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Discovering Latent Gender Bias in Children's STEM Literature

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DISCOVERING LATENT GENDER BIAS IN CHILDREN'S STEM LITERATURE

by

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ABSTRACT

A mixed method, exploratory, sequential research design was conducted to investigate the presence of latent bias in early childhood STEM literature content, applying a non-biased, sociocultural, STEM identity, theoretical framework. A survey of children's perceptions of gender and a content analysis found unintentional bias. Exploratory findings confirmed 102 children were gendering images. An examination of the relationship between the participants' gender and how the participant gendered AND preferred the images indicated differences existed between boys and girls. Children preferred images perceived as matching their own, with statistical significance. Girls were found to prefer images less than boys AND they were more likely to gender the images. Children were more likely to give gender to the 50 images considered in the study, than to non-gender them. The gendering and preference was found to be statistically significantly higher for anthropomorphic and personified inanimate images. Additionally, a content analysis of eight award winning and popular selling STEM children's books were conducted and were found to contain biased narratives and image content. A content analysis found significant differences relating to the frequency of character representation in the eight books. Analysis indicated a higher lexical representation of females to males, and image representation was more male than female. Further analysis of additional books and images is warranted from the findings of this exploratory study.

For my grandfather, Lloyd Albert Proebsting, who always believed I would become a doctor. His love of learning and belief that one is never too old to learn new things, inspired me to reach for my dreams. I know he always wanted a doctor in the family. Hopefully my guardian angel will settle for a Ph.D. in place of an M.D. in the family.

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Successfully completing a dissertation and acquiring a doctoral degree comes at some expense to the individual undertaking the journey, but also for those surrounding the individual. For those people who experienced this voyage with me, there are no words that could truly express my gratitude for your guidance, support and encouragement. A special acknowledgment is presented to my "frolleagues." Thank you for helping me to keep my sanity through this seemingly endless journey. To the faculty members who enlightened this starry-eyed, doctoral student that the journey ahead would be a marathon, and not a sprint, you will never appreciate how the sentiment kept me progressing through each and every step of the doctoral program.

What He Told Me When I Complained About the Boys' Club

There is no Boys' Club.
Pay no attention to the men who are in charge.
They are not "bound by gender."
They care about who is most qualified, not about men and women.
See, that's how we know that there is no Boys' Club, 'cause the men in charge
Are the most qualified.
Like, Obviously! They aren't types who choose people by sex
Or skin color.
Like, Obviously! Or they wouldn't have the big jobs.
It's just such a shame the women can't get off the "gender thing,"
Like, Duh. There's obviously no discrimination.
For one thing, and for another thing,
There's the issue of fit. Like, we want to include all qualified people
But they have to be the right ones for the job,
Like, Obviously! There's a lot more to these jobs than just
Paper qualifications. There's fit, too.
And just that ability to deal with people. Some of these women
Are so angry they can't deal with people, they can't be a
Neutral Presence. Which is like, Obviously, why they weren't chosen.
You Know, they're just so high maintenance, some of them.
I mean, it's a shame, really, because if they wouldn't go on and on so much
People would listen to them.
Especially if they didn't sound so angry all the time.
Like, obviously—no one wants to hear all that anger all the time.
So, you know what I mean, they are just so Bogged Down.
And they aren't doing themselves a service, either.
If they could just Shake It Off and get back to work, like, there
Wouldn't be a problem.
'Cause, like, Obviously, there isn't any Boys' Club.
As If! As if, when we are all standing around in the gym showers together
We would actually bother to talk about this stuff.
Give me a break.
Like we would really waste time plotting to do in our female colleagues.
There is no Boys' Club.
We don't even notice them.

Robin LeBlanc (2016)

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LIST OF ACRONYMS AND ABBREVIATIONS

CLCD: Children’s Literature Comprehensive Database

ELA: English Language Arts

ELL: English Language Learner

NASA: National Aeronautics and Space Association

NSF: National Science Foundation

PCAST: President’s Council of Advisors on Science and Technology

STEM: Science, Technology, Engineering & Mathematics

UCF: University of Central Florida

UNESCO: United Nations Educational, Scientific and Cultural Organization

CHAPTER 1: BACKGROUND AND SIGNIFICANCE

There had been a concerted effort to increase the United States' representation in global Science, Technology, Engineering, and Mathematics (STEM) fields. The President's Council of Advisors on Science and Technology (PCAST) asserted our nation had a "leaky system" of supporting an interest in STEM, particularly among women and minorities (PCAST, 2012). Reports had indicated trivial improvement since the 2012 PCAST announcement (Cardno, 2014; Hansen, 2017). Additionally, a 2016 Hechinger Report indicated gaps in the pipeline were occurring well before children begin kindergarten (U. S. News & World Report, "The Biggest Hole in STEM", February 29, 2016). A study conducted by Microsoft (2011) found STEM students were motivated to pursue STEM for the following reasons: a good salary (68%), job potential (66%), intellectually stimulating and/or challenging subject content (68%), and to secure a good future. However, the Microsoft study reported gender differences in motivation to pursue STEM careers as well as confounding parent perspectives. The study found more male than female STEM students reported the impetus to choose a STEM career came from the enjoyment of playing games, reading books on the topic, and participation in the subject area (51% male versus 35% female), whereas women were more likely to choose STEM because they wanted to make a difference in the world (49% female versus 34% male). In response to a 2012 PCAST report, President Obama declared the goal of pursuing one million more STEM graduates over the next decade to ensure future global success for the U.S. (PCAST, 2012). Furthermore, U.S. Census statistics showed women make up half the workforce nationally; however, only one-quarter of the STEM workforce was represented by women (Landivar, 2013). One metaphor for describing how individuals move towards a STEM career was a leaky pipeline that reduces in size the closer the person gets to a STEM occupation (Figure 1). Other STEM researchers had argued the "pipeline" was not leaky but simply too passive, and also that STEM education does not nurture future STEM professionals (Johnston, 2012).

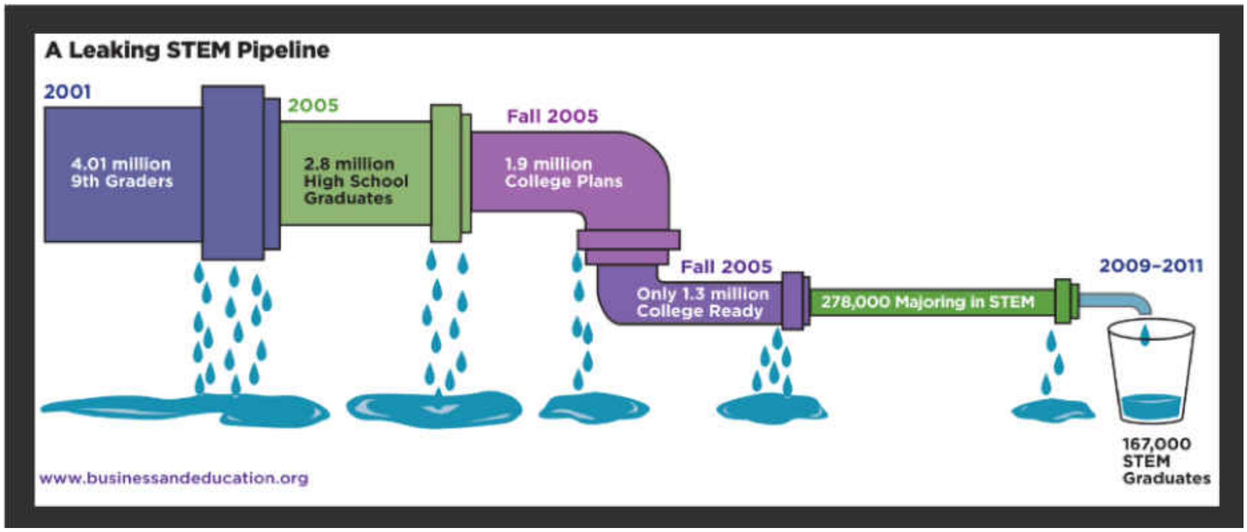


Figure 1: The leaky STEM pipeline – U.S. high school to college graduation

In 2001, four million incoming U.S. 9th graders were registered to begin high school. Four years later in 2005, less than two million graduating high school seniors going into college had declared a STEM major. Seventy-eight percent of STEM college majors decide in high school or earlier to pursue STEM, and 21% decide in middle school or earlier (Microsoft, 2011). Of the 1.9 million college students in 2005, only 167,000 graduated with STEM degrees. Johnston (2012) argued, "we should have a system that doesn't feel as if it has to prevent leaks, but instead is motivating enough that it draws people into the natural flow" (para. 8).

Although college STEM graduates move on to work in various lucrative STEM careers, reports had indicated women, in comparison to their male counterparts, were more likely to leave their post college STEM positions for lower-paying, non-STEM employment (Blickenstaff, 2005; Snyder, 2012; U.S. Department of Commerce Economics & Statistics Administration [ESA], 2011, 2017). Although the gender pipeline for women to work appeared to have been open, severe problems in STEM fields were still shown to exist (Mayock, 2016). Recognized contributors to the leaky system (i.e., leaky pipeline) included:

- a decreased interest in the pursuit of K-12 STEM education (Blickenstaff, 2005; PCAST 2012; True Child, 2011);
- fewer college students graduating with STEM degrees (Blickenstaff, 2005; ESA 2011 & 2017; Lent et al., 2003; NCES, 2013; PCAST, 2012);
- fewer STEM college graduates pursuing STEM careers (Blickenstaff, 2005; ESA 2011, 2017; Herrera, Hurtado, Garcia, & Gasiewski, 2012; PCAST, 2012);
- STEM professionals leaving their STEM fields for other careers (BHEF/ACT, 2014; Blickenstaff, 2005).

The loss of STEM participation was not unique to the United States. A 2013 report published by the Australian Council of Learned Academies investigated STEM education around the world, and this international comparison indicated some countries were more successful than others in increasing STEM participation (Marginson, Tytler, Freeman, & Roberts, 2013; Simon, Aulls, Dedic, Hubbard, & Hall, 2015). However, United States' efforts trailed in comparison to other countries such as Finland, China, Singapore, South Korea, and Taiwan. Even with various measures undertaken to remedy the diminishing numbers in STEM careers, the loss was a continuing problem, particularly for STEM women in the United States (U. S. Office of the Press Secretary, 2016, June 21). U. S. News & World Report (2015) published an online article reporting "in spite of the intense drive to encourage students to study science, interest levels fell between 2009 and 2013 and are now just slightly below where they were in 2000" (Bidwell, 2015, p. 1). While the STEM pipeline represented all genders, the current study emphasizes potential contributors to the loss of in STEM.

Contributors to STEM Inequality

Female STEM workers were outnumbered significantly by male STEM workers due to a variety of factors (ESA, 2011, 2017; Landivar, 2013). One factor was the loss of women's STEM identity, which was shown to be at greater risk than men's (PCAST, 2012). Women were significantly affected by the leaky system, thereby, losing interest and leaving STEM fields, and decreasing in the pipeline at faster rates in comparison to their male counterparts (Landivar, 2013).

Stereotype bias. Factors for the paucity of women in STEM had been attributed to stereotype bias, microaggression, and harassment. Stereotype bias, sometimes referred to as *stereotype threat*, is defined as "being at risk of confirming, as self-characteristic, a negative stereotype about one's group" (Steele & Aronson, 1995, p. 797). Steinke (2017) cited stereotype bias as the principal factor for gender issues in the STEM pipeline. Stereotype bias threatens individuals and they subsequently feel pressured to conform to desired social categories. The social categorization which results from stereotype bias was referred to as *ingroup* or *outgroup* identity grouping. In sociology, an ingroup refers to a group that shares the same characteristics or interests, and with whom a person identifies during social situations and interactions. These characteristics were race, culture, and gender, along with a myriad of other characteristics. An outgroup includes those individuals who do not share the same actions, intentions, attitudes, or system of beliefs as the ingroup (Tajfel, 1974). Outgroup members face stereotype threats in the form of censorship or even overt contempt from "ingroup" individuals. Research has shown that women who face stereotype bias were associated with the loss of STEM group identity (Ambady, Paik, Steele, Owen-Smith, & Mitchell, 2004; Ambady, Shih, Kim, & Pittinsky, 2001; Davies, Spencer, Quinn, & Gerhardstein, 2002; Eddy & Brownell, 2016; Good, Aronson & Harder, 2008; Hill, Corbett, St. Rose, & American Association of University Women, 2010; Shih, Pittinsky, & Ambady, 1999; Steinke, 2017). Furthermore, Mulvey, Hitti, and Killen (2010) indicated "the roots of group identity begin in early childhood" (p. 602). In other words, STEM group identity potentially developed in early childhood.

Microaggressions. Microaggressions are defined as "brief, everyday exchanges that send denigrating messages to certain individuals because of their group membership" (Sue, 2010, p. xvi). Research related to gender issues, such as microaggressions, showed commonly accepted, everyday behaviors and commonplace practices may have affected STEM engagement and STEM identity (Rahm, 2016). Unintentional *micro aggressive messaging* could be a source of stereotype bias formation in STEM. Micro aggressive (i.e., outgroup) messaging in STEM begins at early ages (Mulvey et al., 2010). Studies showed that microaggressions seem innocuous to the dominant culture; however, the constant burden situated on the recipient was cumulative and harmful to the psychological, physiological, and academic well-being of the individual (Bell, Funk, Joshi, & Valdivia, 2016). Even though young girls were being told they can do/be anything boys can, due to the leaky pipeline they potentially lack female role models which unintentionally communicate to girls that they do not belong in STEM.

Microaggressive harassment experiences. Another possible contributor to the scarcity of women in STEM is harassment. Incidents of student harassment are explicit and implicit;

however, the detrimental effects of either type were associated with decreases in commitment, grades, productivity, academic performance, and self-image (Imonikhe, Aluede, & Idogho, 2012). A 2003 study published findings stating most high school students reported having been harassed by other students (92% of females), and some even younger students (e.g., elementary school-level) reported experiences of harassment by their peers (Dahinten, 2003). Harassment incidents involving women were frequently reported in STEM education as well as later in the STEM workplace (Herlihy & Campbell, 2016; McLaren & Gaskell, 1995; O'Hare & O'Donohue, 1998).

A research study on harassment incidents of STEM females (i.e., secondary education, college, and career professionals) indicated that women who stayed in their STEM field experienced no fewer incidences of harassment in either type or severity than those who left the field even though the women who stayed in their field viewed the harassment differently than those who left their STEM career (Herlihy & Campbell, 2016). Women who stayed in STEM viewed the harassment behaviors of men as subtle microaggressions; that is, actions by men who didn't even realize their actions were harassment. The women who left the field perceived these actions as purposeful.

A study examining the experiences of female senior high school math and science students found similar contradictions in how females viewed gender issues such as harassment and discrimination in STEM (McLaren & Gaskell, 1995). Researchers found although race and gender issues were prevalent in the students' educational experiences (e.g., curriculum, class settings/environment, student interactions with teachers and other students), the participants believed STEM should be, and was in their experience, gender neutral. However, females reported being disengaged in their STEM subjects, expressed feelings of being unsuccessful even though they were maintaining high grades in their STEM classes, and described incidents of subtle bullying, verbal microaggressions, racism, and sexism which emanated from both students and teachers.

Additional research had evidenced gender harassment was the most commonly reported type of sexual harassment although many of the behaviors identified as harassment in prior research were not universally perceived as such by study participants, particularly when comparing the gender of participants (O'Hare & O'Donohue, 1998; Powell, 1986). O'Hare and O'Donohue (1998) suggested the existence of sexist attitudes toward women were one of the strongest risk factors for harassment occurrences particularly in male-dominated fields such as STEM. Furthermore, in environments where women were viewed as less-capable, inferior participants, such as STEM fields, the incidence of harassment had been reported to be higher. A 2016 study evidenced that males and females experienced similar types of harassment (e.g., sexual jokes); however, girls were exposed to more severe forms, such as touching, grabbing, and rumors (Gruber & Fineran, 2016). In addition, the researchers indicated although males were adversely affected by sexual harassment, females were affected to a significantly larger degree, resulting in decreased academic performance and other negative school outcomes.

O'Hare and O'Donohue (1998) argued sex role socialization was strongly associated with harassment. For example, if STEM participants believed STEM was appropriate for men more so than for women, then women were more likely harassed due to their gender. Researchers proposed women fitting a more masculine stereotype (e.g., behaving like "one of the boys") create a threat to men and resulted in them becoming a target of harassment by men. Other researchers understood women fitting a masculine stereotype, such as working in STEM, may have perceived harassing behaviors differently than women in less-stereotyped roles (Powell, 1986). The differing beliefs may be due to some women regarding the behavior as inappropriate while others were more accepting. Herlihy and Campbell's (2016) study found STEM females' harassment experiences supported the latter belief. STEM females who persisted in their fields viewed the motivation for the harassment as unintentional (i.e., microaggressions). If the perception of perpetrators of harassment was females were interlopers in STEM, and therefore were implicitly treating women as such through harassing behaviors, then one had to consider where the belief of women not belonging in STEM originates. Rahm (2016) supported the belief that everyday practices, such as children's picture and/or illustrated books, were a source of the stereotype bias and outgroup messaging. Thus, early childhood literature was thought to support a hegemonic masculinity and initiating STEM inequality.

Sociocultural factors. Although prior research had demonstrated the "leaky pipeline" for women and minorities in STEM fields was multifaceted, some research suggested the loss was related to early childhood experiences (Ambady et al., 2001; Bakir & Palan, 2010; Chambers, 1983). Potential contributors to STEM inequities were likely to begin in early childhood. Prior research contended micro aggressive messaging conveying the idea that boys were more capable than girls began during the child's kindergarten year and/or earlier (Krogh & Slentz, 2011; Sadker & Sadker, 1994). Environmental experiences inside and outside of school were deemed to affect an individual's STEM identity (Barthelemy, McCormick, & Henderson, 2016; Eddy & Brownell, 2016; Herrera et al., 2012; Jackson, Hillard & Schneider, 2014; Milgram, 2011; Skaggs, 2011; Steinke, 2005).

Outside-of-school factors. Early sociocultural influencers outside of school, such as media, parent/guardians, caregivers, and others, were considered to be as significant to developing a young child's STEM identity as those early experiences inside of formal education. Some researchers argued that family and close personal relationships were the most important sociocultural influencers to socializing young children; however, they still supported media as one of the secondary sociocultural influencers (Woolley, 2010). In the 2011 Microsoft study caregivers and parents of school-aged children overwhelmingly supported making STEM a priority in the United States with 50% wanting their child to pursue a STEM field; however, less than 25% were willing to spend extra money to help their child be successful in STEM (Microsoft, 2011). The Microsoft (2011) study did not expound on the reasons for parent/caregivers' unwillingness. However, the unwillingness was thought to be due to a belief system that it was the schools' job to educate the student, or due to an inability based on socioeconomics, or even the lack of the parents' own success in STEM. Research supported that caregiver figures were role models for children, and caregivers' attitudes and/or beliefs affected the recruitment and/or retainment of STEM participants (Anderson & Cavallaro, 2002). Therefore, the Microsoft (2011) findings were significant because the research highlighted caregivers' paradoxical attitudes and beliefs, and motivating caregivers as well as students to pursue STEM was shown to aid in stemming the leaky pipeline. A crucial element in the study of STEM and was acquired in this study was identifying external factors which were significant (e.g., parent/guardian information).

