they have quality pictures that enhance the text. Such claims are reasons why the use of quality informational books is encouraged in science teaching (Camp, 2000; Freeman & Goetz Person, 1998; Leal, 1993; Palmer & Stewart, 2003; Saul &

Dieckman, 2005; Sunanon Webster, 2009; Zarnowski, 1995) and again why such books might be available to young readers in the classroom or school library. Also, award winning books are expected to have relevant pictures that enhance the meaning of the narrative, rather than distracting elements, called seductive information (Garner, Alexander, Gillingham, Kulikowich, & Brown, 1991; Wade, 1990), that detract from learning the intended message. So, while these quality claims may not be the case, or also why children might still misread such images, at least with award winning books, one expects relevant pictures that add to and convey similar meanings to the textual content.

Therefore, it seems reasonable to assume that even if unable to comprehend the text, a child might still be exposed to such books, look at the artwork, and be influenced in their worldview.

MIXED METHODS USE – QUANTITATIVE (FREQUENCY/RATIO) AND QUALITATIVE (EXPLORATORY/ROLES)

This analysis was primarily pictorial, with the text associated with each image as a secondary source. Two methods were used. A mixed method approach is often used to incorporate a qualitative component into an otherwise quantitative study, or to build from one phase of a study to another, such as following up a quantitative study qualitatively to obtain more detailed, if less conclusive, information. Quantitative analysis was used for determining frequency (counts of numbers of males or females per image). Qualitative content analysis was used to obtain a list of roles (mother, father, activist) or activities (riding rails, taking bath, playing with dolls). The quantitative content analysis used a single coder over two time periods, rather than the more traditional two coder at one time period method. Reliability of this alternative method is discussed further on in this section. Validity of some of the qualitative study (the list of roles/activities gleaned per image) is also discussed, though the interpretation of the meaning of both qualitative and quantitative results is admittedly subjective.

The following questions were posed:

- 1) What is the frequency of males in images to females in images overall? (quantitative)
- 2) What is the frequency of males to females as the focus of each image? (quantitative)

- 3) What roles or dominant activities are being assigned to males, females or both groups?
(qualitative)

Each book was examined using the following procedure. The title was read (sans any other information) and judged on whether it seemed to be about a male, a female, or neither if it was ambiguous or about something other than a particular person. The cover image was examined in the same way and notes were taken as to what it showed. The back cover was also examined in this way. Next, more information was used (summary, actual text of book) to determine who the main protagonists were (male, female) even if the topic is not specifically about them. For example, M.L.K. Journey of a King is clearly focused on a male and this information is easy to determine using just the title (or the cover image), but the human subject (if any) for Quest for the Tree Kangaroo is not as readily apparent from either the title or the cover image. In the latter case, using additional information contained within the book, one finds that the book focuses on the efforts of a female scientist who is studying the kangaroo. Likewise, The Wall's main character cannot be determined from the title or cover image, but with additional information within the book, one easily determines that the author, a male, is describing his own life.

Next, all the images between the covers were counted, including small iconic images (often just decorative chapter markers) or background images (even just patterns) inside each cover page if they seemed "noticeable," which is admittedly a highly interpretative process. Any images attached to the covers were excluded, including the inset/folded part of the cover page that one can see when one opens the book. For each image then, the number of distinguishable male or female figures was counted, and an attempt was made to determine whether they were a focus character or a background character. Some figures could not be distinguished as either male or female and were excluded. Likewise, not all the figures were counted in large crowd scenes simply because they were too blurry to count individuals and make distinctions between maleness or femaleness. However, as many as possible were counted in these crowd scenes and their gender assessed, even if the impression was vague; this is also a highly

interpretative process, but according to machine vision research, humans have an exceptional capacity to recognize and categorize even extremely information poor images, especially if the images are familiar to them (as cited by Szeliski, 2011).

Finally, both images and the story (for simple picture books) or picture captions (for text-heavy chapter books) were examined for roles and performed activities (mother, father, niece, dancer, singer, leader, soldier, holding baby, riding rail, going to movie, etc.) The numbers of males versus females were then added and summary information given about 1) the two corpora as a whole, 2) each corpora as a separate collection, as well as 3) gender distribution/ratio by individual book. Roles (and activities) were also summarized by gender (which gender was seen in the role/activity).

Other attributes, such as positive or negative associations for each image, were not assessed as that would require greater contextual knowledge, which small children may not possess. There were no truly disturbing pictures in this collection of books, though understanding the context behind the pictures (such as living in oppression behind the Iron Curtain, or being in World War II) would likely lead to positive/negative, active/passive, and other attributes being assigned to the images. Some pictures do lend themselves to such categorization, like Marian singing in front a huge crowd (positive attribute being fame as a singer), or cheering fans or players at a baseball game (positive), but others do not, such as police chasing rebellious teens in *The Wall*. The situation could be read either way if you didn't understand the context. The teens could be seen as rebels against oppression, represented by the police, or as criminals being pursued by police simply upholding law and order. So, since context could not be assumed for all the images, I chose to avoid this complication, but I do note it here, because for a child reader these pictures may indeed be viewed without proper contextual understanding and their meaning misinterpreted.

Books were also classified according to type (picture, chapter book or in-between.) In-between books often appeared to be a picture book, with no chapter breaks, but they had so much text that they

really took on the characteristics of a chapter book and therefore, demanded a more advanced reader. Likewise, some obvious picture books were divided in chapters, but with very simple easy to read text.

INTERCODER AGREEMENT: RELIABILITY OF CODING (SINGLE CODER DUAL TIME METHOD)

Finally, since this was a single coder quantitative analysis, a second coding session was performed at a later time over a sample of the original corpora. This is the alternative to two coders at the same time. There were 1486 images in the combined corpora population, minus duplicates. Therefore, using the standard equation for determining a minimum second set (Riffe, Lacy & Fico, 2005, p. 145), for a 95% desired confidence level (one-tailed test), and a minimum 85% intercoder reliability agreement level for the population, a minimum of 130.3 images must be used in the coder reliability test. To make this easier and systematic, every tenth image in the original set would be used. This resulted in the use of 149 images (and their corresponding text fragment) in the reliability test, which would represent any "slippage" in the single coder's method (Riffe, Lacy & Fico, 2005).

The intercoder agreement (time 1 and time 2) was found to be consistently greater than 94% on frequency counts (quantitative content analysis) and 94% on gender role assignment (qualitative content analysis). This method only used simple agreement per image (same number or roles found both times = true, not same = false) with percentages representing overall averaged matches across all images.

RESULTS

Using titles and additional information, Orbis Pictus was split 5:4 (females to males), and the rest focused on both genders (such as teams being involved with wildlife management, or being subjected to plague or famine), while Sibert was heavily male with six, male-oriented books, two, female-oriented books, and the rest both or indeterminate, though admittedly, this includes such assessments as seeing work on a civil war submarine being male-focused since the original crew was male.