Educational experience factors. Educational experiences such as single-sex STEM (K-12) classes, role modeling and mentoring, in-school and afterschool special programs, and

STEM learning community programs had been effective methods for increasing retention rates of STEM participants and facilitating STEM identity (Dagley, Georgiopoulos, Reece, & Young 2016; Eddy & Brownell, 2016; Milgram, 2011; PCAST, 2012; Simon, et al., 2015; Vezeau, Bouffard, & Chouinard, 2000; Watson, Quatman, & Edler, 2000). A University of Central Florida (UCF) and National Science Foundation (NSF)-funded research project called EXCEL attained significant gains in retention of STEM students through implementation of mentoring, learning communities, and role models (Dagley et al., 2016). Conversely, other reports had argued efforts attempting to increase recruitment and retention had done little to help (Flore & Whicherts, 2015; Mael, et al., 2005; Pahlke, Hyde, & Allison, 2014; Smyth, 2010; Wang & Degol, 2013).

Sociocultural experiences at early ages involving stereotype threat may affect STEM identity. Stereotype bias was indicated as forming at earlier ages than previously understood, yet there is limited research that includes early childhood populations (Aina & Cameron, 2011; Ambady et al., 2001; Bakir & Palan, 2010; Chambers, 1983; Mulvey et al., 2010). Due to biases forming earlier than once believed, early childhood-level learning content such as picture books was particularly important to investigate for biases. Sociocultural influencers during a child's developmental years (i.e., explicit or implicit) were considered to be significant in developing or diminishing an individual's STEM identity.

Prior Research

Over the last fifty years, a plethora of research literature was published reflecting on the prevalent nature of bias in a child's daily environment, including textbooks, children's literature, media, television, magazines, and more. Explicit bias was bias that was *not* hidden; it was a known bias, usually stereotypical. A textbook displaying a scientist as an older white male with glasses, a lab coat with a pocket protector, and crazy hair was an explicit stereotypical bias, and explicit biases affect STEM identity. Davidson and Davidson (1994) contended young children make meaning of their world by simplifying or stereotyping their environment and differences stand out more so than similarities for young learners; however, differences inherently can lead to harmful beliefs. Findings from Chambers' (1983) classic Draw-a-Scientist test, which asked nearly 5,000 children (49% female, 51% male) to draw a picture of a scientist, showed that most children drew a male scientist rather than a female (i.e., 99.4%) with only 28 children drawing a female scientist, and all were female participants. Finson, Beaver, and Cramond (1995) suggested children learn multiple stereotypes about scientists as they mature, which caused elementary and middle school children to increase their tendency to draw white male scientists as they aged. A recently released meta-analysis reviewing five decades of Draw-a-Scientist studies with over 20,000 participants indicated that although students were now more likely to draw female scientists particularly since 1985, older children and boys were still more likely to hold the stereotypical view of a male-gendered scientist (e.g., 72% for all participants, 58% of female participants, and 96% of male participants; Miller, Nolla, Eagly, & Uttal, 2018). Therefore, although the perception of gender diversity in science is more diverse over time, it appears to have changed for females more so than for males. It was important to combat gender bias, particularly when found in the written form, to provide a positive message to all learners/readers.

Types of bias. Stitt et al. (1988) purported six forms of bias in written communications: a) exclusion and invisibility, in that research had indicated exclusion and invisibility were the most usual forms of bias (Kolbe & LaVoie, 1981; Kortenhaus & Demarest, 1993; Stitt et. al., 1988; Weitzman, Eifler, Hokada, & Ross, 1972); b) stereotyping, where Stitt et al. (1988) asserted stereotype bias occurred within several variables including appearance (e.g., visuals, written descriptions), roles (e.g., domestic, career), social class or position, intellectual attributes, and/or personality attributes of characters; c) imbalance and selectivity, where imbalance and selectivity of information presented to the reader resulted in readers misrepresentation, thus misunderstanding, of reality (e.g., Barbie's unrealistic physical appearance); d) unreality, in that readers were presented with information which was likely not accurate or well-informed; e) fragmentation and isolation, where regarding women and/or minorities, the two forms of fragmentation and isolation included information being piecemeal and additionally being depicted, either visually or lexically, as only interacting with others that look like them; and f) linguistic bias, in that linguistic bias referred to job titles (e.g., mailman vs. letter carrier) or generic pronouns (e.g., he, she), which unintentionally distorted an author's message. Stitt and colleagues (1988) contended these forms of written bias could be reduced into explicit and implicit biases.

Explicit bias. Prior international studies have reported explicit bias in textbooks, particularly science and math texts, as well as children's literature (Amini & Birjandi, 2012; Aoumeur, 2014; Atay & Danju, 2012; Blumberg, 2008; Clark, Lennon, & Morris, 1993; Crisp & Hiller, 2011; Davis, 1984; Damigella & Licciardello, 2014; Gijon Puerta & Fages, 2010; Gooden & Gooden, 2001; Grauerholz & Pescosolido, 1989; Hamilton, Anderson, Broaddus & Young, 2006; Macintyre & Hamilton, 2010; McCabe, Fairchild, Grauerholz, Pescosolido, & Tope, 2011; McCleary & Widdersheim, 2014; Moser & Hannover, 2013; Roohani & Zarei, 2013; Sovic & Hus, 2015; Ullah & Haque, 2016; Ullah & Skelton, 2013; UNESCO, 2005, 2009; Weitzman et.

al., 1972). In these studies, women were either underrepresented in text or portrayed in a stereotypical manner, such as when a nurse was the female and a doctor was the male, or women being a damsel in distress and/or needing a man's help. Stitt et al. (1988) referred to these research examples as stereotyping, lexical bias, fragmentation, and isolation, as well as exclusion and invisibility. Other prior research indicated explicit bias in (a) advertising (Bakir & Palin, 2010; Keramyda, 2009; Maher & Childs, 2003); (b) television programming (Potts & Martinez, 1994; Pierce, Carew, Pierce-Gonzalez, & Wills, 1977; Long, Boiarsky, & Thayer, 2001; Rawson & McCool, 2014; Leaper, Breed, Hoffman, & Perlman, 2002); and (c) toys (Anderson & Cavallaro, 2002; Auster & Mansbach, 2012; Owen & Padron, 2015). These studies highlighted unreality, imbalance, and selectivity (Stitt et al., 1988).

Implicit bias. Implicit bias can be hidden, not necessarily considered bias, or could be an inherent bias. Campbell and Herlihy (2016) examined STEM children's book covers for gender bias by evaluating the images, authors, and color representation of a STEM book's cover. The investigation suggested there was gender bias in the book covers of popular STEM children's books. Male authors were more likely to be listed as first authors as compared to females, and the predominant colors on the book covers for last 50 years were blue and green, stereotypically associated with boys (Navarro, Martınez, Yubero, & Larranaga, 2014; Paoletti, 2012). The stereotypical "boy" colors were significantly more likely to be on a STEM book covers than the colors stereotypically associated with girls (e.g., pink, yellow). STEM readers may be less likely to pick a particular STEM book to look at or to read due to the subtle stereotype messaging of the book (e.g., *This has a blue/green cover by a male author, so it's a boy book*). The limited published research on implicit image bias found people gendered image content differently

(Almeida, Vasconcelos, & Strecht-Ribeiro, 2014; Davis, 1984; Flaherty, 2001; Gooden & Gooden, 2001; Kolbe & La Voie, 1981; Kortenhaus & Demarest, 1993; Weitzman et al., 1972). Almeida et al. (2014) found children's attitudes about animal images varied based on the child's gender (i.e., girls preferred butterflies while boys did not). Gender preferences can play a part in the perception of STEM and STEM roles. For instance, while reading literature, children recognized gender related features in objects and animals, such as *beauty*=female, *skirts*=female, *dirty/sweaty*=male (Smith, 1995). Still, there was limited published research regarding children's capacity to assign gender to otherwise gender ambiguous or non-gendered characters, objects, or animals. Implicit biases can be classified under any of the distinct types of biases cited by Stitt et al. (1998).

Problem Statement

Anthropomorphic representations include objects or animals perceived as having human characteristics. Limited research had been conducted involving children's perceptions of objects such as toys, animals, clothes, and foods, and how the participant perceived the gender classification of the object/image (Owen & Padron, 2015; Shutts, Banaji, & Spelke, 2010). Studies examined the preferences of young children and were focused on which toys and/or animals a participant preferred. The objects examined were stereotypically gendered, such as cars were for boys, dolls were for girls, dinosaurs for boys, and kittens for girls. Shutts et al. (2010) found children viewed pictures of people (i.e., adults, children) using novel objects (i.e., toys, foods, games, clothing), and gender categorized the objects based on the perceived gender of the person in the picture. Children's preferences for an object were significantly influenced by the properties like age, race, or gender of the person in the picture; children preferred objects that matched their gender and age group. Shutt's study indicated children assigned gender roles to objects like toys, foods, games, and clothing, but the study did not resolve the question of this study: *Do children assign gender to the objects themselves* (i.e., A girl gender role assigns pots/pans as being for girls, but does the girl see a pot/pan as having female gender itself?). The premise for this study was if children assigned gender roles to toys, novelty objects, and animals as established in other studies, then children should similarly gender print representation of the same. If readers gendered objects they were not expected to, then drawings or photos of objects could have been contributing to implicit bias for the reader. Gendered images in STEM children's literature are an-unexplored source of gender bias and stereotyping. Literature which authors/illustrators/publishers viewed as gender-free were thought to in fact be communicating outgroup messaging to the reader.

Significance of the Study

Due to gaps in the existing literature, an investigation into potential biases in early childhood STEM children's book images was warranted. There was a need for a study examining how children gendered images in children's daily commonplace practices, such as reading books. Studies had indicated stereotypical representations contribute to an individual's perception of a weak STEM identity (Brotman & Moore, 2008; Halim & Ruble, 2010; Steinke, 2017; Steinke et al., 2007). Media such as books and images were known to contribute to interest and identity. Studies indicated that young girls/women were influenced by their interactions with media (Adya & Kaiser, 2005; Ahuja, 2002). Women were known to form perceptions concerning their career choices and interest from the micromessaging during daily commonplace interactions with media, such as television, literature, magazines, and billboards

(Christidou, Bonoti, & Kontopoulou, 2016; Potts & Martinez, 1994). Academic performance, which was a contributor to identity, was shown to be negatively impacted when stereotypical images, such as a male scientist, were viewed rather than a non-stereotypical image in their textbooks (Good, Woodzicka, & Wingfield, 2010). Rahm (2016) argued for an examination of the characteristics of a girl's commonplace practices and how those practices related to engagement in STEM disciplines. In this study, reading and looking at picture books was perceived as a commonplace practice for young children. Most early childhood literature consisted primarily of pictures with little or no lexical content. Children under the age of seven were usually not strong, independent readers; therefore, early childhood literature emphasizes pictures more than words. The focus of the study included investigating children's perceptions of images in early childhood STEM picture books with the intent to identify how children gendered the images they viewed in the children's STEM books.

Research Methodology and Design

The study implemented a mixed method, exploratory, sequential design, including quantitative data from child image surveys (Appendix A), a parent survey (Appendix C), and quantitative and qualitative data from a content book analysis of popular award-winning STEM children's picture books. The survey data gathered from child and parent surveys used images from eight popular award-winning children's STEM books. The content analysis was on the same STEM books from which the images were obtained. Data triangulation was accomplished through conducting analyses of multiple surveys and gathering data from content analyses. Triangulation aided in increasing the validity of the study and in answering the overarching research question being investigated: *Do biased images exist in children's STEM literature?*

Findings in this line of research are expected to aid in (a) reducing the probability of young girls/women losing interest in STEM areas due to stereotype bias, (b) decreasing the extent with which children stereotype who does or does not belong in STEM fields, and (c) identified a possible additional source for the loss of STEM identity in women. The investigation was a first step in building a connection between early childhood literature and media experiences/sources and their influence on STEM identity. Further, the study contributes to what was known about potential foundational sources related to STEM identity and interest, which was a known contributor to the leaky pipeline. Educators, curriculum designers, authors, illustrators, and others may find this study instrumental when intentionally creating curricular materials to promote STEM interest and identity. Results and findings of both survey and content analyses were presented in partial fulfillment of a Ph.D. in Education degree.

CHAPTER 2: LITERATURE REVIEW

Chapter Two explores the literature as it relates to the study. The topics in this review include (a) stereotype and bias in children's writings focused on award-winning children's literature in the early grades as well as educational textbooks for science and math, (b) media sources and other environmental exposures which had been investigated include television, print media including advertising, children's toys, as well as movies and TV shows, (c) prior content analyses research process for analyzing books, (d) sociocultural influencer, (e) theoretical framework, and (f) research design. Finally, the investigation and review of literature focused on STEM literary sources of stereotype bias.

Research on Gender Bias in the Literature

Gender bias issues in literature were not historically emphasized until recently, principally since America's feminist movement in the 1960s and 1970s (McCabe et al., 2011). If women and/or minorities were represented in literature, particularly in textbooks, then the representation was isolated and fragmentary. The isolated information sent negative and implicit messaging to the reader that women and minorities did not belong in the mainstream (Stitt et al., 1988). Numerous studies since focused on the stereotypical sex role representation published in written communications such as children's literature (Bereaud, 1975; Canal, Garnham, & Oakhill, 2015; Crisp & Hiller, 2011; McCabe et al., 2011; Siyanova-Chanturia, Warren, Pesciarelli, & Cacciari, 2015; Weitzman et al., 1972). The classic 1972 study by Weitzman et al. (1972) highlighted the underrepresentation of women in the titles, central role appearances, and illustrations of books published in the five-year period between 1967 and 1971. Weitzman et al. (1972) argued for less stereotyped roles in children's picture books due to the detrimental effects which rigid sex role portrayal had on developing children's self-image, such as self-identity, and future aspirations such as career choices. The researchers purported images in children's literature were synonymous to a role model in a child's daily life. Weitzman et al.'s (1972) seminal study analyzed award-winning books (e.g., Caldecott Medal and Honor books, a small sample of Newberry winners) and non-award-winning books (e.g., etiquette books, Little Golden Books). The study indicated women were either undetectable or made to be invisible in the books investigated. When females were detected in the picture books either visually or narratively, they were defined to be submissive, unimportant, and stereotypically weak. The study lacked constructive methodological reporting; other than frequency counting, limited information was reported regarding the study methods.

Kolbe and La Voie (1981) conducted a follow-up content analysis study to the 1972 Weitzman study. The study included nineteen preschool children's picture books which were Caldecott Medal and Honor-winning books between 1972 and 1979. The study concluded although more female representation was apparent, the portrayal of female characters had not changed in the later published children's books. In the 1990s, Kortenhaus and Demarest (1993) analyzed 150 children's books over a period between the 1940s and the 1980s which included 25 award-winning and 125 non-award-winning books. Their study investigated how gender role representation was portrayed in children's literature. The findings evidenced that although female to male ratios became less disproportionate through the decades, role portrayal transformation was more insignificant. Females were portrayed as more contributory during activities and males less so than fifty years ago. However, female involvement was usually passive in comparison to their male counterparts. Stitt et al. (1988) claimed although the blatant masculinity once observed in children's literature prior had waned, the quantity of male-centered stories where males were central role characters had actually increased, and teachers did not have the time to review text carefully enough to ascertain publishers' changes to textbooks and children's literature were substantive rather than cursory. Stitt et al. (1988) maintained the changes had not been substantial.

Decades after these studies, McCabe et al. (2011) conducted a comprehensive examination of 20th century children's literature to discover how children's books reinforced gender representation, legitimized gender systems, and reproduced patriarchal gendered systems. McCabe and colleagues maintained prior studies only provided snapshots of small sets of literature during certain time periods but made blanket assertions and generalizations to all children's literature. Thus, their study reviewed 5,618 award-winning and other books published during the 20th century to provide a better-informed assessment as to the overall representation of males and females in children's literature during the 20th century.

McCabe et al.'s (2011) findings demonstrated males were more frequently represented in the title versus females, 36.5% male to 17.5% female. Male main characters were found in 26.4% of the books examined; however, female characters were represented just 19% of the time. Human characters were only one type of gendered image examined. The study also surveyed anthropomorphic and non-anthropomorphic animal characters and found the disparity even greater. Male animals were portrayed as central characters 23.2% of the time in the books examined, but female animals were only portrayed in this way 7.5% of the time. The study found regardless of the book series examined (e.g., Caldecott winners, Golden books), male characters were represented more often in the titles and as the main characters of the books.

Similar findings as to the disparity of male representation were found in this study. Lastly, the study highlighted how gender representation in children's literature transitioned over time periods, relating to social movements occurring during the same periods. For instance, findings from books published during the women's suffrage movement (1900-1920), during the feminist liberation movement (1960s–1970s), and again during the third wave of 20th century feminist movement (mid-1990s) indicated female representation was stronger in children's literature, such as central and title characters. Books published between the 1930s and the 1960s were examined and found to contain greater inequality of gender representation in the titles and main characters than those published before or after this period. The feminist movements before and after the 1930s to the 1960s time periods had influenced the writing and publication of more equitably gendered books. Thus, the belief in gender and gender roles being social creations was supported, and the cultural representation like those found in children's literature supported and legitimized gender inequality and gender systems (Smith, 1995).

As cultural norms shifted, the content and perception of literature and media in the content analysis including the illustrations did as well, thus prior study findings of children's literature and its gendered content, as well as other media influences such as advertising, movies, and toys differed with the audience being studied at the time the investigation was conducted (McCabe et al., 2011). The iconic Barbie was a prime example of shifting norms. The negative perception of Barbie's unrealistic body shape as seen in books and toys spawned a change to more diverse skin tones and realistic body proportions, particularly due to the research studies having indicated the negative impact on young girls (Dittmar, Halliwell, & Ive, 2006; Sherman & Zurbriggen, 2014). In addition, the Barbie doll transitioned from being a role-model, shopaholic girlfriend with fashion sense to a more modern-day female role model who was a laptop-carrying professional computer engineer (Betz & Sekaquaptewa, 2012). After surveying over 8,000 mothers, the makers of Barbie found 86% of mothers were "concerned about the kind of role models their daughters were exposed to; therefore, Barbie's creator, Mattel, released a new line of historical female role model Barbie dolls such as Katherine Johnson (an African American, NASA "human computer" mathematician), Amelia Earhart (the first female aviator to cross the Atlantic Ocean), Frida Kahlo (a Mexican artist and activist), and many more female role model dolls (Leguizamon & Ahmed, 2018, para. 2). Research identified the shifting of female roles occurring (Barber, 2015). It was necessary to continue investigations of past and current literature and other media, as well as replication of past studies, to identify contemporary reader biases and gender inequities in literature.

Inequities for much of literary history had indicated an absence of representation concerning women and/or minorities. Prior research indicated women represent half the population in the United States, yet, they represented less than a third of the persons or characters in books and textbooks. Further, textbook illustrations presented an inaccurate view of who was working in the world (Stitt, et al., 1988). The absence of female role models in young children's literature was significant considering research findings had indicated children's inability and/or willingness to consider a character's traits and attributes was tied to their developmental level (Martinez, Keehn, Roser, O'Neal, & Harmon, 2002). Martinez et al. (2002) reported external physical attributes such as gender, age, ethnicity, and so on of a character were most likely to be recalled by a young reader, not intrinsic attributes or qualities such as motivations, feelings, or interests. "When girls do not see themselves in the pages of textbooks, when teachers do not point out or confront the omissions, our daughters learn that to be female is to be absent…" (Sadker & Sadker, 1994, p. 8). Sadker and Sadker (1994) maintained when educators added their stereotyping to the already biased curriculum, the messaging became more damaging. Studies investigating gender issues in children's literature were considered to be of utmost importance due to the 2014 U.S. Department of Commerce Issue Brief #04-11 citing gender stereotyping and lack of female role models as potential contributing factors to the gender discrepancy in STEM jobs.

Prior content analyses research process for analyzing books. Content analysis was considered an acceptable method of analysis for analyzing materials such as textbooks, novels, newspapers, advertisements, television programming, movies, and so on; however, Clark (2002) supported innovative analytical methods in content analysis studies (Gall, Gall, & Borg, 2007). Content analysis studies of children's literature throughout the decades followed comparatively similar measurements for analyzing narrative (i.e., lexical) and/or visual (i.e., illustrations) content. Comparable to this study, early childhood picture books were the focus of analysis for various and notable studies on gender bias in children's literature (Chick, Slekar, & Charles, 2010; Davis, 1984; Gooden & Gooden, 2001; Hamilton et al., 2006; Kolbe & La Voie, 1981; Kortenhaus & Demarest, 1993; Weitzman et al.,1972). For instance, Weitzman et al.'s (1972) seminal study focused on how Caldecott Award-winning picture books communicated and reinforced traditional sex role stereotyping through how characters were illustrated or even if females were present, and how the narrative communicated behaviors, such as activity levels, jobs, or where characters were depicted in indoor or outdoor settings. Kolbe and La Voie (1981) replicated the Weitzman study by examining award winning picture books and establishing frequencies for female representation, sex of title character and/or leading role character, and identified how characters' roles were portrayed (i.e., traditional or nontraditional roles). Kolbe and La Voie (1981) added further criteria for analysis, such as sex of character on the front and back covers, sex of author/illustrator, and frequency of either sexed characters.

Much of the analysis conducted in prior studies had been frequency counting and reporting. Some analysis, particularly related to the imaging/illustrations and behaviors, was subjectively assessed, much like the Draw-A-Scientist test. Therefore, in a process modeled after some of the prior content analysis studies, the coders analyzing the selected books for this study were given operational definitions included on coding sheets (Appendix D) as guides to protect the validity of the subjective assessment of image content (Davis, 1984; Hamilton et al., 2006; Kolbe & La Voie, 1981, Vaughn-Roberson, Tompkins, Hitchcock, & Oldham, 1989).

Additionally, Hamilton et al. (2006) directed coders to record the gender of a group of seven or more individuals portrayed in an illustration to be of the dominant number (e.g., five boys and four girls in a group would be recorded as one male). If the grouping was six or less, the males and/or females were counted individually. Hamilton et al. (2006) based the judgement on the fact the coders "did not want to give as much weight to each depiction of a female or male character in a crowd as we did to female or male characters who appeared alone or in a small group" (p. 761). Other studies reviewed did not report on how groups of people were analyzed. Clark (2002) called for researchers to implement other analysis methods than those found in traditional content analysis studies on children's literature, arguing changes in analysis methods may direct advancements in the fields of children's literature, feminism, and psychology. Fletcher and Reese (2005) argued that a young child/reader's attention levels vary depending upon the frequency and repetition with which a book was presented. Therefore, researchers did not assume all visuals in groupings (i.e., small groups of less than seven or larger groups of more) would not be attended to on an individual level by a reader. Children's books were known to be reread to children; thus, the child may attend to a multitude of images with each reading of the book. Coders conducting the content analyses for this study counted each illustration of a male or female in a group individually. For example, a group of five boys and four girls was recorded as five males and four females.

Prior data analysis procedures. Some researchers studying gender differences and preferences for pictures had used a phi coefficient to measure the degree of association (Almeida et al., 2014). Almeida et al. (2014) investigated two binary variables, which were how much participants liked an animal and whether they thought the animal should be saved; however, the same statistical analysis could not be used in the study. Prior content analysis studies of children's literature utilized t-tests to analyze the interval and ratio data and Pearson's Chi-Square to analyze nominal data (Bereaud, 1975; Canal et al., 2015; Crisp & Hiller, 2011; Gooden & Gooden, 2001; Grauerholz & Pescosolido, 1989; Hamilton et al., 2006; McCabe et al., 2011; Weitzman et al., 1972). Many content analysis studies, including Weitzman et al.'s (1972) seminal work, conveyed frequency data as frequency counts, means, ratios and percentages in their statistical findings of the content analysis. Moreover, most prior content analysis studies had employed an alpha level of 0.05. The same was done for the study in the analysis and reporting of the content analysis findings.

Theories Helping to Frame the Study

The study examined behavioral and cognitive theories uniquely, unlike other studies which referenced one or the other. Behavioral theories view attitude changes from the *outside*; that is, environmental and/or social influences. Cognitive theories view attitude changes from *inside* the individual; that is, a person's neurocognitive abilities, personality, moral codes, intellect, and so on. Martin and Briggs (1986) supported the view, as did other researchers, that internal and external influences affect attitude change and by promoting one theoretical perspective over the other, the researcher introduced bias.

Sociocultural perspective: A behavioral theory. Vygotsky's sociocultural perspective (1978) contended interactions between culture and society influenced an individual's perceptions. For example, people who speak with an accent were more likely to be perceived as less intelligent (Bourhis, Giles, & Lambert, 1975; Fuertes, Gottdiener, Martin, Gilbert, & Giles, 2012). Vygotsky (1978) asserted development depended on an individual's growth (internal) and the symbolic tools and activities (external) which a learner experienced in a sociocultural environment (Kozulin, 2003). The symbolic tools, or symbolic and cultural artifacts as Vygotsky referred to them, were mainly language-based, including written and verbal content. McCabe et al. (2011) maintained children's books, an external tool, and reading to children, an external activity, influenced a child's learning of sociocultural norms such as internal development. Individual reality formation was first internally developed in the mind and then applied externally to the environment. For example, through children hearing readings of their favorite or popular books with potential biased messaging, the child's perception of the book's narrative and visual message changed how they interacted in and perceived their daily environments, such as pursuing or not pursuing STEM careers.

Previous children's studies supported the Vygotskian view of sociocultural influencers biasing children's perspectives of their environment. Research conducted on children's linguistical sensitivities supported the belief that one path for children creating and/or sustaining occupational stereotypes was language; specifically, narrative and image content (Liben, Bigler, & Krogh, 2002). Christidou et al. (2016) studied Greek and American primary children's visual perceptions of a scientist. The findings illustrated distinct cultural influences, including cultural media such as books, affected young children's visual perceptions of a scientist. Additional studies reported children's play (i.e., external activity) with certain stereotyped toys (i.e., external tools) altered their behavior and internal development because of implicit messaging. Sherman and Zurbriggen (2014) discovered that girls who played with Barbie dolls had a more limited perception of their career goals as compared to those who played with Mr. Potato Head dolls. As individuals discovered how to control and facilitate the tools of their culture (e.g., literature), they learned to modify their own social and mental activities and behavior. This type of negotiation between a person and their environment was coined internalization, "the internal reconstruction of an external operation" (Vygotsky, 1978, p. 56). Internalization may incorporate the development of stereotypical biases due to intentional and/or unintentional messaging in a person's environment, and/or the person's misconstruction of those messages delivered through symbolic and cultural objects. Researchers had cited stereotype bias as one of the principal causes for lack of women and minority representation in STEM especially among young adolescent girls (Cheryan, Master, & Meltzoff, 2015; Steinke, 2005, 2017). Stereotype bias formation was rooted in Vygotsky's sociocultural perspective. Research supported media, a sociocultural influencer, playing a fundamental role in the creation, depiction, reproduction, and spread of STEM stereotypes.

Sociocultural influencers may be affecting STEM females. Vygotsky's sociocultural theory, which supported the relationship between learning and development as well as the social-cultural dynamics of learning and development, facilitated the behavioral half of the framework (e.g., a non-bias examination in the study; Kozulin, 2003; Vygotsky, 1978). Vygotsky's sociocultural perspective maintained that attitude change, also known as development, depended on the influences from external tools and activities in one's environment affecting internal growth. Researchers had suggested the inequitable gender representation in leadership roles, particularly in STEM fields, were attributed to sociocultural influences including societal norms and beliefs, various media bias, as well as workplace culture and environment (Basow, 2004; Ceci, Williams, & Barnett, 2009; Steinke, 2005; Wang & Degol, 2013). Yet, it was unknown to what degree the factors contributed to the inequitable ratio of men to women involved in STEM fields.

Prior research studies on women and STEM found numerous sociocultural influencers on the loss of women in STEM. Wang and Degol (2013) conducted a meta-analysis on gender differences in STEM education and career choices to uncover motivational pathways to future STEM career choices. The findings from the study uncovered sociocultural factors (e.g., socialization and culture norms) and ecological factors (e.g., school, family and peers, biology) were responsible for girls STEM career choices. School factors were proven a strong influence on STEM motivational beliefs. For example, when instructional techniques (e.g., curricular differentiation, co-ed vs. same sex class, or class sizes), teacher-student relationships, or STEM related structural features were of lower quality, girls/women were more likely to disengage from science and math classwork. Due to the complexity of school and classroom dynamics found in the research, the authors did not identify specific agents for change. Wang and Degol (2013) noted research indicated a school's influence to be complex and multifaceted impacting students through various delivery methods including multimedia; thus, further research was needed to identify specific agents. School factors considered to investigate were the instructional materials, such as books and teachers' attitudes and behaviors, for the implicit messaging may be conveying to girls that they were not wanted, not capable, and did not belong in STEM.

Negative sociocultural influencers. Schools were unintentionally and implicitly delivering negative messaging conveying girls and STEM do not go together, but the repercussions of the messaging had a ripple effect for the future of women in STEM. The 2012 McKinsey Report identified barriers to female advancement in leadership positions, including institutional and individual mindsets (Barsh & Yee, 2012). The research findings highlighted unconscious bias as a cause from external and internal influences. Although some female leaders had early success and progress in their careers, they had to overcome the extraordinary challenges of a hegemonic system through personal stamina and grit. The gender bias belief that men make better leaders was a male and female phenomenon already present in the individuals under study in their STEM fields. Exactly where the belief stemmed from, however, was not addressed in the study.

Prior research by Shapiro et al. (2015) reported socialized gender roles and evidenced gender role stereotyping by the middle school age, which influenced adolescent career aspirations. Books were cited as important cultural message transmitters of gender role stereotyping of career options. The study found males and females viewed STEM as better career choices for boys than they did for girls. On average, boys self-identified STEM as their primary career choice, whereas girls' self-identified STEM careers as their fourth out of five choices when asked the same question. When adolescents were asked to select careers choices for the opposite sex, boys ranked STEM fourth for girls behind the arts, lawyer, teacher/professor, and medicine, and girls ranked STEM second for boys, only losing out to an athlete as first career choice (Shapiro et al., 2015). The stereotype-biased messaging supported the belief that men, not women, were STEM members and the deterioration of an individual's STEM identity, were likely developed from influences which occurred before middle-grade years during the primary developmental years. A conceptual framework incorporating known and suspected sociocultural influencers was developed for the study and was used during the analysis of the data as shown in Figure 2.

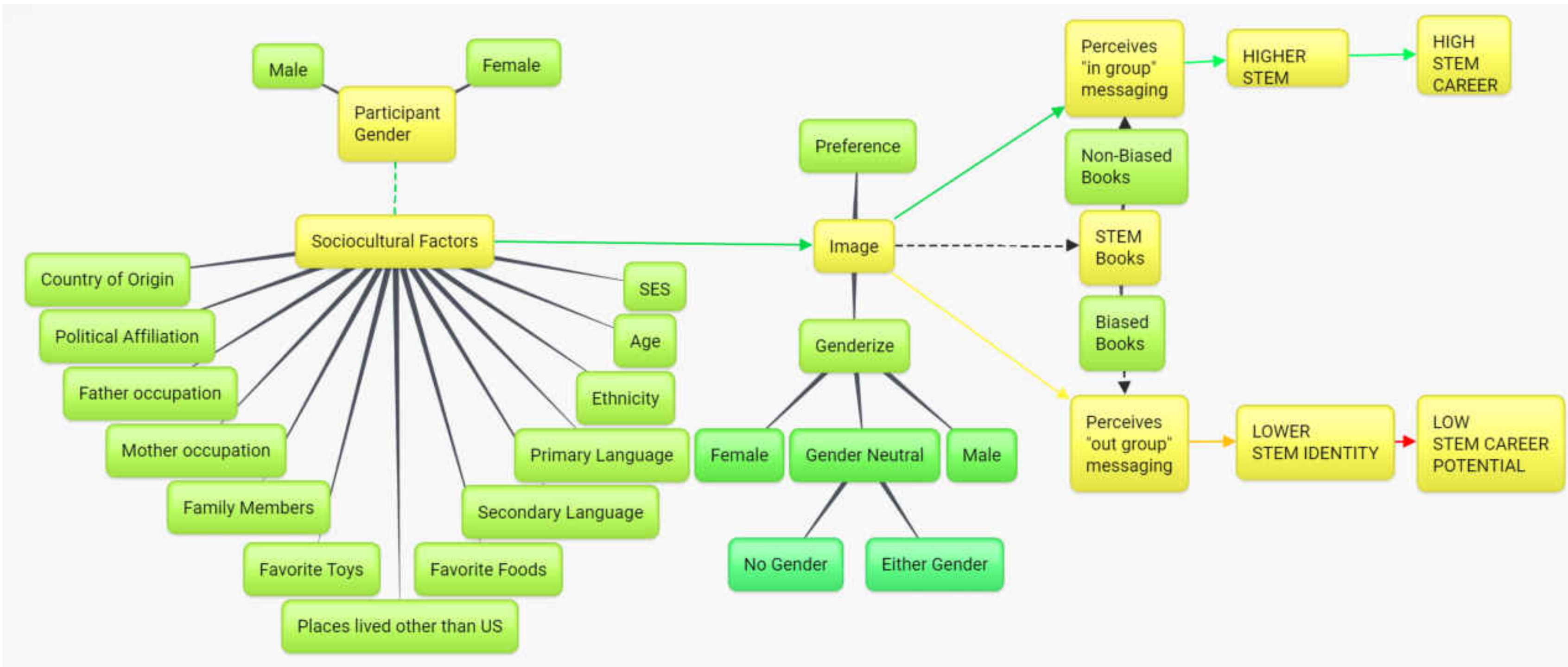


Figure 2: Conceptual framework of the study

Identity theories: Cognitive theory. There were various identity theories such as social and self-identity theories related to stereotype and bias; collectively, identity theories maintained an individual's identity was formed internally and/or externally through interpersonal and group interactions. The interactions individuals experience was realized in a constructed reality based on varied norms and beliefs. For example, Smith (1995) found that young readers interpreted the gender of anthropomorphized characters based on their stereotypical beliefs of what a gender should wear or how they should look or act, not by the narrative or image content within the picture book (i.e., long hair means the character was a girl, even if the pronoun "he" was in the text). Identity was constructed through shared beliefs. Young children form their social identity, and in turn self-identity, through differentiated experiences based on morals (e.g., fair, just, right), social conventions (e.g., social norms and rules), and/or psychology (e.g., personal choices and/or preferences; Mulvey et al., 2010). The dynamics between social identity and self-identity coalesced to form an individual's STEM identity as shown above in Figure 2. Children's literature played an influential role in children processing their identity (Gooden & Gooden, 2001). Researchers studied the influences of various media including books, supported the theory of identity construction through children's media, and the potential it had for detrimental effects (Keys, 2016; Rahm, 2016; Steinke, 2017; Steyer, 2014). Bell (2016) contended "social constructions presented as natural and inevitable are difficult to question"; however, "once their provenance comes into question…. imagining alternative scenarios becomes possible" (p. 8). Thus, just because white men were more often presented as capable STEM members rather than women or minorities, it did not mean the stereotypic messaging had to be accepted as circumstance and the STEM participant would lose their STEM identity.

Identification of sources which diminished a person's STEM identity were a crucial step toward being able to present potential alternative scenarios. Steinke (2017) maintained prior conceptual frameworks highlighted critical constructs and/or variables for developing STEM identity; however, they had not analyzed and developed in detail the potential influence of the construct/variable. Figure 3 demonstrated the conceptual belief of how biased STEM books may have been deteriorating an individual's STEM identity; however, like other frameworks has yet to quantify the constructs/variables. Sociocultural factors altered how an individual perceived an image found within STEM books, and thus ultimately biased STEM books based on the individual perception/s of the reader, not the intentions of the author, illustrator, or publisher.

Social identity theory. Tajfel and Turner (1979) theorized an interpersonal-intergroup continuum for social identity construction in which they claimed social group interactions resulted in social behavior moving away from the interpersonal toward the intergroup. At one end of the continuum were interpersonal behaviors. Interpersonal behaviors included interactions between a few individuals who had similar characteristics and formed relationships, and the individual was *not* affected by the social categories or the groups to which they belonged to individually. For example, a few middle school children who liked anime read and discussed the genre of books while waiting for their school bus to pick them up but were not of the same socioeconomic class, ethnicity, gender, or academic standing. The other end of the social identity continuum was intergroup behaviors, which were interactions between two or more individuals or groups of individuals. Behavior was determined by the individual's membership in different social groups or categories, and the individual was not affected by his or her individual relationships within the group. For example, boys who played football at a park were not open to a girl joining the group, even if most or all of the boys knew the girl personally. Group identity begins in early childhood (Mulvey et al., 2010).