In terms of cover images, Orbis Pictus had a male to female focus ratio of 5:4, with the rest either mixed or focused on an animal. The Sibert corpus had a 3:2 ratio with the rest mixed, or not focused on

humans. Back covers were typically mixed or not focused on humans, but with a strong male-bias overall in the mix.

Within the Orbis Pictus images found, 1697 females (illustrated, painted or photographed) were found and 3849 males. This translates as 69.40% male to 30.60% female overall. In the Sibert collection, 1428 females and 3847 males were found, giving a 72.93% male to 27.07% female ratio overall in the images. When the collections are viewed as a single whole, minus duplicates, we end up with a 71.68% male to 28.32% female split in the pictures. Males clearly dominate both collections, though this is not the case for individual books. Still, as Table III and Table IV show, even when looking at individual books, images of males often dominate. Also, when only looking at the primary focus of each image, the situation was still heavily male-dominated across the corpora (71.10% male overall), though individual books varied, as shown in Table V and Table VI.

TABLE III: AWARD WINNERS SHOWING FEMALE/MALE PERCENTAGES – ORBIS PICTUS

Year	Orbis Pictus	F	M
2011	Ballet for Martha: Making Appalachian Spring	59.76%	40.24%
2010	The Secret World of Walter Anderson	18.75%	81.25%
2009	Amelia Earhart: The Legend of the Lost Aviator	46.00%	54.00%
2008	M.L.K. Journey of a King	26.44%	73.56%
2007	Quest for the Tree Kangaroo: An Expedition to the Cloud Forest of New Guinea	34.71%	65.29%
2006	Children of the Great Depression	27.56%	72.44%
2005	York's Adventures with Lewis and Clark: An African-American's Part in the Great Expedition	16.85%	83.15%
2004	An American Plague: the True and Terrifying Story of the Yellow Fever Epidemic of 1793	17.99%	82.01%
2003	When Marian Sang: the True Recital of Marian Anderson, the Voice of a Country	47.28%	52.72%
2002	Black Potatoes: the Story of the Great Irish Famine 1845-1850	38.03%	61.97%
2001	Hurry Freedom: African-Americans in Gold Rush California	12.79%	87.21%
2000	Through My Eyes	28.55%	71.45%

TABLE IV: AWARD WINNERS SHOWING FEMALE/MALE PERCENTAGES – SIBERT

Year	Sibert	F	M
2011	Kakapo Rescue: Saving the World's Strangest Parrot	63.93%	36.07%
2010	Almost Astronauts: 13 Women Who Dared to Dream	69.29%	30.71%
2009	We Are the Ship: the Story of Negro League Baseball	2.29%	97.71%
2008	The Wall: Growing up behind the Iron Curtain	17.54%	82.46%
2007	Team Moon: How 400,000 People Landed Apollo 11 on the Moon	12.21%	87.79%
2006	Secrets of a Civil War Submarine: Solving the Mysteries of the H.L.Hunley	10.66%	89.34%
2005	The Voice that Challenged a Nation: Marian Anderson and the Struggle for Equal Rights	53.25%	46.75%
2004	SAME AS ORBIS An American Plague	17.99%	82.01%
2003	The Life and Death of Adolf Hitler	5.87%	94.13%
2002	SAME AS ORBIS Black Potatoes	38.03%	61.97%
2001	Sir Walter Raleigh and the Quest for El Dorado	7.80%	92.20%
2000	none (Sibert started in 2001)		

TABLE V: "FOCUS OF IMAGE" SHOWING FEMALE/MALE PERCENTAGES – ORBIS PICTUS

Year	Orbis Pictus	F	M
2011	Ballet for Martha: Making Appalachian Spring	63.40%	36.60%
2010	The Secret World of Walter Anderson	18.75%	81.25%
2009	Amelia Earhart: The Legend of the Lost Aviator	67.80%	32.20%
2008	M.L.K. Journey of a King	25.30%	74.70%
2007	Quest for the Tree Kangaroo: An Expedition to the Cloud Forest of New Guinea	37.11%	62.89%
2006	Children of the Great Depression	30.02%	69.98%
2005	York's Adventures with Lewis and Clark: An African-American's Part in the Great Expedition	17.59%	82.41%
2004	An American Plague: the True and Terrifying Story of the Yellow Fever Epidemic of 1793	15.75%	84.25%
2003	When Marian Sang: the True Recital of Marian Anderson, the Voice of a Country	41.21%	58.79%
2002	Black Potatoes: the Story of the Great Irish Famine 1845-1850	41.12%	58.88%
2001	Hurry Freedom: African-Americans in Gold Rush California	13.22%	86.78%
2000	Through My Eyes	33.45%	66.55%

TABLE VI: "FOCUS OF IMAGE" SHOWING FEMALE/MALE PERCENTAGES – SIBERT

Year	Sibert	F	M
2011	Kakapo Rescue: Saving the World's Strangest Parrot	66.07%	33.93%
2010	Almost Astronauts: 13 Women Who Dared to Dream	74.13%	25.87%
2009	We Are the Ship: the Story of Negro League Baseball	0.45%	99.55%
2008	The Wall: Growing up behind the Iron Curtain	14.73%	85.27%
2007	Team Moon: How 400,000 People Landed Apollo 11 on the Moon	11.04%	88.96%
2006	Secrets of a Civil War Submarine: Solving the Mysteries of the H.L.Hunley	9.57%	90.43%
2005	The Voice that Challenged a Nation: Marian Anderson and the Struggle for Equal Rights	74.61%	25.39%
2004	SAME AS ORBIS An American Plague	15.75%	84.25%
2003	The Life and Death of Adolf Hitler	5.22%	94.78%
2002	SAME AS ORBIS Black Potatoes	41.12%	58.88%
2001	Sir Walter Raleigh and the Quest for El Dorado	18.03%	81.97%
2000	none (Sibert started in 2001)		

Finally, a vast number of roles were found including aviator, scientist, astronaut, photographer, dancer, singer, soldier, doctor, pastor, and various types of leaders as well as traditional roles such as mother, wife, father, athlete, student, sweetheart, teacher, religious follower, etc. However, as might be inferred, since males dominated the pictures, most of the roles are associated with males, including many of the technical roles. A few roles had no gender attached simply because they were drawn solely from the text description and therefore did not have a pictorial component for association.

DISCUSSION

Given the results of this exploratory mixed methods analysis, even allowing for interpretative bias, award winning informational books seem to show a gender bias similar to what has been found with fictional award winning books or other popular book samples. In addition, while roles seemed to be less gendered in these books than in fictional counterparts, especially the science oriented winners, the fact that so many of the books are historical in nature tends to reinforce gender role stereotyping. The story in *Almost Astronauts* shows how male astronauts and a male-dominated political culture kept women out of the space program for decades despite proof that they were just as good as men.

Likewise, *Team Moon* was dominated by male images and the fact that the mission control roles were also assigned to women is only because careful searching managed to find three women sitting in the control room picture (among nearly a hundred men). Visually, this is not obvious unless you are specifically looking, so readers would most likely see only men in the control room performing engineering duties. In terms of baseball, if one goes by Nelson's *We Are the Ship* book, then it appears that women do not even exist, not even as spectators – and since these were paintings, it was well within the illustrator/author's control to add or delete women as desired. This illustrator chose to delete women, potentially sending the message that women are not welcome in sports, in any capacity.

However, more contemporary science-oriented books do show women prominently, but in both cases the subjects were concerned with the biological sciences, not computer science, engineering, mathematics or physics – all of which are key STEM areas in addition to biology and chemistry, and areas where women are grossly underrepresented (New formulas for America's workforce: Girls in science and engineering 2003; Encouraging the participation of female students in the STEM fields, 2009; Murphy & Whitelegg, 2006).

Overall though, pictorially, males are still dominant in pictures and therefore in roles, at a ratio of approximately two and a half to one (2.5:1). We see this even in books that imply an even balance, such as *Children of the Great Depression*. The title, since it says "children," should imply an even balance but in fact, the results still tend to favor images of boys over girls – and this is without an examination of attributes such as positive/negative, active/passive. This book, in particular, showed two girls naked in a bathtub, something to which there was no male equivalent, while a picture of boys jumping onto freight trains (rail riding, an active not passive activity) was shown with no girl equivalent, so a case might be constructed about gender roles in this as well, not to mention objectification of women and girls (that it is acceptable to show naked girls but not naked boys in children's books). However, more data would be required to show a true correlation.

In the historical books, the images tended to be male dominated and the roles of explorers therefore also male dominated. In fact, in both York's *Adventures with Lewis and Clark* and Sir Walter Raleigh, explorers are male (as are slaves like York) and few images of any women are shown, as if they did not really exist in those worlds. The only *Orbis Pictus* book that had a higher percentage overall of females to males was *Ballet for Martha* (59.76%).

In Sibert, we find three female-dominant books: *The Voice That Challenged a Nation* (53.25%), *Kakapo Rescue* (63.93%) and *Almost Astronauts* (69.29%). However, even female subjects like Amelia Earhart (46.00% female), *When Marion Sang* (47.28% female), and *Through My Eyes* (28.55% female) are

dominated by male images overall, though both *Amelia Earhart* and *The Voice That Challenged a Nation* increased significantly (by 20 percentage points or more) when looking solely at the focus of the image.

By comparison, male subjects like *The Secret World of Walter Anderson* (81.25% male overall), *The Life and Death of Adolf Hitler* (94.13%), *York's Adventures with Lewis and Clark* (83.15%), or *We Are the Ship* (97.71%) are clearly male-dominated. These numbers changed little when looking purely at the focus of the image.

Historical books like *Team Moon* might be expected to be dominated by men, or even a contemporary story about raising a Civil War submarine even though some recovery crew are female (but not focused on), but a plague affects males and females equally. Yet *An American Plague's* images do not support that equality with 82.01% male overall. An interpretation could be made that implies that either women didn't get the plague, unlike men, or perhaps their deaths and suffering were considered less important. Likewise, it is historical fact that women were involved in Lewis' and Clark's exploration, both as guides and as members of the peoples visited, yet their existence is practically erased in this book's images.

CONCLUSIONS

Taken as a whole, while there are a number of roles, including some scientific roles, being shown in these books, the roles are dominated by males. This does imply that in this set of quality informational books that female role models are still lacking, even in books intended to teach about real events and professions. The sheer number of males being represented pictorially tends to dilute the representation of women, even when women are the supposed focus of the book and/or image. The fact that the award winners tend to also be biased toward male protagonist main subjects, as the Sibert winners show (but not the Orbis Pictus winners), increases this dilution effect by decreasing the overall number of books where women are the focus. Since these books are more likely to be in school libraries – librarians using the award as a measure of quality and therefore as one criteria for spending their limited budget – girls

are not being exposed to an equal number of female role models when compared with boys. The additional fact that few of these award winners were focused on STEM areas only magnifies the effect.

This is an exploratory work and while focused on quantifying measures, this analysis is still highly interpretative as to what the effects might be, though again, the interpretations are based on previous research findings and theory on gender stereotyping and role model effects. Therefore, while there is no correlation-based evidence that these particular award winning books being gender biased will decrease girls' interest in STEM, getting girls interested in STEM through exposure to role models is a recognized intervention method that is supported by research (New formulas for America's workforce: Girls in science and engineering 2003; Bennett et al., 2007; Buck et al., 2007; Epstein Jayaratne et al., 2003; Hoh, 2009; Häussler & Hoffmann, 2002; Jenson & Brushwood Rose, 2003; Jenson et al., 2003; Jenson et al., 2007; Jones et al., 2000; Matson et al., 2004; Murphy & Whitelegg, 2006; Nhundu, 2007; Reed Rhoads et al., 2004; Rogers & Portsmore, 2004; Taylor et al., 2007).

As such, gender biased books like these award winners are possibly limiting girls' interest in STEM fields, if only because they do tend to show a male dominated world where women are outnumbered or even rendered nonexistent. And these award winners are the books that are more likely to be selected by librarians for school libraries since they have been judged to be quality nonfiction books. So if the books that girls have access to via their school libraries do not portray varied and strong female role models, then that is one less avenue of influence available to us, as a society, for increasing STEM interest among young women and girls.

It does follow that further research into the effects (or lack thereof) of informational children's picture books is warranted, such as longitudinal surveys or trend analysis coupled with visual content analysis. Such studies could prove or disprove any correlations between early exposure to science careers in children's picture books and later career choices. Since researchers such as Sipe and Mjør stress the importance of early learning and the effects of stereotyping, the results found here at least suggest that not only are Caldecott and Newbery award winning books gender biased (Ernst, 1995; Gooden & Gooden,

2001; Kolbe & La Voie, 1981; Tepper & Wright Cassidy, 1999; Tsao, 2008), and that popular books are also gender biased (Hamilton et al., 2006), but so might be Sibert and Orbis Pictus books, even if unintentionally. For while the text of these award winning books was not analyzed for gender bias or gender role stereotyping, the images, at least as far as this analysis delved, did show some bias. Roles were varied, but there were more roles and more images supporting those roles for males rather than for females, including many roles where women were not included at all, from painting to police work to sports.