Tajfel and Turner (1979) maintained social groups alter the behavior of an individual to act in ways which supported the group, not the individual. Ford, Brickhouse, Lottero-Perdue, and Kittleson (2006) maintained that “identities are performances that girls try out in order to be perceived by others in ways they find desirable” (p. 285). In addition, Tajfel and Turner (1979) proposed acceptance or rejection from a social group supported the “in group” or “out group” status of an individual. If an individual met criteria set by the group, then they were “in,” but if they do not then they were “out.” Ford et al.’s 2006 study investigated the sociocultural influencers of girls and their science reading choices and found girls were more willing to engage in activities facilitating the construction of “in-group” membership. Moreover, female STEM participants find themselves considered “out group” members of their female group identity due to their fellow female group members seeing STEM as not for girls and thus not socially acceptable to the female group identity. The incongruity placed undue pressure on the female STEM participant to choose between either being in the girl group or the STEM group, but not a member of both. The inequity of either choosing to be smart or popular was particularly severe for STEM minorities; therefore, educators and parents had to motivate minority females early to engage in STEM and perceive themselves as having ingroup status (Kunjufu, 2014). Literature, such as STEM books (e.g., textbooks, children’s literature), provided a window for stereotypical messaging to be communicating “out group” messaging to both gendered groups and therefore the social identity for girls belonging in STEM at the intergroup and interpersonal levels was diminished (Ford et al., 2006). Words, spoken or written, help to construct identity and were viewed as a social practice or a shared community of practice which was actively constructed jointly and individually (O'Shannessy, 2015).

Self-identity & self-categorization theory. Research implied that an "in group" bias existed in intergroup relationships. Tajfel and Turner (1979) maintained "the mere perception of belonging to two distinct groups – that is social categorization per se – is sufficient to trigger intergroup discrimination favoring the in group" (p. 38). For example, males were considered "in group" STEM members and females were "out group" members of STEM. Criteria for group membership was determined by how the individuals defined themselves and how the group members defined the individual also with much of the criteria being arbitrarily set. Self-identity and self-categorization were determined cognitively but unconsciously by comparing individual and group dynamics and categorization. In other words, *who am I and who were they? How were we alike or different? Where did I fit in?* By determining which groups they were most comparable to and compatible with, the individual self-categorized their own group membership.

Furthermore, a social group or social identity offered group members a means for further developing their self-identity. Social identity or the social categories, which an individual saw themselves as having a part in, affected an individual's self-image. As individuals endeavored to improve their self-concept, self-esteem, etc., they worked to be associated with social categories that developed a "positive value association" (Tajfel, 1974, p. 72). If girls or women did not see a positive value or added benefit for being a STEM group member to their self or social identities, then they would not pursue STEM interest because they self-categorized as "outgroup" members of STEM. Conversely, if they were part of a STEM group but saw themselves as having an outgroup or inadequate social identity because of their membership in STEM, then they left the existing social group for a more positively distinct group. Gee (2008) held "learners must be willing and motivated…in such a way that they take on and grow into a new socially-situated identity, a[n] identity that they can see as a fruitful extension of their core sense of self" (p. 31). Tajfel and Turner (1979) supported the idea individuals must "internalize their group membership as an aspect of their self-concept" or they did not remain in the group (p. 41). Individuals would rather had improved their self-identity and self-esteem through ingroup membership with a different group rather than be stereotyped as having "outgroup" membership. The individual based their beliefs, practices goals, and norms on a salient social group or an "in group;" hence, the lack of STEM identity was a root cause of the leaky pipeline for women (Ertl, Luttenberger, & Paechter, 2017; Else-Quest, Hyde, & Linn, 2010; Herrera et al., 2012; Steinke, 2005, 2017).

Studies indicated the overt and hidden messaging delivered to readers contain implicit and explicit stereotype bias, much of which was not conducive to STEM membership (Clark et al., 1993; Ford et al., 2006; Smith, 1995). Additional research indicated although stereotyped messaging affected boys/men and girls/women, girls/women were more strongly affected in general to stereotyped messaging, particularly implicit messaging (Pavlova, Weber, Simoes, & Sokolov, 2014). If women were going to be seen as "in group" members of STEM, stereotyped messaging needed to abate because the stereotype messaging negatively affected female membership in STEM.

Stereotyping and the effects of a stereotyped environment. Turner and Oakes (1986) cited stereotyping as a main cause of an individual establishing an "outgroup" status, either by themselves or the group. Stereotyping was defined as the unfair belief all people or things with a particular characteristic were the same (Merriam-Webster, 2016). Feminist theorists claimed stereotyping lead to hegemonic systems. "The construction of hegemonic meanings … is a constant process of denying alternative meanings…the celebration of a dominant identity hides the 'dependencies, inequalities, and oppressions' that mark contemporary societies" (Arnot & Weiler, 1993, pg. 213). To pretend the stereotyping of women in STEM was nonexistent was equivalent to the promoting of said stereotype and reinforcing the patriarchal hegemony.

Research evidenced the detrimental effects of stereotyping. Lassonde (2015) found prior stereotyped knowledge detrimentally affected a reader's comprehension. Pavlova et al. (2014) found negative stereotyped messaging diminishes a person's neural processing, whereas positive messaging leads to the recruitment of effective processing strategies. Jordan and Lovett (2007) reported a student simply having an awareness of a negative stereotype could depress their test performance. Researchers recognized the damaging effects of stereotype bias and stereotype threat to a child's physical, emotional, and mental development (Shenouda & Danovitch, 2014). Anderson (2013) purported children's picture books could potentially offer a feasible intervention method to fight STEM girls' negative stereotypes; however, he acknowledged children's literature appeared to be acting as a vehicle for promoting stereotypes.

The negative messaging conveyed through stereotyping can lead to oppressive environments for some STEM individuals such as girls/women and underrepresented minorities (e.g., Hispanic, African American populations). Oppressive environments result in settings ripe for exclusion and harassment (CUPE, 2014). Oppressive environments caused by stereotyping had been established as having detrimental effects on women in STEM. A Canadian report by the Canadian Union of Public Employees (2014) cited oppression as the root cause of harassment. The report defined oppression as one social group knowingly or unconsciously exploiting another social group to its own benefit. Unconscious attitudes and behaviors involving structural oppression, inequalities so prevalent as to appear normal in the environment, or interpersonal oppression were of great concern. The unintentional exploitation present in oppressive environments then reinforced the stereotype, and the cycle continued and strengthened. Recent research indicated undergraduate women in STEM fields reported harassment as a common occurrence in their STEM field (Barthelemy et al., 2016; Herlihy & Campbell, 2016). Additionally, women also reported the normalcy of the occurrence in that the belief and acceptance that one could not exist without the other (i.e., "If you want to be a woman in STEM, then you have to deal with harassment from men", because they "just aren't aware they are even harassing you"; Herlihy & Campbell, 2016, p. 13). A two-year study found female silence was the norm concerning harassment incidents and the older women get, the quieter they become (Sadker & Sadker, 1994). The same study found college-enrolled women were less likely to participate in class discussions than K12 participants; for example, in a typical college class, 45% of the class doesn't speak, with the majority of these silent students being women. If research reported that oppression was the root cause of harassment and stereotyping caused oppression, then one would surmise by preventing the stereotype of women as not being suited for STEM such as having outgroup status for the STEM social group, the issue of STEM women being harassed would diminish as well.

Stereotype threat theory. A situational dilemma an individual can face concerning their social group membership was considered a stereotype threat (Steele & Aronson, 1995).

Although stereotype threat was not alleged to be the only reason for gender inequality in STEM populations, research evidenced stereotype threat was responsible for affective, cognitive, and motivational process deterioration (Pennington, Heim, Levy, & Larkin 2016). Researchers discovered K-12 females competed equally well as their male counterparts in science and math aptitude; however, females lost interest and pursued STEM majors in college at much lower rates than their male counterparts (Ceci et al., 2009; Lindberg, Linkersdorfer, Ehm, Hasselhorn, & Lonnemann, 2013; Simon et al., 2015; Wienclaw, 2013). If a person was a member of a stereotyped social group and the individual feels at risk of conforming to a stereotype, then they chose to leave the group rather than face outgroup status because of the stereotype (Steele & Aronson, 1995). The choice for STEM females to leave STEM and give up their STEM identity in order to retain their feminine identity, or stay in STEM and retain their STEM identity but conform to a more masculine ideology in how they present themselves through clothing or hairstyle/makeup and/or how they speak was the result. Herlihy and Campbell (2016) evidenced STEM participants reported a need to 'be one of the guys' to fit in with the STEM social group. The individual, however, did not need to conform to the stereotype to feel threatened by it. An example of this was a female who was part of the popular cheerleading group at her high school and who was also part of the Math Olympiad club at the school. When the popular cheerleading group stereotyped the math group as being geeky and unpopular, the female cheerleader felt threatened by the stereotype and chose to disassociate from the less salient in group. Additionally, the stereotyped messaging was not needed to be verbal. Through media imaging, such as a poster portrayed a Math Olympiad competition team as male and less physically attractive by societal standards, the outgroup messaging was implicitly conveyed. McLaren and

Gaskell (1995) maintained science was perceived as masculine, particularly the physical sciences, where typical classrooms predominantly displayed posters and pictures of male science role models.

Stereotype threat affected people of various ages, not just adults or adolescents. A meta-analysis study found stereotype threat had a large effect size on children under the age of eight years old. Prior research reports had indicated an effect on young children was not reasonable due to pre-adolescent children not yet obtaining a consistent sense of identity (Flore & Wicherts, 2015). The new finding of stereotype threat on children under the age of eight encouraged future studies of the stereotype threat effects on young girls. Neuburger, Jansen, Heil, and Quaiser-Pohl (2012) measured the mental rotation performance (i.e., visuospatial awareness) of fourth graders and found female performance decreased in gender stereotyped learning domains in comparison to non-gender stereotyped learning domains. The finding was significant as visuospatial ability was shown to be an essential prerequisite in the study of math and science.

Pennington et al. (2016) reviewed psychological mediators of stereotype threat and found seventeen distinct mediators of the threat; however, one important mediator affected women worse than men which was an affective/subjective mechanism called individuation tendencies or gender-based threats. Gender-based threats were more likely to affect women in disassociating from a group than men. For example, women who were the lone female within a group of males tended to have higher anxiety levels, another affective mediator, and they left the group. Pennington et al.'s (2016) study found stereotype threat was most likely to be activated through subtle environmental factors rather than explicit ones suggesting that low group identity (e.g., STEM identity) made an individual more susceptible to stereotype threat. By improving female participant's STEM identity, women were less inclined to be affected by stereotype threat and therefore less likely to leave their STEM fields.

STEM identity theory. STEM identity was a social identity and self-identity. STEM identity was dynamic, impressionable, multidimensional, socially imposed, and individually constructed (Ertl, et al., 2017; Steinke, 2017). Some researchers maintained a weak STEM identity was one source of the gender inequity in STEM (Ertl et al., 2017; Else-Quest et al., 2010; Herrera et al., 2012; Steinke, 2017). Social identity theory suggested a girl's STEM identity was affected by media models of STEM professionals who the viewer perceives as corresponding to salient ingroups based on gender, race, and so on (Steinke, 2017). STEM media models found in every day practices both inside and outside a child's school environment in the form of textbooks, children's literature, toys, magazines, adult STEM role models, and advertisements affect STEM identity. Keys (2016) indicated there were limited STEM role models for young girls, particularly minority women. In children's popular media, only two animated minority female main characters were on television for young girls between two and five years old (i.e., Doc McStuffins, Dora the Explorer). The characters were portrayed as strong female STEM leaders, which was unusual as most STEM animated characters were portrayed as white males. Steinke (2017) reported gender stereotyped media models provoked "identity interference for adolescent girls," particularly when the exposure created a perception of incompatibility between gender identity and STEM identity (p. 7). CNN published a report produced by Common Sense Media stating TV and movie programming was engendering a generation of young preschool-aged children to biased influences regarding the expectations of boys and girls in society (Knorr, 2017). The everyday environment of some individuals (i.e., what they see and/or interact with) provided sociocultural influencers either develop or diminish one's identity, including their social identity, self-identity, and STEM identity. Rahm (2016) argued for research to include the everyday practices of young girls and how these practices influenced one's STEM identity. The everyday practice this study addressed was young children's STEM literature.

Integrated STEM education supported STEM identity. Additional literature in the field of STEM education supported an integrated STEM education to foster a child's STEM identity (Honey, Pearson, & Schweingruber, 2014). The National Academy of Sciences published a report which supported the integration of the four areas of STEM. By integrating STEM areas, learners had an increased interest in STEM and, in turn, a stronger STEM identity. Honey et al. (2014) suggested experiences in an integrated STEM program provided opportunities for engagement in STEM which may potentially transform learners' identities, particularly for populations that had been historically underrepresented in STEM fields. The collaborative nature of an integrated STEM environment provided social and cultural experiences that required students to actively engage in discussion, problem-solving, and decision-making across genders and cultures. Such experiences during the K-12 years were one approach to help deter the proliferation of the negative stereotyping of girls in STEM. Early and frequent occurrences of boys and girls working collaboratively and/or seeing others working together on STEM topics lessened the stigma STEM girls/women face as outgroup members.

Microaggression theory. As stereotyping and bias were explicit or implicit, research had shown girls/women were more affected by implicit/subtle messaging; therefore, an additional theoretical perspective was considered in the investigation: Sue's Microaggression Theory (Sue, 2010). Research on microaggression was a contemporary area of investigation which had helped to conceptualize why women were not as successful in STEM areas despite demonstrating equal capabilities to their male counterparts (Hill et al., 2010). Microaggressions were historically studied in relation to race and ethnic relationships; however, the experience of microaggressions were also a gender-related phenomenon (Lester, Yamanaka, & Struthers, 2016).

Sue (2010) suggested microaggressions, which were "brief, everyday exchanges that send denigrating messages to certain individuals because of their group membership," had a devastating impact on oppressed and underrepresented populations (p. xvi). Researchers evidenced common everyday practices of young children such watching TV, reading children's literature, among others, adversely affected young children's STEM identity through implicit messaging (Keys, 2016; Rahm, 2016; Steinke, 2017; Steyer, 2014). The negative implicit messaging found in children's literature was a form of microaggressive messaging (Bruce, 2014). For example, the Asian character depicted stereotypically in the Dr. Seuss' 1937 children's picture book *And to Think I Saw It on Mulberry Street* was considered by some to be a negative, ethnic microaggressive image (McClurg & Puente, 2017). Some researchers argued Dr. Seuss' books were gender-biased as well (McIntyre, 2017).

Research on gender microaggressions in STEM was a relatively new area of study, and research specifically related to STEM literature was absent. The study of microaggression were not without opposition (Lilienfeld, 2017). Some had maintained the concept of microaggressions were being aggrandized and people were being too sensitive (Chumley, 2017; Lilienfeld, 2017). However, social identity and stereotype threat theories supported the claim that negative group membership perception deterred identity formation due to unintentional stigmatizing messaging;

consequently, microaggressive messaging in children's STEM literature was a potential source of stereotype threat to be studied. There was increased support for the investigation of microaggressions in STEM education (Kao, 2017). Unintentional microaggressive messaging toward young children was thought to affect STEM identity development. Still, the existence of "micromessaging," or unintentional negative messaging, in children's STEM literature images was yet to be established. Latent and implicit negative messaging (i.e., narrative and/or visual gender microaggressions) in children's STEM media, meant to promote STEM identity, was an area requiring investigation and was the focus of the dissertation study.

Theoretical Framework of the Study

Behavioral *or* cognitive theories were historically applied to the study of stereotype and bias. In this study, both types of theories formed the framework for the investigation to promote a non-biased view. Research has supported promoting one type of theoretical perspective over another introduces bias (Martin and Briggs, 1986). The following theoretical framework which encompassed external and internal influences in behavioral and cognitive theories guided this investigation (Figure 3). The examination of behavioral and cognitive theories indicates attitude changes can occur from the outside (e.g., socio-cultural, environmental influencers) and from inside the individual (e.g., neurocognitive abilities, personality, moral codes, intellect).

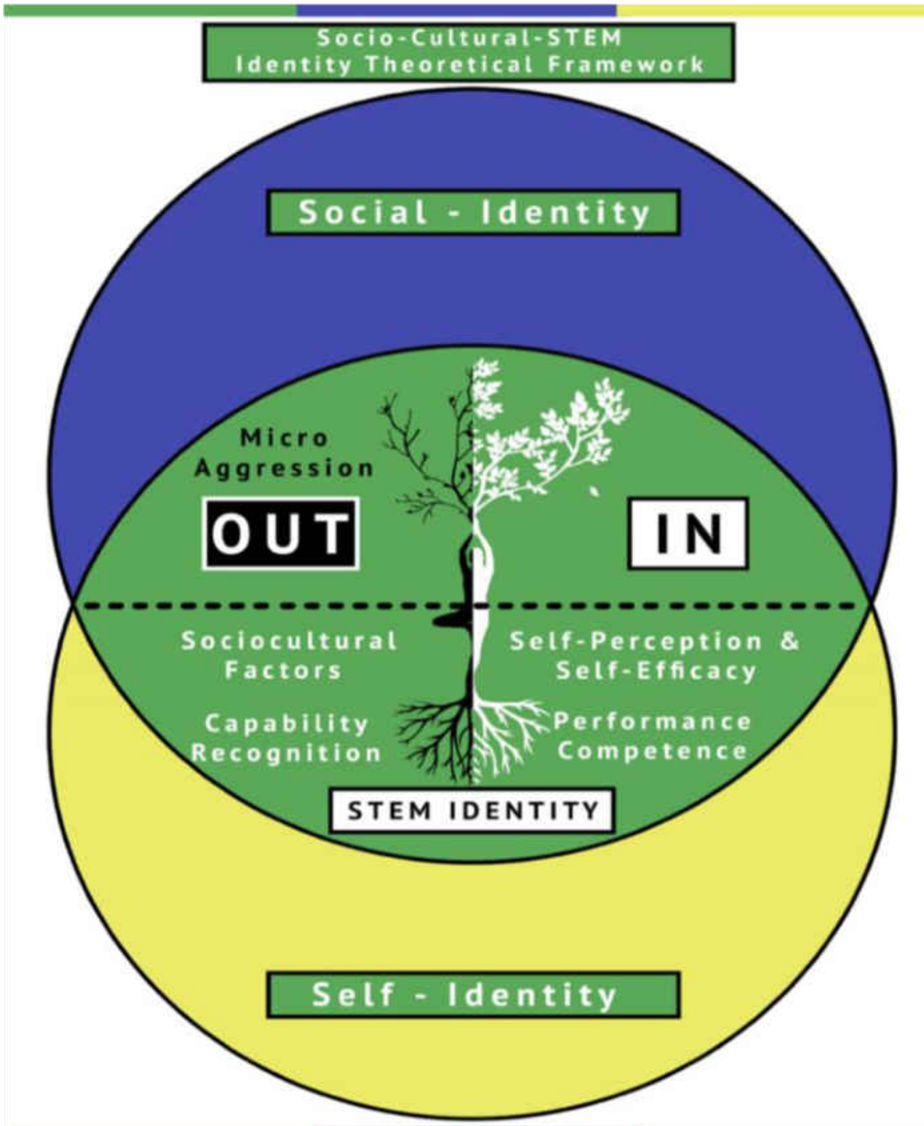


Figure 3: Theoretical framework = behavioral + cognitive theories (Herlihy & Campbell 2018)

Identifying and Resolving the Bias in Literary Content

Prior studies reported gender and race biases in educational text (Jay & Schminke, 1975; Krogh & Slentz, 2001; Nowakowska, 1997). Stitt et al. (1988) reported obvious female under-representation in textbook images existed in that female representation occurred in less than one-third of the textbooks. Additionally, as the grade level of the textbook increased, the illustrative representation of girls/women and minorities decreased. The minority female was virtually invisible in sixth grade science and math textbooks and was represented by less than seven percent (Stitt et. al., 1988). These biases, particularly in STEM materials, deterred interest in STEM by marginalized populations such as women and minorities. Recommendations at the time were to produce instructional materials which presented more gender neutral and/or non-gendered materials (Schmuck, Runkel, & Schmuck 1994). Since the less-gendered instructional materials were implemented, there was a scarceness of research as to the efficacy of the gender-neutral approach applied.