It seems possible that the sheer number of males to females in images tends to marginalize and minimize the accomplishments and/or opportunities available to women and girls. A girl might want to become an astronaut or a pilot, and the book winners included role models for both, but at the same time, the images that would then confront those young female readers would tend to show them a world where women are in the minority, surrounded by men, and if they want to be a pilot or an astronaut or a scientist, they require the approval and support of men in order to achieve such a goal, and without that male approval, such roles are denied to them and typically, with books like these as a guide, they see that those roles *will* be denied to them. They have no recourse and they see that most roles, but especially STEM roles are the nearly sole dominion of men. They see a world that is dominated and controlled by men and where most women, save for a rare few, tend to be invisible and irrelevant.

FINAL THOUGHTS – A PERSONAL APPEAL TO ARTISTS, AUTHORS, AND EDITORS

While the visibility of women has improved in children's books over the decades, and as this thesis seems to indicate, real life roles for girls and women have also expanded, there is still a gap in equality. The research results found during the literature review do not support a gap caused by lack of inherent ability or initial interest, but rather the information found points more to social conditioning and a debilitating cycle where girls' are dissuaded from math and science early on, where both girls and boys experience gender socialization where boys are preferred and encouraged more in STEM areas, and girls

are discouraged. To be blunt, far too many are told to focus instead on beauty and boyfriends. This result then, later in their schooling, after their K-5 years, leads girls to find themselves lacking the skills needed to do well in science, even if they want to pursue science, and therefore, leading to the appearance of a natural gap in ability when compared with better prepared, encouraged boys. So many if not most of the girls avoid the “tough” subjects even further, deepening the gap, and instead, follow the paths that teachers, parents, peers, and society encourage (consciously or unconsciously). The media, as influencer, is part of this process, but as educational television has demonstrated, can help students learn new skills and envision new roles. This same influence also applies to other forms of media, such as children’s books. Books don’t necessarily have to reflect current cultural stereotypes. They can also choose to encourage new forms of thought and new paths to follow, even if the research currently shows that many groupings of book types, including award winners, continue to demonstrate gender and role imbalance.

Still, gender and role balance in children's books is achievable, and that power lies with the creators of children's books (and other media). It is easily within the power of a writer, or an artist illustrating a book, or a photographer or editor creating or selecting images to use in one, to choose or create material that shows equality in numbers and variety of roles. While it is not reasonably within their power to control the interpretation of their work, thoughtful decisions on frequencies of males or females, or roles highlighted might still help create a more balanced view of the world. And just because this thesis’ particular focus was on STEM engagement, does not mean that other areas are free of gender bias, as many in the field of art have already informed me. Therefore, creating a world where a child can imagine any career and feel empowered in that choice can only be, in my own personal opinion, for the good of all, whether that child wants to be a scientist or an artist, an engineer or a dancer, a business mogul, a TV star, a farmer, a teacher, a stay-at-home parent, and so on....

A child’s choices shouldn’t be limited by the opinion of another, even if it’s done with the best of intentions. The road *less taken* might just be the road *most important*, and not just for them, but for all of us.

APPENDIX A – MY PERSONAL PIPELINE STORY (A MEMOIR)

TO THE READER:

I am in an interdisciplinary program that appreciates a blending of qualitative and quantitative research and also a blending of personal views alongside academic rigor. It was recommended by my chair that I keep a personal, "not academic" essay included, a memoir. However, that said, and since I come from a strong quantitative background, I need to stress that this essay is only my personal views and can only be considered 'anecdotal' evidence at best. I prefer that people judge the thesis work (expanded literature review and mixed content analysis) separately from this personal memoir, but that readers should understand that my perspective has likely been affected by my experiences in the gender science pipeline and take that into consideration when analyzing my thesis research results. That said, I also stand by this memoir, for it is my truth and is a part of my life. As scientists, we know that we are part of our culture and that bias can only be minimized, not eradicated, from our work. Then again, as long as we are aware of that fact, we can be introspective about our place in our culture as well as our perspectives, motivations, and directions in science.

PERSONAL REASONS FOR THIS THESIS - MY FIRST-HAND REFLECTIONS FROM ACTUALLY BEING IN THE GENDER/SCIENCE PIPELINE

In certain cases, not all, it seems you must justify your interest in a particular topic and offer up your credentials as proof of your suitability to explore that topic. Sometimes, just saying "it was interesting" is enough – but inevitably the professors are disappointed with the answer, wanting a more intimate and deep motivation. Therefore, I've relegated my credentials and interest to an appendix, as I think it is secondary to the actual thesis work, but to pass off my experiences with a single line is to trivialize the importance of those experiences. Therefore, as my life does have a particular bearing on this particular thesis choice, I will write honestly and openly about my own experiences in the gender pipeline (even as I fear that my words will be mocked and taken out of their proper context). For those interested, it may help you understand how painful it was for me to research and write this thesis in the first place. It

brought back a lot of unhappy, painful, and angry memories, but thankfully, most of them can't hurt me anymore.

In my case, in a nutshell, my interest seems easy to justify. I have Bachelor of Science degrees in both Physics and Mathematics. I have a Bachelor of Arts degree in Communications. I have graduate work in Computer Science (C. S.) though I did not finish that masters. I worked as a civilian research scientist for the government at a naval research laboratory and followed that up with years as a software developer at a major software firm before I quit and worked at a wide variety of things. I was accepted into several graduate programs, from Aerospace to MBA, but backed out for fear that it still wasn't quite right. I got A's all through my K-12 time but had to fight during my college years in Physics and Math. I got all A's again in Communications and even in C.S. (A's and B's). I am accomplished in several areas, from analysis to art. I have always been pulled in many directions at once – and never felt totally comfortable anywhere.

Additionally, I have always experienced some level of gender bias and/or harassment from my peers, though not necessarily from my teachers or superiors. In fact, I have experienced more harassment and hostility from the corporate sector (from both men and women) than I ever did working for the Navy as a civilian scientist.

I am likely a typical, yet still unique, example of the leaky gender pipeline.

Any decent police detective will tell you that witness testimony is the least reliable form of evidence, and psychologists studying human memory will back up that claim. They both know that memory is highly subjective and highly malleable, making it easy for a person to remember things through a lens of their own preferences, even to the point of remembering an event wrongly (but truly believing that their account is true). (In terms of actual, physical events, I do not accept constructed reality theories – nor do police officers, I might add.) So with that fore knowledge, dear reader, remember that my experiences are subject to my recollections and only mine – but they are the only memories I have and as

such also shape my current and future motivations and prejudices. As Nodelman would say, my reality here is still a constructed reality, despite its claims to non-fiction, since I am the narrator, and I choose what to put in, what to exclude, and how to tell the story – all through a potentially muddied lens.