Narrative bias. Of the published research concerning the use of gender-neutral text in children's literature, reports indicated a lack of effectiveness toward readers who had previously biased perceptions (Lassonde, 2015; Liben et al., 2002; Smith, 1995; Stitt et al., 1988). Smith (1995) supported the view that textual/lexical changes did not support the reader in changing their prior gendered views of characters. Lassonde (2015) researched the activation of stereotyped knowledge in narrative texts and how the prior knowledge affected reader comprehension of text. The findings reported an activation of stereotyped knowledge (e.g., *surgeon* = boy, *cheerleader* = girl) and an inability to suppress passive activation even if qualification text, such as pronouns, were added to the narrative (e.g., *"He" makes a great cheerleader*). Qualification text did help to lessen the stereotyped perception, but not eliminate it from the reader's comprehension. Lassonde (2015) argued for future research to investigate the influence of implicit bias in children's literature content.

Liben et al. (2002) studied children's sensitivities to linguistical forms of job titles, such as *fireman* versus *firefighter*, *policeman* versus *policewoman* versus *police officer*. The findings of the study suggested lexical content meant to be inferred as gender neutral (i.e., *firefighter*, *police officer*) was assigned a gender by the participants. The hypothesis that gender-neutral titles were not universally understood by children was supported by the findings prompting recommendations for linguistical materials that avoided lexical content containing strong-marked occupational titles, thereby increasing occupational choices that children would consider. Some children came to school holding stereotypic beliefs and attitudes concerning male and female roles (Stitt et al., 1988). Implementation of non-biased books helped make a difference in children's perceptions of who belongs in STEM. Talbot (2004) argued for more inclusive and friendlier language being implemented into written educational materials, such as the use of first-person pronouns.

Biased book content was not only found in American literature. Aoumeur (2014) conducted an analysis of Algerian school textbooks and found patriarchal content promoting gender bias was still in circulation even after concerted government efforts to reduce this type of content. A content analysis of Malaysian children's literature found male characters significantly outnumbering female characters in number and quality of description (Nair & Talif, 2010). Multiple studies evidenced significantly higher numbers of adjectives used in children's books to describe male characters in comparison to the female characters, and the descriptions of male characters conveyed them to be more active and cleverer than females (e.g., males were bright, brilliant, strong, and brave versus girls were beautiful, exhausted, tiny, nice; Davis, 1984;

Vaughn-Roberson et al., 1989; Kolbe & La Voie, 1981; Nair & Talif, 2010). Thus, the lexical choices constructed stereotypical concepts of what it means to be a boy/man or girl/woman.

A comprehensive analysis of textbooks from multiple countries was published in 2009 by UNESCO. Findings from the study indicated even though efforts over the last few decades had been made in various countries to eliminate patriarchal messaging discriminating against girls/women, negative and biased messaging was intentionally, or explicitly, and unintentionally, or implicitly, present in the books analyzed. The researchers deemed that masculine dominance in books as a cultural norm that may be slow to change among male dominated cultures.

Visual bias. Visuals and images were also shown to be biased based upon the gender of the viewer/reader (Almeida et al., 2014; Finnegan, Oakhill, & Garnham, 2015). Images of animals and people as well as anthropomorphic characters showed bias, even if the image had no specified gender. Smith (1995) found that young readers were influenced by sociocultural factors such as stereotypical roles and behaviors when determining the gender of animals and anthropomorphic characters. Even when the textual content referred to the character as one gender, the reader perceived the character differently due to his or her own bias. Further, traditional picture books were more likely to semantically convey the gender of anthropomorphic characters. Smith (1995) contended that modern children's picture books were less likely to clothe or color an anthropomorphized character in a conventional manner, like dressing a girl pig in a pink dress. Instead, readers assigned gender to picture book characters based on an interpretive construction, at the word and image level, and were defined by the reader's cultural experiences. Frawley (2008) discovered similar reader misrepresentation concerning recall of factual story information due to prior gender bias of the reader. For example, if a reader were to see an anthropomorphized character who was portrayed as a Scottish boy pig in a kilt, then the reader interpreted and recalled the character as a girl even when the narrative referred to the character as a boy. The design of the images affected viewer/reader emotions, cognitive load, and/or learning.

Plass, Heidig, Hayword, Homer, and Um (2014) replicated a 2011 study investigating the effects of the shape and color of images and visuals on learning and emotion. Their findings stated that a girl's preference for images were for round shapes with face-like features and warm colors. Plass and colleagues (2014) supported the premise that gender differences existed relative to affective responses to visuals, color preferences, and cultural differences related to meanings and learning. When comparing live and inanimate objects, Greenberg (2010) found stronger preferences for animals than for inanimate objects with the girl participants from 35 to 68 months old. The study found boys and girls gendered certain images differently. For example, cats were perceived as girls and liked by girls more than boys, while dogs were perceived as boys and liked by boys more than girls and elephants were overwhelming gendered male, particularly by male participants.

There has not been sufficient examination as to how, or even if, the design of gender neutral or non-gendered image content implemented by authors, illustrators, and publishers was effective in influencing a reader's or viewer's perceptions differently than prior gender-biased content. Research published in the late 1980s determined that more literature was being produced by publishers containing gender-neutral anthropomorphic characters and stories in an attempt to eliminate gender stereotyping (Vaughn-Roberson et al., 1989).

Instructional Design Research

Instructional systems designers, defined as practitioners, create "instructional experiences which make the acquisition of knowledge and skill more efficient, effective, and appealing" (Merrill, Drake, Lacey, & Pratt, 1996, p. 6). Instructional designers considered graphical representations important in the design of instruction to foster learning, yet images are not always used appropriately or beyond a page decoration (Mayer, 2009). In a research analysis of sixth-grade science texts, 85% of illustrations "served no important instructional purpose" and were solely decorative in order to interest or entertain or representational in order to portray a single element; however, Mayer (2009) maintained "people learn better from printed text and supporting illustration than from printed text alone" (p. 235). One multimedia instructional design principle referred to as signaling stated people learned better when cues were added (Mayer, 2009). These cues may be illustrations, like those found in children's books. Research supported the signaling principle applies principally to low-skill readers, not high skill readers (Mayer, 2009). Non-readers or low-skill readers listened to stories which others read to them, using the illustrations in the stories to follow along with the narrative read to them and formed an understanding of the message in the children's book. For young pre-readers and early readers, visual material was as important as the lexical content they heard to their comprehension of the information provided to them. Biased visuals, or illustrations which children perceived as stereotypical, had a larger effect on young readers than once understood (Aina & Cameron, 2011; Mulvey et al., 2010). The potential micro-messaging contained within the visual content of early childhood STEM books was considered in this study due to the potentially contradictory messaging the visuals may be sending to young STEM readers/learners. Researchers had reported gender bias content and curricula around the world in formal and informal educational materials, including educational text and children's literature. As the inequality in STEM areas was a recognized social justice issue and past stereotype bias was found in instructional texts, which consequently communicated a hidden curriculum, instructional designers (IDs) had examined how instructional systems, such as children's book development, was unknowingly participating in the oppression of the marginalized STEM populations such as women and minorities, making this study a worthwhile instructional design research project.

Hidden curriculum. Feminist researchers argued for the formulation of strategies to counter the escalating educational crisis of gender bias in educational materials and instruction (Arnot & Weiler, 1993; Talbot, 2004). Arnot and Weiler (1993) reasoned for an analysis of the policies and choices in curricular materials implemented within education to resolve the ongoing crisis of a hidden curriculum supporting the gender inequity in educational systems. The term *hidden curriculum* implies unintended learning, positively and/or negatively (Gibson, 2012; Great Schools Partnership, 2015; Talbot, 2004). Some researchers speculated the informal education children obtain through daily encounters with media such as books, advertisements, television, and movies were influential to their identity via hidden curriculum (Trend, 1995).

A well-publicized study by Sadker and Sadker (1994) demonstrated how teachers were being unintentionally gender biased against female math students, even though the teachers knew they were being observed for acts of sexism in their teaching practices. Sadker and Sadker (1994) reported students received lessons or messaging from peers, adults, and curricular materials (e.g., books), which were not part of the formal curriculum or the intended messaging (e.g., how they should perceive people and/or how their behavior or dress should conform to socially acceptable norms). However, the ability to recognize subtle sexism increased "once the hidden lessons of unconscious bias were understood" (Sadker & Sadker, 1994, p. 3). The unacknowledged and/or unexamined lessons, values, and perspectives children learn from "unwritten, unofficial and often unintended lessons…consists of implicit academic, social and cultural messages that are communicated" to children (Great Schools Partnership, 2015, para. 1). The hidden curriculum examined in this study references negative hidden curriculum; thus, the meaning used herein was not intended to be complimentary and implied a gendered-hegemonic messaging.

Hidden curriculum reinforced bias. Feminist researcher Wienclaw (2013) supported the concept of a hidden curriculum which subtly reinforced social stratification in the educational system. The application of a feminist perspective in the content analysis of the study facilitated the discovery of unintentional biased STEM literary materials. Researchers in fields such as education, instructional design, gender issues, STEM, and the like had supported expanding research efforts investigating girls/women and minorities in STEM (Arnot & Weiler, 1993; Honey et al., 2014; Milgram, 2011; UNESCO, 2016, 2017). Research indicated one place hidden curricula existed for young children was in picture and illustrated books (Beckett, 2010; Nodelman, 2010). Researchers of children's picture books supported the benefits and disadvantages of the genre. Benefits included the development of linguistic, written, and visual literacy as well as learning cultural values and social norms (Colomer, 2010). Problematic within the genre was the hidden curriculum that can be implied in the story through narrative and image content (Beckett, 2010; Nodelman, 2010). Picture and illustrated books produced cultural meanings and agendas through the images and narratives (Bradford, 2011).

Nodelman (2010) argued adult picture book authors and illustrators construct ascribed cultural values and lessons offered from adult perspectives. The construction of these values and lessons, and the possible subtle/hidden messaging (intended and unintended) they conveyed to the reader, was the basis for this content analysis study. Young readers of picture books are expected to silently accept the views of the adult/narrator and subjugate their own perspectives; thereby, hiding the implied relationship between the adult/narrator and the child/narrate (Nodelman, 2010). Bradford (2011) stated,

> For just as the language of narratives is never innocent or transparent, so images for and about children are always imbued with the fears and desires of those who create them and with the complex and often contradictory ideologies of the cultures where they are created. (p. 194)

The premise of this study was to examine picture books for hidden curriculum and not take the STEM children's literature at face value or as benign opportunity for entertainment. Children's literature was found to provide an opportunity for cultural and hegemonic beliefs to be inadvertently conveyed (Nodelman, 2010). Findings of bias in the literature examined herein did not convey the need for educators to censor books with hidden curriculum; however, the acknowledgment of the bias (gender and ethnic) should be addressed and considered a learning opportunity.

Basow (2010) maintained the hidden curriculum, pervaded the educational system via biased curricular materials and the classroom environment, and limited the educational achievements of children. The patriarchal culture was shown to be prevalent within educational systems worldwide includes the hidden ethos that men were better and more valued than women, which supported an environment predisposed for harassment, predominately against girls/women in STEM. It was argued the suppressive culture of educational systems does not end with gender but extended to race and economic status (Woolley, 2010; Krogh & Slentz, 2011). The following investigations aims to uncover the hidden curriculum of biased messaging in early childhood STEM books.

Content analysis. Content analysis was an appropriate method of analysis that used a "set of procedures for collecting and organizing information in a standard format" which allowed the researcher "to make inferences about the characteristics and meaning of written" materials (United States General Accounting Office [US GAO], 1989, p. 6). Three factors were important when deciding to apply content analysis in the research (a) objectives of the study, (b) availability of data, and (c) the kind of analysis required (US GAO, 1989). If the objective of the analysis was to describe or summarize written content, perception or attitudes of a writer, or the effects of the material on its audience, then content analysis was reported to be appropriate. Analysis was conducted by counting or listing issues within the written content. Content analysis was an accepted method used frequently in the study of children's media (Anderson & Hamilton, 2005; Bereaud, 1975; Canal et al., 2015; Crisp & Hiller, 2011; Hamilton et al., 2006; MacNamara, 2005; McCabe et al., 2011; Weitzman et al., 1972).

Prior research studies conducted content analysis for stereotyped gender bias in young children's media and literature (Bereaud, 1975; Canal et al., 2015; Crisp & Hiller, 2011; Gooden & Gooden, 2001; Grauerholz & Pescosolido, 1989; Hamilton et al., 2006; McCabe et al., 2011; Weitzman et al., 1972). In prior research, the principal method utilized for conducting a content analysis included the frequency method, tallying specific criteria set by the researcher. Book characteristics analyzed in prior studies included: gender of the main character; gender in title; gender of author; gender of characters, gender of image; gender represented in the plot; ratio of primary versus secondary characters' gender, the role or description of characters' behavior/s or activities, such as adventurous, outspoken, sporty, leadership, companionship/friendships for boys, or shy, helpless, domestic, passive/dependent, or isolated for girls; location setting for the characters, like indoors for girls versus outdoors for boys; image size of character; and the occupational and domestic role depiction.

Flaws related to content analysis included coder interpretation based on age and language. Nodelman's (2010) perspective that most children's literature provides an "entertaining and unsettling opportunity both to enter into and to question the values of their elders," including their cultural and hegemonic beliefs was in part the reason the survey image findings from child participants were included in the content analysis of this study (p. 24). Researchers argued adult research coders do not interpret either visual or lexical information exactly like that of a young reader or that of all children universally (Canal et al., 2015; Crisp & Hiller, 2011). Additionally, the language of the coders may have influenced their perception of image and lexical content.

Within prior content analyses, linguistic researchers presented findings that readers gendered literary content dependent on their native language, indeterminant of the words they read or images they see (Sato, Gygax, & Gabriel, 2016). The influence of potential masculine or feminine articles was explored in reference to home languages for the coder and the child participant. The primary language of the reader was thought to play a role in how or if the reader gendered an image other than intended by the author or illustrator. Commins and Miramontes

(2005) posited bilingual learners had an increased cognitive flexibility and manipulated words to express their ideas in ways single-language learners did not. Due to the potential for readers' native language affecting how an image was gendered, images gendered in the survey review of the study had a deeper analysis conducted to determine if language was a mediating factor in the genderization of images.

Research Design

The design used for the study was a mixed method, exploratory sequential design. Creswell (2014) maintained a mixed methods design aided in overcoming weakness and bias that exist in quantitative and qualitative data sets; however, with the collection of both the data sets, to offset the weakness of each data type. The design was appropriate due to the development of a measurement instrument that fits "a sample by first exploring qualitatively … and using the information to design an instrument that then can be tested with a sample" (Creswell, 2014, p. 177). The study followed this design by conducting a content analysis of STEM children's books, selected images from the books, developed, and implemented a survey instrument, and then reanalyzed the books with the findings from the survey instrument. The advantages and motives for applying the research design were multipurpose. First and most importantly, the study design reflected the participants point of view (e.g., perception of images); whereas, other prior content analysis studies of children's literature had not investigated the phenomena of gender bias from the reader's perspective. Secondly, the research design afforded the analysis of the content of the books, as well as the image content of the books as they were perceived by the participants (e.g., the survey instrument analysis).

Summary

Given the historical gender bias found in children's educational and leisure literature, the modifications publishers made to children's literature (e.g., implementing anthropomorphic images and gender-neutral pronouns with the intent toward achieving gender neutrality in books) and the lack of prior content analyses related to these areas, an investigation of gender bias, specific to children's STEM literature was identified as a needed area of research (Clark et al., 1993; Gooden & Gooden, 2001; Hamilton et al., 2006; UNESCO, 2009). As an increasing number of young girls were losing interest in STEM prior to their early adolescent years and literature was a known primary influencer of young children, the study investigated STEM literature resources in preschool and early elementary education. Furthermore, as research had shown stereotype formation began much earlier than once believed, STEM literature aimed at emergent readers in preschool and early elementary (i.e., R.L. 2.0 or less) was the focus of examination for the study (Aina & Cameron, 2011; Halim & Ruble, 2010; Martin & Little, 1990).

Investigation into the likelihood publishers unintentionally biased instructional materials against women and minorities by implementing neutrality was important in correcting a social injustice. Foundationally, microaggression theory supported the notion bias can be unconscious or unintentional (Nadal, Whitman, Davis, Erazo, & Davidoff, 2016; Solorzano et al., 2000; Sue et al., 2007). Considering the subtlety of microaggressions and some published research addressed implicit bias in children's books to be subtle as in stereotypic role portrayal, stereotypic colors of book covers or character clothing, the study investigated STEM children's literature for latent biases in literature images.

The focus of this exploratory study included a content analysis of popular-selling award-winning STEM literature, and a survey of young learners' preferences and perceptions of image content in selected texts. The guiding research questions and hypothesis developed from the literature included:

Research Questions and Hypotheses

RQ1: Are the STEM children's literature under investigation biased? If the survey interviews and content analysis found the literature to be biased, was one gender represented more than the other?

H1: Popular selling, award-winning children's STEM literature contains gender bias content.

RQ1-A: If yes, does the perceived bias favor males?

H_{1-A}: Popular selling, award-winning children's STEM literature contains gender bias favoring males.

RQ1-B: If yes, does the perceived bias favor females?

H_{1-B}: Popular selling, award-winning children's STEM literature contains gender bias favoring females.

RQ2: Do sociocultural factors of readers (e.g., gender or language) affect a reader's perception of images in STEM literature?

RQ2-a. Does a readers' gender affect how they perceive an image?

H_4: Images perceived as matching the gender of the reader in popular-selling, award-winning children's STEM literature will be preferred more by the reader than those not matching the reader's gender.

RQ2-b. Does a reader's language affect how they perceive an image?

H_5: ELL (English Language Learner) readers will perceive the gender of images as they relate to the gendered article of the reader's primary spoken language.

RQ3: Do readers gender images not expected to be gendered?

H_2: Anthropomorphic images will be gendered more than non-anthropomorphic images.

H_3: Inanimate objects will be personified (given gender identity).