To begin with, I always remember thinking and feeling *too much* as a child – and always that feeling of inferiority and being the second daughter of two followed me. I also remember that I was quite stubborn and despite being reserved (shy isn't the word), I was more than willing to stand my ground whether the opponent was another student or an adult. (This is why shy isn't the right word. I was more than ready to fight when pushed – as a result, would-be bullies didn't get very far, and I never did have to actually fight anyone, much to my disappointment – and regardless of whether I could have actually won.)

I was also a very good student and very smart. My parents were both teachers and scholarship was important – just as sports were not. My mother studied to be a librarian and ended up doing substitute junior high teaching before she became an executive secretary. As I remember it, she liked school, studying and politics, just as she liked cooking. She taught me how to bake a cake from scratch, in fact, and defended my right to argue a point with anyone, even when that person was an adult. She also made it clear that I would go to college and would major in something practical, so that I could get a job – preferably, in math, science or engineering. My father agreed with her. My father's passion, as I remember, was music, and his hobby was building model aircraft. He started as a band director and taught music, then switched over to teaching grade school. He taught me how to change a tire as well as do regular car maintenance. He also tried to teach me how to fly model planes, but I really wasn't that interested. He thought it was great that I ended up a physics major.

Both of them might disagree with how I remember things regarding them, but with apologies to them, these are my memories, right or wrong. And regardless, I thank them for those memories and the results.

I don't remember ever reading any grade school books about science, save one favorite story about a hermit crab. I did however like to play with my Barbie dolls. I dressed them up in shiny evening gowns – and then had them go rock climbing, or fly off in rockets in search of adventure, or ride horses, or fight bad guys. They were never housewives and never took care of babies. I was always drawing pictures. I was creating stories with my pictures; I still have one small book I made about a horse. Additionally, I explored the nearby swamp and pretended to have adventures. I read books, played dress up, listened to music and played with tinker toys. I also remember watching a lot of television – action adventure, war movies with my father, cartoons, old musical comedy movies, and science fiction. I loved the action adventures the most, regardless of form, and I loved Disney films, though I typically identified more with the male characters, who actually performed the action. Despite the focus on princesses and some multicultural stereotyping, I think some of the newer Disney films have done a good job of an active heroine, rather than a damsel-in-distress (especially Mulan)!

You see, I wanted to be a guy when I grew up. Guys had all the fun; they raced cars, rode horses, went to the moon, had intergalactic battles and saved a planet, fought bad guys, saved the princess, fought with swords, and flew planes – though I did notice that Trixie in Speed Racer did fly a helicopter but other than that, she never did much else of note. But I didn't really think of it as a desire to be a guy at the time, you see. When I was a kid, I just thought that those were the things I wanted to do. It wasn't until I was older that I began to realize that those were the things that men were allowed to do – not women.

My parents never told me that science or math wasn't for girls – rather they told me the opposite. I was always good at math. I was good at anything scholastic, in fact, but didn't really know what to do about it. My sister was always interested in dinosaurs as a child, and eventually biology and chemistry. She got a microbiology degree but told me she was bored with the work she ended up doing, and would need an advanced degree to do the interesting stuff. Growing up, she knew how squeamish I was, and enjoyed telling me about the microscopic bugs in my milk – just to see it come spitting out my

nose as I gagged. She eventually went back to school and got a second degree in computer science and became a software developer. She's very good at it, and as best I can tell, she is much happier in that role. However, she still tortures me when I try to drink milk.

I wasn't that fond of biology and avoided it. (Squeamish, remember?) I certainly never wanted to hurt animals – not even cut up an already dead frog. I liked studying about geology though – and looking at different kinds of rocks and picking up interesting ones I found, which inevitably ended up banging around in the washing machine. My mother said she learned to check my pockets after that. I didn't particularly like chemistry either. But when it came to physics, something sparked – maybe because physics was behind rockets and moon landings and adventure. Physics was about blowing stuff up, flying around space like in those TV shows, and making amazing machines like rockets and robots. I had an early interest in artificial intelligence (AI) and robots, but also in machines in general. I didn't remember that, but my mother did – she said I was always talking about AI. I must have seen it on television.

To be frank, I still don't quite know what it was, but physics and I clicked. However, to be honest, I didn't get any formal school exposure to it until my senior year in high school when I took physics, though being in Science Club during high school did help with informal exposure – especially considering the advisor was also the Chemistry/Physics teacher, and his enthusiasm rubbed off on you.

Often, teachers were scared of me – because they'd heard that I'd been argumentative and would challenge teachers, or had heard about my older sister doing similar things. When they found the opposite, they were delighted that I was such a good, and typically, quiet, obedient, student. (Notice the stereotype of girls being obedient and quiet?) I wasn't a troublemaker, but I was a fighter. I spoke up when I felt it necessary and would definitely argue a point and be quite passionate about it. It was innate, and came from both sides of my family, who saw value in that kind of attitude.

Yet, I was also insecure and lonely. I always felt left out and unwanted. I couldn't just "go along" with the crowd and inevitably that led to being left out. I was also overweight and felt the full effects of that as well. (A bad experience when I was fourteen may have further decreased that low-esteem. The male friend of a lady I babysat for returned one night before she did. He was drunk and I had quite a scare. I talked him out of it, but to some extent, the damage was done.)

My self-esteem dropped even further as time progressed. I did have friends, but not many, yet the ones I had become close friends, often with similar experiences to mine with science and life in general – and I didn't really have enemies, not even the ones who initially tried to bully me, since when they asked for my help, I freely gave it. Thinking back on it now, perhaps not being able to bully me had reversed our roles – now they sought my approval instead. However, when you're a kid, you don't think like that. I just helped people because they asked – even if I didn't like them. I had high empathy; I realize that now, but I typically reserved my affection for animals. They didn't judge me or try to make me feel bad. However, I think I understand now. If you combine empathy with a fighter personality, you get someone that can't just let things go, or walk away, or ignore a situation – especially if they believe it's wrong. I was also born in the last month of a Tiger year. Or maybe that's just my own conceit speaking. (Yes, I'm joking...a little.)

Perhaps it's why I never gave up on science – even when I fervently wished to, thinking that if only I could change myself, do something else, find an acceptable social role where I was appreciated and not harassed, then I would finally be happy.

Things never really changed that much from grade school to junior high to high school. I became known as a "brain" and didn't mind that. I judged my self-worth by my grades. I shunned physical education and sports. My family wasn't into sports and despite my own personal interest (and competitive spirit), especially for tennis, I didn't do sports. Sports classes were graded and could (and in my case, would) lower your grade average.

Because my last name began with 'A' I was typically seated at or near the front of the class, so I became used to being more visible. I think now that teachers should seat their classes by alphabet (to avoid gender grouping), but also that they should then divide the class into thirds and alternate the seating sections so that each group feels what it is like to sit in front. It might help teachers, too. They might be more inclined to see the invisible students more than they do now. But they need to be sure to explain to the students why they are doing that, so that the ones now in back don't feel so slighted.