CHAPTER 3: METHODOLOGY

The exploratory research design endeavored to close gaps in the literature. It did not seek to prove causation for the gender inequity in STEM fields. The purpose of the study was two-fold. The first purpose was to examine how children assigned gender to objects not necessarily intended to be personified. The second purpose included analyzing a subsection of children's STEM literature which had not been a focus of content analyses studies. Chapter Three describes the methodology for the research design including, but not limited to, research questions and hypotheses, setting and samples utilized, data collection, and data analyses.

The study sought to explore and identify a source of sociocultural messaging in award winning and popular STEM children's books as a potential contributor to STEM involvement. The novel process of the study included: (a) the STEM children's literature selection, (b) the image selection from these books, (c) instrument development cycle including the pilot phase, (d) data collection (including parent and student surveys), and the subsequent content analyses (Figure 4). The resulting book and image choices were developed after consultation and review with a library scientist and early childhood specialist with extensive experience in their fields. The criteria for the study (i.e., content analysis and image survey) was developed based on prior content analysis studies and the research questions.

Overview of the Study

This study design flow began with an intent statement (e.g., the intent of the study was to explore latent gender bias by considering children's' perception of gender and preference for an image), then conducted the qualitative first stage of the research (e.g., Step 1 of the design flow: an image search in books) to develop the survey instruments. IRB approval was acquired on

July 31, 2017 from the University of Central Florida (Active-Expedited IRB – SBE-17-13092, Appendix N), prior to beginning the pilot study. The pilot phase of the study was the second stage of the design that validated the measure (e.g., Step 2 of the design flow: selection of common images found). The instruments were disseminated and due to issues with internet site connectivity, the instrument was refined to be a paper based study. Next, the quantitative stage of the of the research was conducted (e.g., survey of images in Steps 3 through 5) to assist in triangulating for validity and reliability of the images selected. Lastly, the final stage of the qualitative research to conclude the triangulation of the study (e.g., Step 6: content analysis of book image and lexis) was conducted utilizing the findings from the survey instrument (i.e., child). Final data analysis and report of the findings concluded the study.

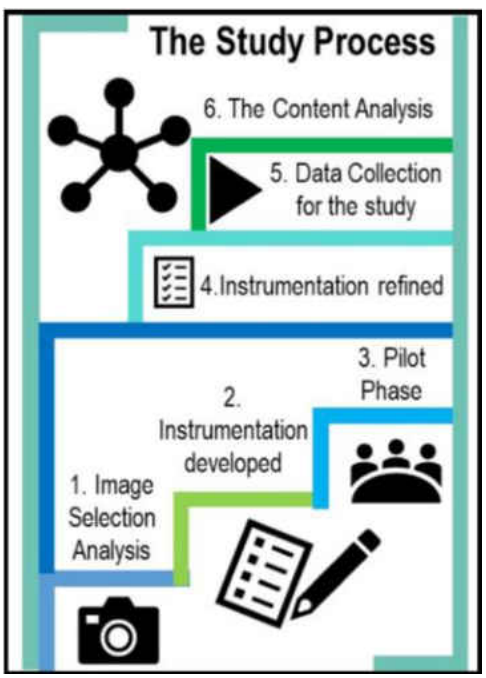


Figure 4: The study process

Research Design

A mixed method, exploratory, sequential research design using survey and content analysis was implemented for the study (Figure 5). The research design was dictated by the needs of the study to select and analyze a diverse sampling of popular-selling, award-winning STEM children's literature. Creswell (2014) described the exploratory sequential mixed method design as beginning with a strong intent statement, and reporting the multiple stages of the study. Content analysis was considered appropriate to implement due to the researcher making comparisons within and between written documents (Gall et al, 2007; US GAO, 1989).

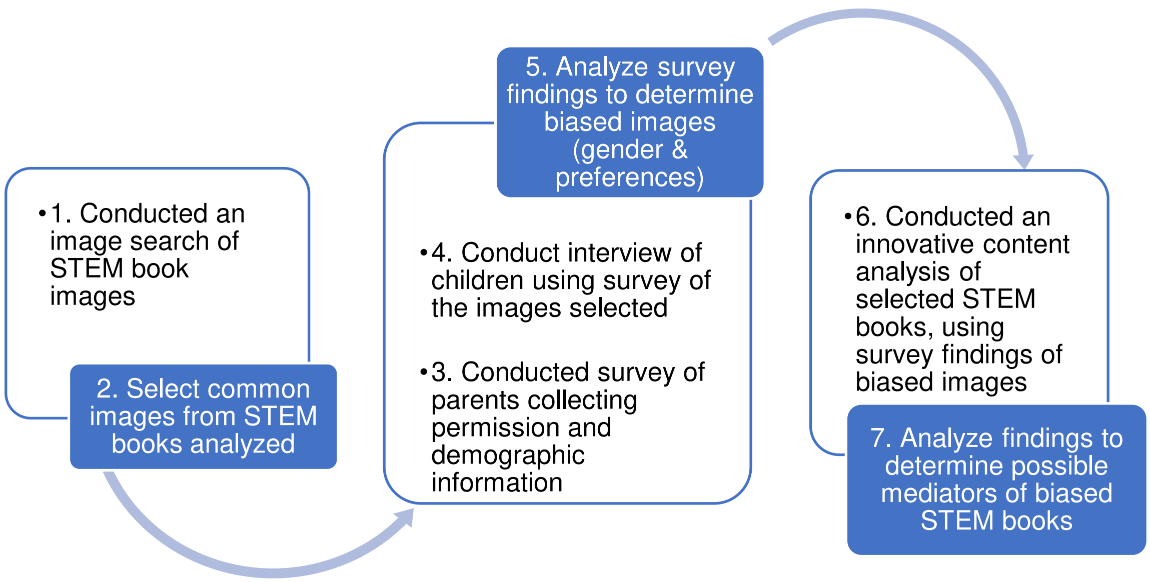


Figure 5: The research design flow

The research design utilized in the study included quantitative and qualitative survey data of children's gender identification of images, children's preferences for images, demographic data, and STEM content analysis data. The qualitative analysis imitated in part prior content analysis studies conducted on children's literature (Bereaud, 1975; Canal et al., 2015; Crisp &

Hiller, 2011; Gooden & Gooden, 2001; Grauerholz & Pescosolido, 1989; Hamilton et al., 2006; McCabe et al., 2011; Weitzman et al., 1972). The quantitative data were gathered from child and parent/guardian surveys. The research design extended prior content analysis research studies by implementing the data findings from the child surveys into the content analysis. The method of implementing a young reader's perceptions as part of a content book analysis was an innovative approach, not undertaken in prior content analysis studies. Through conducting multiple analyses of data and gathering data from varied sources, the data triangulation increased the validity of the study (Yeasmin & Rahman, 2012).

Independent and dependent variables. The independent and dependent variables (Table 1) were numerous due to the research design. The parent/guardian survey as shown in Appendix C provided demographic information to help the researcher better understand the sociocultural influencers (i.e., dependent variables) that affected how participants gendered and perceived images.

How the participants gendered the images (independent variable) and how much the images were preferred (independent variable) helped to determine if an image was considered biased or non-biased (dependent variable) for male and/or female participants. Lexical and narrative content (independent variables) was assessed by the coders to evaluate book bias (dependent variable). These variables helped to answer research questions one through three. If a participant indicated having a biased gender or preference for an image, the researcher used the demographic information for investigation of biased findings. Two independent variables reported on the parent survey were a participant's gender and native language, which helped to answer research question four. A participant's primary language which gendered articles, like

Spanish (i.e., *el perro* - masculine; *la tortuga* - feminine), was thought to be a sociocultural source for gendering images.

Table 1

List of Dependent and Independent Variables

Dependent Variables	Independent Variables
Gender Biased Lexical Content: (e.g., Bias or Non-Bias)	Participant Gender: Male or Female
Gender Biased Image Content: (e.g., Bias or Non-Bias)	Images Surveyed: 1-50
Bias View: (e.g., Gendering & Preference)	Home Language: English, Spanish, Portuguese
STEM Book Bias: (e.g., Bias or Non-Bias)	STEM Book Area: Science, Technology, Engineering, Math
	Anthropomorphism: AP, Non-AP, Photo, Drawing
	Author's Gender: Male or Female
	Illustrator's Gender: Male or Female
	Lexical Bias: Male, Female, No gender, gender neutral
	Preference rating of image: Absolutely didn't like (-2), Didn't like (-1), Neutral (0), Like (1), Love (2)
	Image Gender ID: Male, Female, No gender, gender neutral

Threats to validity.

Internal validity. The principal internal threats of the study were related to the parent/guardian survey (Appendix C), STEM image survey (Appendix E), and in the coding of book content (Appendix D). It was expected participants responded honestly and fairly to the survey content and the coders analyzing the STEM books were accurate in their assessments (Davis, 1984; Hamilton et al., 2006; Kolbe and La Voie, 1981; Krahenbuhl & Blades, 2006; Vaughn-Roberson, Tompkins, Hitchcock & Oldham, 1989). The researcher endeavored to prevent participant misunderstanding by implementing age-appropriate response techniques such as Likert-scale pictographs responses for child participants and one-on-one interviewing

(Krahenbuhl & Blades, 2006). Additionally, the researcher limited the number of images presented and the testing time allocated to ensure the child participant did not experience fatigue so they would be attentive to the images being surveyed as seen in Appendix E. An open-response section on the parent/guardian demographic survey to allowed parents/guardians to provide additional information for any necessary clarification. Lastly, coding sheets included operational definitions to ensure the accurate and fair assessment of STEM books. The operational definitions were intended to reduce coders from subjectively defining the book content in favor of consistency of scrutiny. Interrater reliability was assessed and confirmed to ensure validity of the content analysis.

Construct and content validity. Further validity included construct validity. The STEM image survey instrument supported constructs of the study. Although content validity was a subjective measure, the instrument was developed under the guidance of field experts in early childhood education and library sciences and used images from the STEM books under analysis; thus, content validity was established. To test for construct validity, the existence of the construct under measure was demonstrated, meaning the criterion was established at the same time as the measure (i.e., concurrent validity; Drost, 2011). The construct under measure was biased view of image types in children's award winning and popular STEM literature. Although readers had been found to gender literary content dependent on the language, it was not based on lexical or image content (Sato et al., 2016). The construct was novel in the area literature, as well as how the construct would be measured, hence the exploratory study. The review of literature revealed an absence of prior publication regarding the construct; therefore, although content validity was established prior to study implementation, construct validity was confirmed after pilot data collection and analysis. Construct validity was substantiated by accumulating evidence for content validity and concurrent validity.

Pilot survey phase issue resulted in alternative data collection process. Pilot testing utilizing a Qualtrics test was conducted on seven kindergarteners at one approved urban charter site school in December 2017. The pilot phase supported the researcher's preliminary concerns regarding connectivity issues at research sites; thus, paper-based surveying was employed for further data collection. Paper survey images and answer options were exactly as created online in Qualtrics. The paper-based survey collection procedure used a printout of all the images from each of the two surveys (N=50) and an answer checklist for response collection (Appendix O). The answer checklists was then transcribed into SPSS and all data were confirmed by two separate undergraduate researchers for accuracy prior to analysis.

External validity. External validity of the study implies the findings are generalizable to other persons, settings, times, etc. (Drost, 2011). External validity issues were related to the size of the population being surveyed and the number of books being analyzed. As this was an exploratory study, the findings were not meant to be generalizable to a larger and/or similar population of people or books (Drost, 2011). The investigation was cursory and meant to establish a need for a larger investigation of population (i.e., ages, number), in addition to STEM literature.

Setting and Sample

Recruitment: Schools, students, and parents. After acquiring IRB approval through the University of Central Florida, a list was developed to identify possible school sites for data collection. Institutions were considered if they had students aged four through seven. Next, potential site school administrators received information concerning the study (e.g., parent consent, parent demographics, images tested) and requested school participation in the study (Appendices C, E, and F). Permission to conduct research was requested and obtained from the sites through the schools' governing/advisory boards, along with a mutually agreed upon on-site space, prior to implementing the research study.

For those schools who opted to participate in the study, potential child participants were recruited through the schools' population, via a recruitment letter to parents/guardians of eligible children (Appendix F). Accompanying the request for participation was an additional demographic data sheet for parent/guardian to complete and return (Appendix C). Children whose parents sent back the permission and demographic paperwork were selected to participate in the study. Survey research was conducted onsite at two private schools in one secular and one non-secular suburban Florida cities. The setting for the parent survey research took place where the parent selected to complete the survey. The setting for content analysis was at the University of Central Florida. One private summer school-based program in North Florida (Site 1, n=36) and one private parochial school in Central Florida (Site 2; n=66) were recruited to attain the needed number of participants for the study (N=102). Some of the participants from site one attended public school during the regular school year (58.3%).

Participants. There were three separate groups of participants: (a) children, (b) parents, and (c) content analysis coders. *A priori* sample size of 102 child participants and parents was calculated, with a medium effect size of 0.5, a statistical power of 0.8, and a probability level of 0.05 using Soper's (2019) online student calculator for a one tailed t-test. The minimum sample size was achieved (N=102) with nearly equal male (n=49) and female (n=53) groups. Child participants were 4-7 years old and grouped into four rounded age levels: four-year-old (19.6%), five-year-old (28.4%), six-year-old (31.4%), and seven-year-old (20.6%). The 102 participants were in grades PreK through second: PreK (20.6%), K (28.4%), 1st (31.4%), and 2nd (19.6%). All participants were acquired from two separate sites.

Three languages were reported as primary languages of the child participants: English, Spanish, and Portuguese. English language was the largest primary language of the participants (78.4%). Additionally, 19.6% of the participants reported their primary language as Spanish. Only two participants (2% of the total participants; one male and one female) reported Portuguese as their primary language. Although findings of analysis of Portuguese were presented, a comprehensive analysis was delayed until additional data were acquired. Although, some participants did report speaking a secondary language, the researcher analyzed only the language reported to be most frequently used in the home; thus, no analysis of secondary languages was conducted.

Child survey interviews were conducted during the summer and fall of 2018. Participants were between four and seven years of age. The reading level of the participants was irrelevant in the selection process as the survey had been developed to utilize pictographs for answering questions (Figures 6 through 8); therefore, the reading level of the participants was unknown. Child participants completed the surveys on school property. No anticipated risks for subjects in this study existed. No student was required to participate, as participation was voluntary, and participants could stop at any time during the interview.

Each child participant individually reviewed the images one at a time, in person with the researcher or a trained volunteer. The parent/guardian survey (Appendix C) was completed by each participants' parent/guardian (*N*=102). Adult coders completing the content analysis of the selected STEM books consisted of four graduate researchers and two undergraduate students, five female and one male, with a mean age of 22.2 years and a range age of 35 years. No compensation was given to any participants or coders for participation in the study.

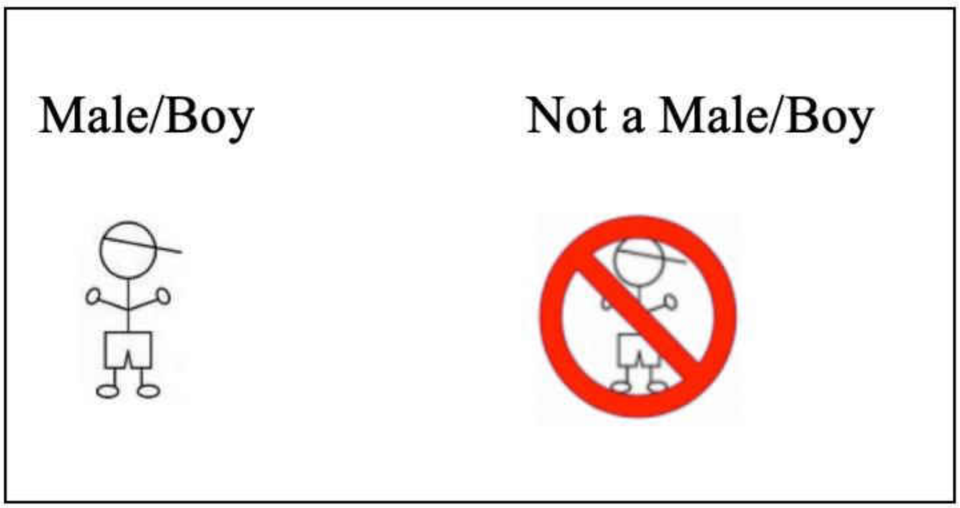


Figure 6: Male-gendered pictograph

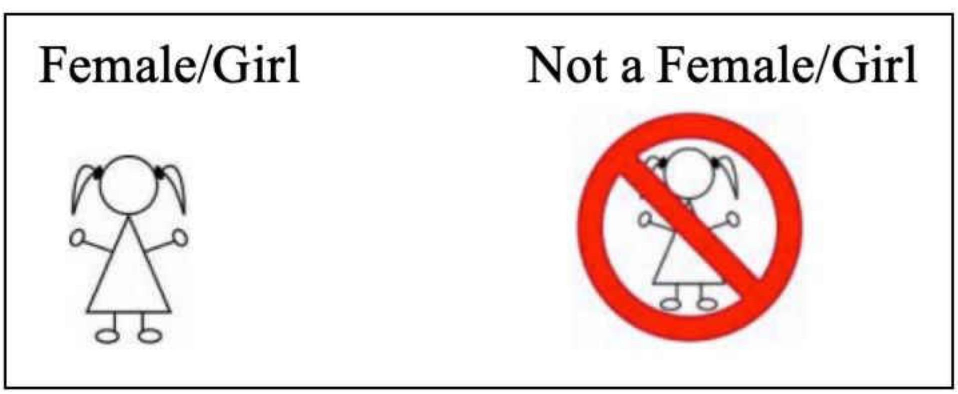


Figure 7: Female-gendered pictograph

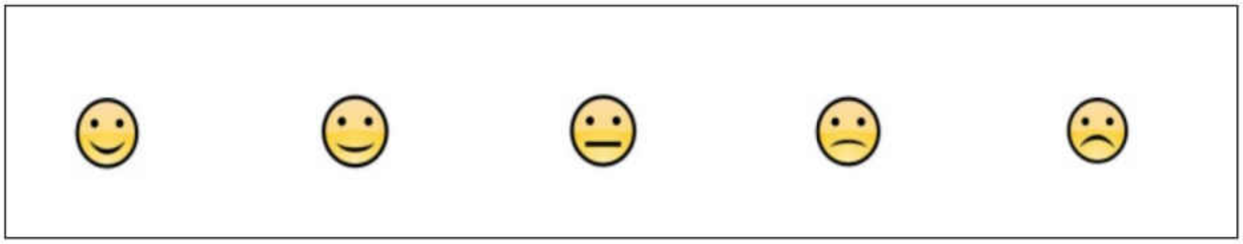


Figure 8: Likert pictograph response scale for preference response

Survey procedures. Parent demographic survey was completed and returned by parent/guardian with the parent consent forms. A child assent was obtained prior to testing. All child participants tested answered affirmatively when given assent prior to survey completion. Survey data collection were completed using a paper-based system consisting of a checklist and picture cards on 3x5" index cards. The researcher and child participant sat across from each other at a desk with two chairs. Rapport was established by a brief discussion about if the child likes to read and what books are their favorite. The researcher or the designated trained undergraduate presented one image at a time to the child participant. The child participant answered the three questions asked by pointing at the figure that matched their response (Figures 6 through 8). These questions included the following: (a) Do you think this (picture) could be a boy or could not be a boy? (b) Do you think this (picture) could be a girl or could not be a girl? and (c) Can you point to a face to show me how much you like the picture you see here? Child participants verbally answered while pointing at the selected answer. Responses were recorded on the data collection checklist by the researcher or designated trained volunteer (Appendix O). Responses were kept concealed from the children participant so as to not impede data collection or affect how the child participants answered.