Being used to being in front helped later when I had a choice of seats, I realize now. In fact, since I was also myopic, I learned to sit closer anyway to read the board. As I said, you are more engaged when you are closer, and teachers also notice you more – again forcing better engagement. Engagement, in my opinion, is more important than gender. In junior high, high school and college, I found that my honest interest in the subject led the teacher to engage with me more. It wasn't because of my gender. Nothing makes a teacher happier than a student that really wants to learn – and especially a student that wants to learn what the teacher is also passionate about. The reverse is also true.

However, that might just be my perceptions. Still, for a long time I was the lone female in a physics department consisting of male students and male professors (and female clerical workers). Yet, my professors were very supportive, even ones you might think would be gender-biased because of their culture. Maybe, in physics at least, a passion for physics was far more important than any biased belief system – or perhaps it was because it was a small physics department with small classes. It wasn't one of the "money" fields like electrical engineering, where there was a long waiting list. Or, perhaps, sadly, it was just that particular group of professors, and that particular period of time when there was a greater awareness of gender bias (and a strong government and academic drive to combat it).

Likewise, I found the same thing with my first job, a civil servant working at a naval research lab. The blatant harassment of women in the Navy and other military services was well-known, including civil servants who were not military themselves but worked on the research bases. I found the same thing. In fact, it was during this time that I lost 40 pounds (over a very short period of time) and suddenly, guys that

typically ignored me now swarmed around me and commented on "how different I was" and "how my personality had changed. How I was friendlier." My personality hadn't changed that much and in fact, I wasn't friendlier but rather the opposite. I was more shocked, angrier in fact, and more fearful at all the attention. A wall of flesh that had ostracized me for so long had disappeared and now I was, instead, being objectified and sought as a trophy – an object to be won, possessed and bragged about. I know this because the guys would tell stories, and you would eventually hear about it – lies about you, i.e., their wish list.

In fact, it wasn't a good experience in the least, the guys that were attracted to me also got excessively competitive with me, to the point of mania, trying to prove that they were "better" at something I was good at. One even spent an entire date trying to show me up and yelling "HA! YOU'RE WRONG! SO THERE! I THOUGHT YOU KNEW ALL ABOUT CARS?" when I couldn't identify a particular squeak his car made. He knew that I did some of my own car maintenance, but I hadn't made any claims of expertise. That was our one and only date. I don't give second chances to such jerks. It's funny now, but tragic, too. I learned of similar experiences with other women scientists and engineers I worked with – we were to be made to feel like dirt because of the insecurity of our male counterparts. Despite efforts to the contrary, I began to gain the weight back.

Over the years, like so many other women, I went through the yo-yo diet cycle. I regained and re-lost the weight, only to finally regain it again, if slower than before. My weight and accompanying lack of self-esteem and confidence has prevented me from doing many things I'd like to – I fear the social stigma and I fear being laughed at. Yet in other ways I am definitely stronger. I'll never fit the media ideal, but frankly, I don't really care about having a relationship any more, not on those terms – I'd rather be alone and relatively happy, than try to conform to unfair expectations and biased treatment. However, that was my choice and ultimate realization about social conditioning, so I wonder how many other women see that as a fearful rather than happy fate?

Anyway, my experiences with the Navy lab were shocking but had good moments, too. Like with my male professors, I found my male supervisors highly supportive of me. I also found the new professional (NP) program of the Navy for its civilian scientists a tremendous help. They created an atmosphere where each year's NP group was a cohort. The group would tour Navy facilities as well as have other activities and meetings to share our experiences. We bonded and became friends. Everyone (practically) was in a new city without contacts, so we were all in the same boat (regardless of background or gender) and as a result, reached out to each other instead of floundering on our own – lonely and isolated.

I don't know if the Navy has continued the program, but I hope so. Despite ageism and sexism (as well as racism, as I was told by others), they were still light years ahead of the corporate world – as I quickly learned when I left and subsequently became a software engineer.

Unlike overt sexual harassment, which is easily noticed and therefore dealt with, here I found covert harassment that was embedded and tacitly supported by management – and included sexism, ageism and racism. As I experienced mainly sexual harassment and general demeaning behavior toward women, I'll confine my comments to that. (Ageism has only recently become a problem for me.) Such harassment is hard to notice, to pin down, to expose, and the result is a hostile atmosphere where women are still objectified and harassed, but the victims feel powerless to affect any real change, knowing that to complain is to be labeled a troublemaker by management and by HR, with severe career consequences. It's a system that breeds bullying – not just of women but of anyone. It breeds lying and brown-nosing as a way to get ahead as well, where achievement isn't measured by actual innovation or good work.

Suddenly, unlike the government/military research world, I was in a world where being part of a useless committee was more important than doing actual work that helped the customer, despite the fact that the whole point of the company was to do good customer service. One guy just dropped all his actual work and did nothing but committee work – committees that were put together by his manager as

a way to show how she was doing something that her management thought important, and were designed to make her look good come review time. None of the committee work ever resulted in anything, by the way, and even he admitted that he knew that going in. They were just for show. Regardless, he got the highest review possible and a huge bump in salary, while those that decided doing actual work was more important, that cared about the work, found themselves with low reviews (and they were even told that it was because they didn't play ball. I know because I was not only one of them, but I asked others in a similar situation.) A low review meant you should look for other work, but likely wouldn't find it, since a low review told other managers that, despite your accomplishments (of which you could easily prove), that something was wrong with you – you, and not the system or the manager who gave you that review. No wonder software companies have a reputation now for fly-by-night quality and hostile environments, and yet they still complain about attracting quality workers and claim they have work/life balance. I think perhaps they believe that work/life balance means only 60-80/hr. work weeks instead of 90-100/hr. work weeks, and that free soda (if that) will balance out everything – especially if you are a young guy.

I personally knew of another manager (at a different company) that was even more blatant in not only his bias but his embrace of the current orientation of short-term, selfish gains over long-term, company goals. He made it clear that he just ignored information he didn't like, hoping that the problem would just go away, and thought of work as a war zone, so if you didn't like someone then you should try to make them quit. (Yes, he said that and said it in front of witnesses, signaling that he found nothing wrong with the statement.) He said as long as he liked you, you would be OK. It didn't matter what work you did. I was told by one of the witnesses, that he was very good at what he did, even if it wasn't people management (of which he was now in charge of as well). This was a way of excusing his behavior, however concerning it was since he was managing people now. There's a saying about promoting people to the level of their incompetence, right? Maybe instead we should promote people because they would excel in the new position, especially people that are supposed to lead and inspire?

Throughout the software world, I even found women turning to bullying as a way to fit in and succeed – though unhappily, as a result, their targets were typically other women – since women were the acceptable target of such behavior, and bullying of women by women was even seen as "not a big deal" by the male supervisors. It was trivialized as cat fights or just how women are, a bunch of bitchy whiners. Not one male I talked with thought it might be related to how men treated women in the industry, or how they treated each other for that matter, hazing and bullying each other as well, but to which they would say was "perfectly fine and normal" and if I "couldn't hack it, then it just proved that I wasn't up to the challenges of software."

I find it oddly jarring that so much of the research implies that one reason girls and women drop out of science, especially after all the hard work it took to get that science degree, is because they often have better language skills. So, because they have more choices, they just leave and do something else. That seems far too casual and trite an excuse. I went through hell at times, with hours upon hours of hard work, to get into science and to work in science. Every time I left it was because I was miserable, depressed and even suicidal at times. It wasn't a casual decision. I came back because I missed science and technology. I love physics and AI. I'm driven by it in fact. I wasn't happy doing something else despite my variety of skills and therefore choices. Besides, those other choices also came with harassment and demeaning treatment, or lack of status, and very often the people in those less scientific fields were insecure around a "science type." It was like my bad dating experiences all over again.

I've never truly been happy outside of the world of science, but sadly, I've never truly been happy inside that world either. It isn't the work that is the problem – or me – it's the environment, plain and simple. That environment is all around us, and it starts at birth. It's a systemic problem that needs a multi-pronged systemic and continual approach to fix it. It's a problem with our society.

Obviously, I have some very bad memories of some of my experiences, and as I have already indicated, others might have differing accounts. I also have good memories of good people as well. The truth probably lies somewhere in the middle. However, those memories color my thoughts and actions.

Only my actual love of science and technology, and my fighting spirit, keeps me coming back, despite the fears of further abuse and humiliation. However, I wonder how many others have lost any taste for further confrontation and just given up? I wonder if they are happy as a result, or even could be happy, knowing that they gave up on something that they had (I assume) wanted and worked hard for, and knowing that they let a wrongful system win?

What lessons, intentionally or not, will they pass on to their children? Will they encourage them to pursue their goals? Or will they try to divert them to something safer, more socially and stereotypically acceptable, so their daughters won't have to go through what they went through – even if by doing so they kill their daughters' spirit and potential? And what will they teach their sons?

So I wonder what insights and innovations have been lost because of male insecurity, need for power over women, and government and corporate short-sightedness. Governments, universities, and corporations always talk the big talk – about how they want more innovation, more competitive advantage, how they want to be leaders – yet when it comes to actual implementation and perseverance, they turn around and destroy more than half the population's chances at achieving those goals, and therefore, their own lofty goals as well.

I think about things I've learned – seductive information it's called, because it diverts you from learning the lesson you are supposed to. But often, those little human details that have nothing to do with the science concept tell you a lot about the state of the science world and the world in general. I think about what I now know about Einstein and how he was essentially a selfish, self-centered jerk (my opinion, mind you!) who didn't acknowledge the help of his wife (a graduate student in physics who quit to work to support him), not just her financial help, but her own ideas and thoughts on his papers. I know how much talking with other physics people helps clarify ideas and even inspires new ones. Then he breaks his promise to her (that he would give her the proceeds from the Nobel Prize if she granted him a divorce, so that he could marry his new love interest, his cousin). He gives her only a small fraction of it eventually, according to some accounts (but they differ in how much she got), and she and his kids

essentially are left with nothing. I think about how famous women scientists have been shut out of history, their work dismissed or attributed to males, their characters assassinated as part of the cover-up. (Read Sharon Bertsch McGrayne's *Nobel Prize Women in Science*.) Those are just the ones that eventually were recognized in some way. How many others have been missed by history? It's probably that way with all roles in society, if you think about it – not just science.

I also think about the state of science and how it's failing as an institution. Not only is there still sexism, racism and ageism, but there is short-term, profit-seeking thinking. Now, many discoveries lead to great profits, of course...but they didn't start out with that purpose. In fact, no one would have funded some of these wild, crazy ideas if they were just thinking about eventual profits. People don't realize that quantum mechanics, something many physicists hated and fought against (and still do), is why we now have the electronic technology world of today. Sorry folks, no quantum, no iPad – no computers. We'd still be back in the 19th century.

Science happens in increments, even the apparent leaps. Einstein was building and expanding upon current research. He didn't come up with his theories in a vacuum. Science is about that – wanting to push further from the known into the unknown, building upon what has already been done before – expanding upon it, or if necessary, pushing off in new directions that might destroy precious, current, safe theories. It's one of the most risk-taking industries in the world and requires people that are willing to take such frightening risks, professional as well as personal – and knowing that what they discover might be misused, or even suppressed if it might create ripples in the power structures or the profit sectors. It's the most thrilling world there is – and killing interest in it because of petty insecurities and power plays is criminal – and deadly.

Yet institutions are about profits now, and stereotypes still reign. Ageism makes headlines now, especially in computer science but also in academia. Younger is seen as better, despite facts to the contrary. Racism is still rampant. And female? Well, research has already shown that you really do have

to be twice as good as a male just to be perceived as adequate, even by other women. That hasn't changed.

Perhaps the real insights, the earth-shattering ones like quantum mechanics, will actually now come not from institutions, governments or corporations, but rather from individuals, outcast and on their own, working on the problems because they can't help themselves. In fact, quantum mechanics was actually like that, too. It came from an obscure professor whose work was ignored until a simple grad student decided to create the suggested experiment that would shake the world. In fact, the early history of science is about how the idle rich pursued it for its own sake, not because there were profits or large institutions involved. It was reserved for the idle rich because there wasn't an appreciation for it or institutional support; so think on that, and how much insight might have been lost just because of that lack.

A starving artist starves; that isn't romantic, it's tragic. A starving science world, one that has been retooled to supply assembly-line-like tech workers, rather than scientists, and that relies on stereotypes instead of facts, doesn't find the answers in time – and everyone – and I do mean everyone, from the rich to the poor – pays the price, especially in the long-term. Short-term thinking is killing us – and our world.

Stereotypes do damage, and the more negative stereotypes being applied to you, the more magnified the effect. Worst of all, the people applying them typically don't realize that they are doing it and furthermore, will not believe that they are. The research backs that up, too. They will in fact, just see you as a troublemaker, and will do what it takes to silence your voice – for the good of the company and their own career.

They're shooting themselves in the foot, in truth, and damaging, not helping, the company – and damaging the government, the society, the culture, and the future, for that matter. Short-sightedness applies to stereotypes and fixing them (or rather the lack of fixing), as well as to scientific discovery.