STEM Book Selection Process

Content analyses studies regarding gender bias in children's literature utilized mostly award-winning books, and few studies considered top-selling books that may be considered more popular (Easley, 1973; Hamilton et al., 2006; Luyt, Lee & Yong, 2011). Books utilized for this study included those children's STEM books that were top-selling and award-winning books; thus, having high quality and most likely to be seen/used by young readers (Kovacs & Sharkey, 2014). The sample literature selected for the study included award-winning STEM books as denoted on the Children's Literature Comprehensive Database (CLCD), which were also top sellers on Amazon rankings during the week of April 9, 2017. The CLCD is an online database that compiles and creates book information (e.g., book lists) to provide exploration tools for educators, librarians, researchers, etc. Final criteria for STEM book sample selection was a 2.0 reading level (RL) or lower, a Lexile level less than 1000, English language availability, published in the year 2000 or later, categorized on the CLCD as being for readers aged one to seven years old, ranked within the top 100 bestselling Amazon books for their STEM subject, and contained common picture book images as determined by the initial image content analysis. The researcher did not triangulate sales from other sources which could have changed the books and images investigated or considered other time periods from which to pull sales rankings for book/image analysis. eBooks were not included in the selection process due to digital copies of books differing from print copies, and not all books were available in eBook and print forms.

Regarding the availability of materials used for this study, as well as future researchers' abilities to replicate the study, US GAO (1989) stated materials be available to reanalyze for reliability checks and be of quality. All books used in the study were retrieved from the local county library or were available for purchase online (e.g., Amazon.com). All books were published after the year 2000, and it was reasonable to assume the materials would remain in circulation for the near future for reanalysis. Since the books were award-winning STEM books, the books used for the study were assumed to be of acceptable and prior standards, regarding quality (Kovacs & Sharkey, 2014).

Criteria for inclusion in the study.

Step One: CLCD search. Initial examination of books from the CLCD used the following criteria: Lexile under 1000 or RL < 2.0, award winners or honorable mention for children, STEM topics, and published since 1900. A list of books was generated; however, limited books were found for technology, engineering, or math focused literature (Appendix G). The diversity of image content, such as anthropomorphic versus non-anthropomorphic images and real versus photographic images, was difficult to find in the initial book list generated from the CLCD. The book selection process was extended to implement Amazon's book list, utilizing similar criteria, and adding sales rankings also to include books that would be more likely found in children's homes.

Step Two: Amazon sales search. The Amazon website had subsections under their children's literature books, including topics such as "Computers and Technology" and options to locate the books required, such as criteria age range, reading level, language, and so on. The search for books was under the children's book section in the book department of the Amazon website. Only books published in English with Lexile rankings under 1,000 and for children who were eight years old and under were considered. Each topic subsection was searched, examining book covers and descriptions for STEM topics and the top selling books were noted

(Appendix H). If a subsection book met the above criteria, then the book titles were cross-compared to the CLCD to confirm award winning/honorable mention status (Appendix I). The subsections were investigated until at least five STEM books were retrieved in each STEM subsection with at least one science, one technology, one engineering and one math book, or the subsection list of the top twenty bestselling books was exhausted. The subsection STEM books were placed in four separate lists for each STEM topic: a Science list, a Technology list, an Engineering list, and a Mathematics list (Appendix I). The 39 selected STEM books were then put in descending sales ranking order, with the author, illustrator, and year published recorded for further analysis as shown in Table 2. The Amazon book lists indicated the lack of technology, engineering, and math STEM literature on the market from the earlier search on the CLCD; however, not to the extent realized on the CLCD website.

Table 2

Book List Sampling

Title	***Author/ Illustrator***	***Year***
1. The Very Hungry Caterpillar (S)	Carle	1994
2. Oh, Say Can You Say What's the Weather Today? (S)	Rabe/Ruiz	2004
3. Over the Mountain	Berkes/ Dubin	2016
4. Your Pulling My Leg (S)	Street & Brace/ Brace	2017
5. Over in the Grasslands (S)	Berkes/ Dubin	2016
6. Being Safe with Tech (T)	Kesselring/McGeehan	2011
7. Small Wonders (S)	Smith/ Ferri	2015
8. Ice Cream Summer (S)	Sis	2015
9. Builder Mouse (E)	Eldarova	2016
10. High Tide for Horseshoe Crabs (S)	Schnell/ Marks	2015
11. Ida Always (S)	Levis/ Santoso	2016
12. The Black Rabbit (S)	Leathers	2016
13. Not Quite Black and White	Ying/ Ying	2017
14. Dinosaur Rescue (T/E)	Dale	2016
15. Where do Steam Trains Sleep at Night? (E)	Sayres/Slade	2017
16. Good Night Baby Animals (S)	Winnick & Watkins	2017
17. Good Night Owl (S)	Pizzoli	2016

Title	*Author/ Illustrator*	*Year*
18. Nanobots (T)	Gall	2016
19. Drew the Screw (E)	Cerato/	2016
20. Ada Twist Scientist (S)	Beaty/ Roberts	2016
21. Robots, Robots Everywhere (T/E)	Fleiss/ Staake	2013
22. Digger, Dozer, Dumper I	Vestergaard/ Slonim	2016
23. The Great Graph Contest (M)	Leedy	2005
24. Chameleon, Chameleon (S)	Cowley/ Bishop	2005
25. Simple Machines: Wheels, Levers, and Pulleys (T/E)	Adler/ Raff	2016
26. Rosie Revere, Engineer I	Beaty/ Roberts	2013
27. Over in the Ocean: In a Coral Reef (M)	Berkes/ Canyon	2004
28. Sometimes You Barf (S)	Carlson	2014
29. The Shocking Truth About Energy (T)	Leedy	2011
30. Papa's Mechanical Fish (T/E)	Fleming/ Kulikov	2013
31. Over in a River: Flowing Out to the Sea (M)	Berkes/ Dubin	2013
32. Waiting for Snow (S)	Arnold/ Liwska	2016
33. Tek: The Modern Cave Boy (T)	McDonnell	2016
34. Good Night Owl I	Pizzoli	2016
35. Me & Annie McPhee (M)	Dunrea/ Hillenbrand	2016
36. Explorers of the Wild (S)	Atkinson/ Atkinson	2016
37. I Love Mom (S)	De la Bedoyere	2016
38. Beneath the Sun (S)	Stewart/ Bergum	2014
39. A Number Slumber (M)	Atkinson/ Bloom	2016

(S)=Science, (T)=Technology, (E)=Engineering, (M)=Mathematics

Additional books were removed from the final book list for several reasons, after the researcher attempted to confirm study book criteria (Appendix J). The list of 39 books that found all but one of the books were published in 2000 or later. The one book published earlier than 2000 was removed from the list of books to keep uniformity. The deletion of the book was done with the goal of obtaining STEM books most likely to be in current circulation, coupled with having been written/published in the current time period as to avoid inconsistency of cultural time perspective. McCabe et al. (2011) contended a cultural time perspective refers to what once was considered culturally acceptable but was no longer acceptable, and thus may be more likely to be perceived as biased content in the current era. Of the 39 books, many had the same author and/or illustrator. Since diversity of images and writing was needed for validity, no more than two of the highest-ranked sales books by the same author and/or illustrator were kept, and in the case where the same author/illustrator was utilized, the books were not from the same category such as science, math, engineering, or technology. Because of this, two additional books were removed from the list of 39 books. Upon further review of the books by cross-checking criteria with publisher sites, author sites, CLCD sites, and content of the STEM books, it was decided five additional books should be removed from the list for reasons including: (a) the book was not focused on STEM topics, (b) discrepancies in publishing dates (before 2000), (c) reading level (higher than second grade), (d) sales ranking (not popular selling), and (e) books having only eBook format. A list of 31 books was compiled, meeting all the book requirements set by the researcher. Next, the books were analyzed for image content.

Step Three: Common images determining final book selection for study. The 31 books which met all required criteria set for the study were then examined thoroughly for image content. The researcher sought to acquire common images that would be found in most of all the selected STEM children's literature. Continuity of image type (e.g., dogs, trees, vehicles) would aid in comparison of images across the books under investigation. Images from all the book pages and book covers were inspected and listed for each of the 31 books; for instance, a tree, grass, or a bus (Appendix K). Book covers, back and front, as well as images accompanying a story were considered important elements of story comprehension (Nikolajeva, 2010). The image content lists of each of the 31 books were then cross compared for the most frequently observed images. A descending list of the most frequently seen images from all 31 books was analyzed and became the categories investigated. The images were examined and classified as anthropomorphic (e.g., a frog acting like a human), non-anthropomorphic (e.g., photograph of a frog), and pseudo anthropomorphic (e.g., a personified frog).

Those books with the highest frequency of the eleven categorized images were retained for inclusion in the study. An image examination produced a list of 20 children's STEM picture books, containing images classified as anthropomorphic, photograph or caricature (personified). The culled list of twenty children's STEM picture books was retained for final study analysis, containing: seven science topic books, four technology topic books, four engineering topic books, and five math topic books (Table 3). The 20 books retained consisted of 19 authors and illustrators. One author/illustrator was used in two separate books. Children's books focusing on engineering and technology were limited. The two most popular selling books in each of the STEM areas, which resulted in a replication of an author/illustrator in the science and engineering categories. The list of books was made available to each site school and provided to any parent/guardian upon request (Appendix L).

Image selection process. The 20 STEM books selected as shown in Table 3 were placed in descending sales rank order, as denoted on the Amazon bookstore website for the week of April 9, 2017. The top book from each category in science, technology, engineering, and math, as shown in Table 3, rows one through four was examined. Every observable type of image in each of the four STEM books was noted, from cover to cover (Appendix K). A list of the most commonly seen images in the first four STEM books were then ranked from most frequently to least frequently observed (Appendix M). The most commonly observed images, which were birds, flowers, food, turtles, auto/transport vehicles, and dogs, were selected from the first four books, which were science – *Ada Twist*; technology – *Robots, Robots*; engineering – *Digger, Dozer, Dumper*; and math – *The Great Math Contest*.

Table 3

Books Selected for the Study

Title	Author/Illustrator	Published
1. Ada Twist Scientist* (S)	Beaty/Roberts	2016
2. Robots, Robots Everywhere* (T/E)	Fleiss/ Staake	2013
3. Digger, Dozer, Dumper* (E)	Vestergaard/ Slonim	2016
4. The Great Graph Contest* (M)	Leedy	2005
5. Chameleon, Chameleon* (S)	Cowley/Bishop	2005
6. Simple Machines: Wheels, Levers, and Pulleys* (T/E)	Adler/ Raff	2016
7. Rosie Revere, Engineer* (E)	Beaty/ Roberts	2013
8. Over in the Ocean: In a Coral Reef* (M)	Berkes/ Canyon	2004
9. Sometimes You Barf (S)	Carlson	2014
10. The Shocking Truth About Energy (T)	Leedy	2011
11. Papa's Mechanical Fish (T/E)	Fleming/ Kulikov	2013
12. Over in a River: Flowing Out to the Sea (M)	Berkes/ Dubin	2013
13. Waiting for Snow (S)	Arnold/ Liwska	2016
14. Tek: The Modern Cave Boy (T)	McDonnell	2016
15. Good Night Owl (E)	Pizzoli	2016
16. Me & Annie McPhee (M)	Dunrea/ Hillenbrand	2016
17. Explorers of the Wild (S)	Atkinson	2016
18. I Love Mom (S)	De la Bedoyere	2016
19. Beneath the Sun (S)	Stewart/ Bergum	2014
20. A Number Slumber (M)	Atkinson/ Bloom	2016

Note: * Citation in reference list

The process was continued for the next group of books as shown in Table 3, rows five through eight. The most commonly observed images in the next four STEM books were birds, food, flowers, auto/transport vehicles, frogs, fish, trees, and houses. The second group of book images were collected from science – *Chameleon, Chameleon*; technology – *Simple Machines*; engineering – *Rosie Revere*, *Engineer*; and math – *Over in the Ocean*. The 11 most common image categories identified as determined in Step 3 of the book and the image selection process in all books were: birds, dogs, frogs, food, flowers, transportation vehicles, turtles, fish, numbers, houses, and trees.

Eleven categories were established, images were randomly selected from the books, ensuring a mixture of anthropomorphic, non-anthropomorphic, and pseudo anthropomorphic (i.e., personified) images, as well as varied colored and black-and-white images (if available), were included in the list of images. The images were cropped and enlarged for ease of viewing, as well as to lessen confounding image content (Appendix E). Arrows pointing to the image being tested were added to the cropped image. Figure 9 below illustrates examples of the cropping and identification from the STEM children's book, *The Great Graph Contest* by Loreen Leedy.

Figure 9: Cropped image examples

Twenty books were selected for inclusion in the study (Table 3); however, only the top eight books in the list of twenty were utilized for this dissertation study. The 50 images tested were selected from the first eight of twenty books (Table 3, rows one through eight) because they were identified as having the most commonly observed images within all of the 20 selected books. As findings indicated gender bias (e.g., significant differences between male and female representation and perception of images) in the first eight selected STEM books, further investigation utilizing the remaining books (Table 3, rows nine through 20) and additional images was warranted.

The importance of selecting images likely to be found in other books was to highlight the potential of reader biases in respect to common and frequently found imaging in children's literature. Therefore, common images and popular books were selected for the study. Additionally, images selected from the books were used to develop the Qualtrics surveys as seen in Appendices A and B which were implemented with kindergarten aged populations at a local area school during a pilot investigation phase. Due to connectivity Wi-Fi issues, images were placed on 3x5" cards for the child participants' survey interview.

Pilot Phase

The researcher originally intended to collect survey data via iPads, but Internet connectivity proved to be an issue in the pilot phase, which slowed down the collection and frustrated the children. Internet bandwidth was causing the delivery of the testing information to consistently pause. The delays during testing thus caused the testing to become time-consuming, and the children became inattentive and bothered. Due to the concern regarding the issues may have occurred at additional site schools in the future, the decision was made to collect all subsequent survey collection by hand. Furthermore, due to the pilot school participants' having incomplete, and possibly invalid survey data, the pilot participants' data were not included in the analysis.

Data Collection

IRB approval was acquired on July 31, 2017. Pilot testing was conducted in December 2017. As pilot testing of the survey instruments supported the researcher's preliminary concerns regarding connectivity issues, paper-based surveying was employed for data collection. Answer checklists were transcribed into SPSS and all data were confirmed by two separate undergraduate researchers for accuracy prior to data analysis.

Data collection procedures. Parent survey data collection procedures (e.g., Qualtrics online vs. paper based) were dependent upon parent/guardian preference; however, child image surveying was only offered as a paper-based assessment. Although it was thought, prior to dissemination of parental approval and demographic information sheet, parent/guardian survey collection via Qualtrics may be more convenient for parent/guardians, all 102 parent participants completed the paper-based survey and returned it to the school.

Completed survey data from both parents &and children were collected, transcribed, uploaded, and kept on a UCF database server called UCF OneDrive and/or Google Drive. All paper surveys were destroyed after verification of the accuracy of the transcription. Parent/guardian consent forms were collected, uploaded, and kept on UCF OneDrive and/or Google Drive. All data collected were collated and de-identified for dissertation purposes. All data were kept confidential. Data collection ceased and data analysis commenced after participant threshold (N=102) were met.

Instrumentation. Three instruments were developed for the study: Parent/guardian demographic survey, child image survey, and the content analysis coding sheet.

Surveys. Survey methodology was considered an appropriate method for collecting data to estimate the behaviors and attitudes of people in a population (Andres, 2012; Dillman, Smyth, & Christian, 2009). Web-based survey methodology such as Qualtrics was reported to have had limitations; issues reported were motivation, communication, and inaccessibility (Adams, 1974).

Dillman, Smyth, and Christian (2009) contended one limitation dealt with poor connectivity, as was found during the pilot phase of this study. Therefore, alternate survey methods (e.g., paper-based collections) were developed to collect data.

Child surveys. The child survey was entitled *Discovering Latent Gender Bias in Children's STEM Literature Images* (Appendices A and B). The survey instrument was established as a valid measure for assessing images. The STEM image survey was constructed using images from the STEM books under analysis (Table 3, rows one through eight) and consisted of 50 images. The survey interview started with the participant being asked their gender using the following symbols for answer choices as shown in Figure 10. Although most children by the age of 36 months can correctly label the gender of themselves or others and were said to have achieved gender identity (Woolley, 2010), it was important to identify if a participant understood the concept of gender in addition to the use of the boy/girl gender symbols to answer survey questions. Therefore, participants were asked to identify their gender with a male, female, or questioning response. The questioning response neither inferred the participant did not understand their own gender (i.e., gender non-norm, LGBTQ) nor that they did not perceive the concept of a gendered system. All participants in the study selected either male or female pictographs to identify their gender. Child participants did not identify their gender differently than how their parent/guardian responded on the parent demographic survey. It was important to recognize while the male and female sex were emphasized in the study, gender identity was considered as on a spectrum and the human experience involves more than two genders, which were socially constructed based on societal expectations (Brown & Eddy, 2016; Sears, 1998; Woolley, 2010). For the purpose of the current study, a binary gender system was utilized and reported.

Figure 10: Self-identity gendered pictograph

The participants viewed 50 cropped images from the STEM books. The participants were asked by the interviewer if they thought the image *could be a boy or could not be a boy* using the gendered symbols (Figure 6), if they thought the image *could be a girl or could not be a girl* using the gendered symbols (Figure 7), and lastly, the participant was asked their preference for the image using the Likert-based pictographs (Figure 8). Preference paradigms, such as a Likert-based pictograph scales, were commonly accepted for use with young participants who may not read and were applied in the child survey research (Martin & Little, 1990; Wallen & Hassett, 2008). Answers to all three questions were collected via a survey instrument checklist (Appendix N) for all images.

Parent survey. Demographic parent survey information was considered an essential element for the study; thus, the additional survey instrument (e.g., Parent/Guardian Survey – Demographic information Collection; Appendix C) was developed. The significance of obtaining information concerning the participants' home environments like language, religion, preferences for food/toys/animals, among others, was to attempt to better understand mediators of sociocultural influencers. Child research participants were at various stages of their social identity development which related to distinct aspects of their daily lives (Bell, Goodman & Ouellett, 2016). Therefore, a better comprehension of the differences among the child participants and their home environments aided in a more robust analysis of the data collected.