So my advice? I think that women (and men who feel similar pressures) should complain – and leave. They should be loud and clear as to why they are leaving and what a loss it is to the company that they are leaving – and take their innovations and ideas with them. They should look for a company that accepts them, respects them, and encourages them. They should NOT stay in a place that doesn't – but again, I think it's critical that they be loud and clear and vocal about why they are leaving and why it is a loss to that company.

I've found most companies only respond to extremely direct criticism. So my advice is not to say "personal reasons" or give the company any reason to excuse itself from guilt (or to scapegoat you as the troublemaker). They won't bother until they hear it a thousand times or more. Only then will they realize that it hurts their bottom line, and you aren't just a "dime a dozen" troublemaker, easily replaced. But critically, I stress to any readers the following: don't stop believing in yourself, don't stop believing that you do offer something, that you can make a difference, create innovation, and succeed in your profession. Don't let the inept, insecure, power-mongering bullies win. Show them instead how they've lost. Keep looking for the dream environment, even if you're forced to stay in a hellish one for a little while because of economic reasons – just don't give up. It takes effort and persistence – and belief. It's not your fault – it's theirs and they should pay the price for it, not you.

If our country, or any country, loses competitive advantage, or jobs, or its standard of living, or even stability, then that country has only itself to blame. Despite my empathy and desire to fix things, I won't feel sympathy for them, not any more – but I do for all the women and men who don't feel that way, who are and were supportive of me and others, who got past insecurities and social conditioning and tried to create change, knowing it takes at least a generation of trying before any real change occurs – even knowing that the next generation or political group, often for short-term or selfish reasons, can come along and destroy everything already won, continually forcing us to begin all over again.

On a final note, one of the most important things I learned, I learned recently. It involves sports. Personally, I wish that I had gotten involved in some kind of non-graded sport when I was a child. (I did do

horseback riding. My parents even paid for lessons until I got bored, though I was also worried about the cost to them and the feeling that I had to show instant progress as a result.) What I mean now is that I wish I had done a low to no cost sport, but one that I personally would find fun – like tennis.

However, given that, I wouldn't want a competitive coach, or for the sport to affect my grade – leave that to the people that see their best talent in sports, who are looking for sports scholarships and careers. I like the idea that Japan has – that kids must belong to a club (sports or culture), but while it's required, it's not graded. You see, aside from the grade aspect, I think sports are important. You see, for most of us, our future is about technology jobs not sports jobs, the government has said so – so grades...no...grades just create unneeded stress.

So I hold my sports belief only when sports aren't being done for competitive reasons or grades, but rather, instead, when they help you learn self-motivation and that wonderful feeling that comes from doing something fun, without expectations or fears of failure. Perseverance can come from passion, which is fed by a sense of choice and that too illusive feeling of enjoyment.

You see, decades later, after multiple false starts because the tennis classes were so badly done and actually quite demeaning, I finally learned to play tennis – on my own, by simply learning to hit the ball and practicing. Why? Because it was fun and it didn't matter if I was any good or not. I just enjoyed hitting the ball. The result was that about eight months later, when I did take a beginners tennis class yet again, I found that I was good, and recognized as one of the more advanced players! I suddenly realized how far I had come, and all it had taken was steady, incremental practice – without the pressure of needing to be perfect instantly.

That is a far cry from the stress and dread I experienced with sports in a K-12 atmosphere. Even in college, when I took two PE classes – pool (i.e. billiards) and riflery – even when I took them pass/fail, I still felt the pressure to have an immediate result. However, I also learned that I had excellent hand-eye coordination and both instructors encouraged me to continue (and one wanted me to try out for the rifle

team). That was a happy surprise, considering my fear of sports and of being demeaned, but in college, as with K-12, my focus was on academics and I couldn't spare any time for anything else. My fear of failure was too great and the work load of a double degree in Physics and Mathematics was too stressful.

That tennis experience is what really gave me the impetus for the rest of my life. I now tackle problems that I'd been avoiding previously (because I feared that I wasn't good enough). My initial skill level doesn't matter. My gender doesn't matter. My age doesn't matter. My goals, my desire, and my perseverance are what matters. I know now that it takes practice and that I won't – absolutely WILL NOT – see the results until FAR into the process, but that I WILL succeed if I keep at it. My passion is important but it isn't enough, no matter what corporate America wants or says. Instant success, like instant gratification, is a pipe dream, and, especially for women expectations like that only make the pipeline that much leakier, and women that much unhappier.

You may just say "oh that's just the tortoise and the hare story" and you'd be wrong, but also right. I'm not saying ability isn't important. Ability, like the hare's natural superiority in a speed race, gives you a feeling of mastery and of instant fun. It helps in the short-term. But if you rely on ability alone, then you'll fail as time drags on as you hit all the hills, valleys, mountains and walls along the way. The fun will be destroyed and your interest will die.

However, ability, wherever it started, grows with endurance and perseverance; that is the key point. From whatever starting point, it's a willingness to continue the race that wins the race – to grow in ability, to endure, to believe, to push the limits, to take the risks, to know that your passion will come back and the fun will return even if one or the other has temporarily abandoned you.

You need to understand the long view; that, in itself, helps you remember why you started the race in the first place, and why it's worthwhile to finish it. It isn't just the beginning, the end, or the path in-between that is worthwhile – it's the entire process. It's your journey and no one else's – and your goals are waiting for you, but only if you have the courage to shake the belief that it should be easy or

quick – or without pain. For women in particular, there will be a lot of pain to be endured, but with time, perhaps the pain along the journey will become the same pain, no more and no less, than that experienced by their male counterparts.

So I wonder. What if I had been required to be involved in a sports club from K-12 – not attached to grades and not a competitive club with a competitive atmosphere, but definitely a club that I could choose and not be forced to "fit in" to someone else's vision? What if I was simply to enjoy myself and try to get better at my chosen sport? No failures, no pressures, no competition with the other students (with an instructor that made sure everyone understood that message loud and clear) and no fears attached – I wonder if I would have learned the lesson sooner and what result it might have had on my life?

What if I had learned (from the beginning) to take the long view of life?

What if we all learned that lesson earlier rather than later – male or female, teacher or student, corporation or government?

Maybe we'd all be happier with ourselves, and not feel so insecure that we needed to keep another person (or group, or sex) down in order to feel better about ourselves?

Maybe we'd have the competitive advantage that corporations and countries seem to fear they've lost, because we now know to believe in ourselves, follow our passions and keep at it, not expecting quick and easy solutions?

Maybe we'd finally fix the leaky pipeline and wonder why we ever thought it was too difficult or too complicated to fix?

Maybe the word "impossible" would disappear from our vocabulary and we'd look to the future, to the unknown on the boundaries of the known, with anticipation instead of fear?

Maybe.

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