The parent survey entitled Parent/Guardian Survey – Demographic information Collection (Appendix C) collected demographic data, which aided in the analysis of data collected from the child image survey. Information collected included the following: (a) child age – to confirm study age target, (b) child's gender – to confirm child's assessment of participant gender, (c) ethnicity –possible mediator, (d) primary & secondary languages spoken at home –possible mediator, (e) free or reduced lunch status – to measure low-income status (possible mediator), (f) countries or states of residence for the child, to ascertain language influence, (g) favorite animals – possible mediator, (h) favorite toys – possible mediator, (i) favorite foods – possible mediator, (j) religion & political leanings of family (optional info) – possible mediator. The information collected from the parent survey provided general demographic information about the child participant to aid with the exploration and identification of environmental influencers. The exploratory nature of the current investigation considered sources for bias concerning expected factors, such as gender, and unconventional considerations such as language.

Content analysis. The current study followed Kolbe and LaVoie's (1981) content analysis procedures using similar criteria for assessment of book content (Content Analysis Coding Sheet – Appendix D). Some differences existed between the prior content analyses discussed in the literature review and the dissertation investigation conducted. For the study, this researcher counted all male and female characters individually, regardless of group size. The decision to individually count characters in large groups was based on prior research published supporting a Vygotskian view that young children, their reading partners (e.g., parent, teacher, or caregiver), and the book itself, particularly the visuals in picture books, were all sociocultural factors interacting together supporting child development (Fletcher & Reese, 2005).

The image survey data were analyzed separately from, as well as collectively with, the content analysis data (Figure 4). In other words, the child and parent survey data were analyzed separately from the STEM book content analysis data. Then, a content analysis of the STEM books was conducted again examining those surveyed image categories tested.

First, three of the six coders surveyed the books for image content. Frequency counts were recorded and common image categories were determined. Then, all six coders coded lexical and image content of the books using the coding content analysis sheet (Appendix D). Next, the coding data were merged and coded into a spreadsheet. Then, analysis of the images from the child image survey determined which image categories were biased. Lastly, biased image findings from the child image survey were combined with the data from the content analysis and analyzed collectively. Figure 5 presents the research design flow.

The content analysis of the children's STEM books was distinctively different from prior content analysis studies of children's literature. The content analysis incorporated the coding criteria and methodology of prior studies to maintain a continuity of literature content evaluation; however, the survey data findings concerning images were assimilated into the final analysis (Bereaud, 1975; Canal et al., 2015; Crisp & Hiller, 2011; Gooden & Gooden, 2001; Grauerholz

& Pescosolido, 1989; Hamilton et al., 2006; McCabe et al., 2011; Weitzman et al., 1972). The incorporation of children's perception of book content images into the content analysis was unique to the study and provided a more robust understanding of what was perceived as biased book content.

The content analysis coding in prior studies had been conducted by multiple undergraduate and graduate coders and/or the primary researcher to insure interrater reliability. Some researchers asserted the method of utilizing adult analysis of characters as male or female during the examination of illustrations in children's literature does not stand up to scrutiny, and was biased and flawed (Canal et al., 2015; Crisp & Hiller, 2011). Therefore, the children's findings of the image content were triangulated with the content analysis data of the multiple coders. The data findings from the participants' image survey were part of the coders' second content analysis (Figure 5, Step 6).

Data Analysis

Statistical assumptions. Descriptive analyses, of the survey and content analysis indicated the data to be non-parametrically distributed. The non-normality of the data could have resulted from having a limited number of books to analyze (Foster, 2014), and thus a low number of image types and/or differing amounts of images from each of the selected books. To remove any of the images would have violated the exploratory nature of the study and would have also decreased the sample size of images examined from selected books. Therefore, as conducted in some prior studies, the Mann Whitney U - Wilcoxon Rank Sum test and the Pearson's Chi Square test in addition to the Wilcoxon Sign Rank test were used for the analyses of the non-normal data sets (Foster, 2014; Atay & Danju, 2012; McCabe et al., 2011).

Analysis of survey data. Survey data included responses from participants on fifty separate images (Appendix E) found in and selected from the books. Prior to analysis, data were cleaned and variables were recoded and/or transformed into new variables (Figure 11). The gender of each image was coded to define how the images were gendered by the participant (i.e., genderization; Davis, 1984; Flaherty; 2001; Gooden & Gooden, 2001). Additional coding was conducted to separate the participant's gendering of the images into two categories: biased (i.e., male OR female) or non-biased (i.e., both OR neither) and two preference categories: biased or non-biased preferencing of the images (Flaherty; 2001). Images were identified as having a neutral preference if the participant answered with a Likert scale Level 3 answer (i.e., neither liked or disliked), and all other answers were considered biased for or against an image (1-Highly dislike, 2-Dislike, 4-Like, 5-Love). Researchers reporting on Likert scales defined a neutral measurement as the median of the scale, and thus a positive or negative measurement beyond the mean could be considered biased positively or negatively (Douven, 2017; Laerhoven, Zaag-Loonen, & Derkx, 2004). The data were then coded into having a non-biased or a biased view by combining the gendered view (e.g., Biased versus Non-Biased) with how the participant preferred the image (e.g., Biased vs Non-Biased). Biased views were established if either the gendered view or the preference level was considered biased.

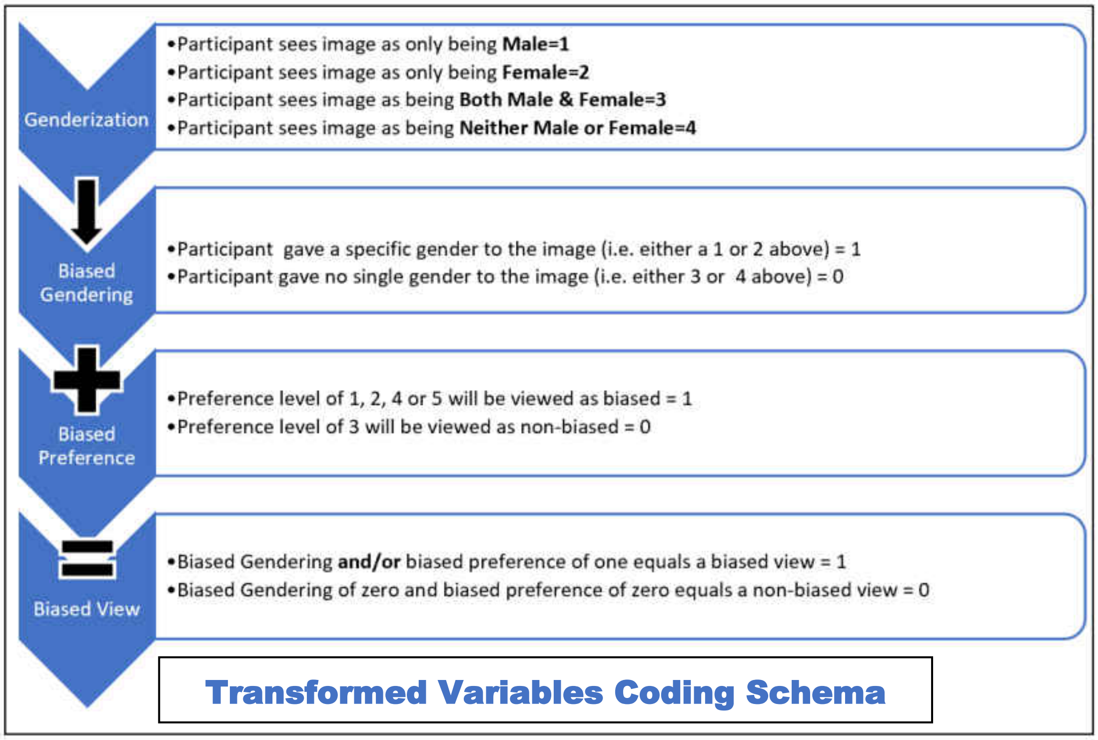


Figure 11: Coding of new variable for analyses

Once all survey data were collected from the minimum number of participants needed for analysis, *N*=102, the survey data were analyzed. Data analysis was conducted with IBM SPSS 25 software, and a $p<0.05$ significance value. Multiple statistical analyses were used to analyze and correlate parent/guardian survey data and participant survey data. A Wilcoxon Signed Rank test was used to compare differences between male and female participants. A Pearson's Chi-Square test of Independence was utilized to test for homogeneity between participant gender and gender identification of and preference for the images. Lastly, a Wilcoxon-Mann-Whitney U test was used to analyze differences between male and female participants' preference for images.

Initial analysis of each of the images was conducted implementing a Pearson's Chi-Square test of Independence investigating the relationship between the participant's gender and how they gendered each of the images (i.e., male, female, both, or neither). Pearson's Chi-Square test of Independence tested whether there was a significant relationship between the two variables. Effect sizes were reported utilizing Cramer's *V*. Additionally, how the participants preferred the images on a five-point Likert scale as they related to participant gender was analyzed implementing a Mann Whitney U – Wilcoxon Rank Sum test. Further, the selected image categories (i.e., the most commonly observed types of images) were analyzed implementing a Mann Whitney U - Wilcoxon Rank Sum test. The Mann Whitney U - Wilcoxon Rank Sum test compared the means of two, non-normally distributed, independent groups (e.g., male and female participants' gendered view of the image categories or preference for/against the image) and a dependent variable (i.e., continuous, ordinal) to determine if there was a statistical difference between the two populations (i.e., male and female participants). Findings were reported as percentages. Lastly, separate analyses of anthropomorphic and personified images were conducted using the Wilcoxon Sign Ranked test, a non-parametric test for paired samples. Effect sizes were reported using Rosenthal's formula *r* (Rosenthal, 1994).

Analyses of book content. The book analyses occurred in two parts: Image search (Step 1) and complete content analysis (Figure 5, Step 6). This section discusses the latter, how the totality of book content (Step 6) was conducted. The first part was discussed in the last section – analysis of survey data (i.e., image search – Step 1). Coders using coding analysis sheets (Appendix D) reported on specific book elements. Those elements were transcribed in SPSS as frequency counts. Additional qualitative remarks were compiled for each of the eight books.

The weakness of utilizing adult coders for interpretation/analysis of book content was abated by combining the findings of the image content surveyed (e.g., child participant – image search findings) into the content analyses conducted by the adult coders. The content analyses analyzed lexical and image content for bias, including frequency counts of the surveyed image categories. As prior content analysis of children's literature had not implemented the method of using children's perceptions of images, there were not studies to use as a model. The data analyzed from the children's perceptions of the images were additional data points in the content analysis (e.g., total number times the image categories were reported to be in the books). Lastly, data were excluded from the content analysis when gender and/or ethnicity of the characters was not able to be determined.

Using standards from previous content analyses an alpha level of 0.5 was employed for reporting significance. However, due to the exploratory nature of the research design, findings at the 0.10 level were also noted when they were discovered. Descriptive statistics to compare means, medians, and ratios were included. The Pearson's Chi-Square test of Independence which utilized nominal data and assessed whether categorical variables were related or independent was employed. Observations were measured as frequencies and reported as percentages. A Wilcoxon sign rank test was used for analysis.

Hamilton et al. (2006) utilized Pearson's r to assist with interrater reliability in the content analysis conducted by multiple coders. To ensure interrater reliability, an r value of .70 or higher was considered acceptable. Values differing by 10% or less were averaged and those values greater than 10% were not included in the analysis completed by Hamilton et al. (2006). The researchers' premise being "disagreement fell among subjective items or items for which it was very difficult to obtain accurate counts"; therefore, to ensure rater reliability, discrepancies greater than 10% in frequency counts were removed from the analysis (Hamilton et al., 2006, p. 760). Prior content analysis studies investigating picture books had used similar thresholds for interrater reliability, as well as the study approached the content analysis implementing similar criteria and methods (Foster, 2014; Ganea, Canfield, Simons-Ghafari & Chou, 2014; Luyt et al., 2011). As multiple coders performed the content analysis, the researcher removed counts that differed more than 10% from the mean score of the group of coders (Hamilton et al., 2006). An average mean was then implemented for content analyses.

Interrater reliability. As prior content analysis studies utilized the coding of multiple undergraduate and graduate coders and/or the primary researcher to insure interrater reliability, the same was implemented for this study. Each of the STEM books were analyzed and coded by three coders using the coding analysis instrument (Appendix D). Two of the coders worked collaboratively to code the image and lexical content, and a third coder worked independently. Coders were trained by the researcher prior to conducting the analyses through a joint coding exercise using the content analysis instrument. With the lead researcher the coders went through the entire instrument to practice completing the analysis of one book. The coders were then given the books to conduct the analyses for their assigned books. Not all six coders analyzed all eight books.

The coders first identified all general information for the book (e.g., author, illustrator, sex of author and illustrator, type of book). Then the coders identified the main character/s in the STEM book and coded (i.e., counted) the illustrations for each of the targeted behaviors on the content analysis coding sheet. In a similar manner, the coders identified all lexical content targeted on the coding sheets. The procedure was repeated for each book analyzed by the coder for main character/s and secondary character/s.

Reliability was measured by percentage of agreement between the three coders, based on total frequency counts for each targeted behavior and/or lexical message determined by the following procedure:

1. A table of frequency counts for each element (i.e., targeted behavior or lexical message) analyzed by each coder was created (Figure 12). Then combinations of the coders were also created in the table.

2. The mean of each element in each book was determined. The mean was then compared to the frequency count tallied. All counts which were more than 10% from the mean frequency were removed from the analysis and those values differing by 10% or less were averaged. A new rounded mean was created and used as the final tally count for the element for each book. Each factor assessed in the content analysis was given a mean frequency count and the mean frequency count was used for statistical analysis.

3. For each combination of coders a new variable was formed (e.g., C1/C2, C1/C3 and C2/C3). Thus, there were three possible pairs for the three coders of each STEM book, for each element.

4. Coding pairs were then evaluated for agreement (1) or disagreement (0).

5. The mean of the agreement was calculated by adding each agreement fraction and dividing that number by the total of eight books. Thus, for the example below

the researcher calculated the following: 18/3 agreements = 6 Total / 8 Books = .75. Thus, the IRR for this target example would be 75%.

Book	Coder 1	Coder 2	Coder 3	Mean	New Mean (Rounded)	C1/C2	C1/C3	C2/C3	Agreement
1	10	12	10	10.67	10	0	1	0	1/3
2	15	15	15	15.00	15	1	1	1	3/3
3	4	5	8	5.67	4.5	1	0	0	1/3
4	8	8	7	7.67	8	1	1	1	3/3
5	30	31	30	30.33	30	1	1	1	3/3
6	27	25	26	26.00	26	1	1	1	3/3
7	9	10	9	9.30	9	1	1	1	3/3
8	0	0	1	0.33	0	1	0	0	1/3
Total Agreement									18/3
Interrater reliability percentile									75%

Figure 12: Example of determining target score and IRR

Conclusion

The methodology applied to this study was innovative to content analysis investigations. The sequential research design implementing children's perceptions/evaluations of book image content allowed for a novel methodological approach regarding the content analysis of children's literature. The exploratory investigation had uncovered new and more effective methods of analyzing children's book content. As the content analysis designed herein discovered biased content in children's STEM literature, further investigation of additional STEM literature should be considered. The findings from the analyses discussed herein can be found in Chapter Four.

CHAPTER 4: ANALYSIS

Introduction

The purpose of the research study was to explore the possibility of bias in popular selling, award winning, early childhood, STEM literature. The study defined how children gendered images in the STEM literature, and where bias existed the researcher quantified the existence. As summarized in Chapter Three, the sample literature was selected from award-winning STEM books as denoted on the CLCD, which were also reported as top sellers on Amazon rankings during the week of April 9, 2017 (Table 4). Further analysis of book content determined if STEM books contained biased content similar to prior research studies as discussed in the Chapter Two literature review.

Table 4

Books Analyzed for the Study

Book Title	Author Gender	Illustrator Gender	Anthropomorphic Content	STEM Area
1. Ada Twist Scientist	Female	Male	Yes	Science
2. Robots, Robots Everywhere	Female	Male	Yes	Technology
3. Digger, Dozer, Dumper	Female	Male	Yes	Engineering
4. The Great Graph Contest	Female	Female	Yes	Math
5. Chameleon, Chameleon	Female	Male	None (Photos)	Science
6. Simple Machines: Wheels, Levers, and Pulleys	Male	Female	Yes	Technology & Engineering
7. Rosie Revere, Engineer	Female	Male	Yes	Engineering
8. Over in the Ocean: In a Coral Reef	Female	Female	Yes	Math

In this chapter, the researcher presents the results (i.e., quantitative) and findings (i.e., qualitative) of the study. Data included: Survey data on book image content and STEM book content analysis. Additionally, explanations of the relevant statistical assumptions, descriptive statistics of the samples, and statistical results for each of the hypotheses were presented. Results for survey data and content book analysis data were analyzed and presented. The sequential design of the study required the findings be presented in the phases in which they were conducted: 1. Image Content Analysis; 2. Image Survey Analysis; 3. Book Content Analysis. Although the significance level for the study was $\alpha=0.05$, due to the exploratory nature of the study, findings at $\alpha=0.10$ were also reported. All data analyses were conducted using IBM SPSS Statistics 25 software.

Image Content Findings

All books were analyzed for image type and frequency. The coders recorded any observation of the categories regardless of size, color, etc. After all images were tallied from each book (Appendix K) and common images were determined, the eleven most common image categories were recorded from each book (Table 5). Findings determined vehicles, which were defined as any auto a person can drive, such as a car, bulldozer, taxi, etc. (121 total occurrences), food, such as cookies, apples, hamburgers (110) and trees (101) were the most common image categories found in the books. Dogs (5) and turtle (5) were the least frequently observed image type.

Table 5

Category Frequency in STEM Books Analyzed

	Frog	Bird	Dog	Number	Flower	Food	Vehicle	House	Tree	Fish	Turtle	Other
Ada Twist						17	3	5	13			
Rosie Revere		25		6	3	33	55	6	14			
Digger Dozer	1	4	4				21		3		3	
Robots		1	1		6	8	21	6	3	4		
Great Graph	31			14	49	25		2	5		2	
Over Ocean				20						55		13 Stingray
Simple Machine		2		4	29	27	21	11	34			
Chameleon	1								29			29 Chameleon 1 Scorpion
Frequency Totals	33	32	5	44	87	110	121	30	101	59	5	13/29/1

Table 5 above reports on the total number of categorized images found in the STEM books. Category bias was determined through a t-test analysis resulting in a mean score bias for each category. Category bias was determined by the gender and preference bias (i.e., bias view) for each of the 50 images from the 102 participants. Each of the images was determined to be biased or non-biased (e.g., biased view) and all similar images were collectively analyzed as one type of category (e.g., frogs, numbers, food).

Analysis of category bias found three of the categories were statistically significantly different between male and female participants. The category flowers was statistically significantly different (α=0.05) between males (45.34) and females (57.20), U = 1600, p = .013, *V* = .04. Moreover, at the lower significance level (α=0.10), the category for trees was statistically different for male (46.95) and female (55.71) participants, $U = 1521.5$ $p = .073$, $V = .02$, as well as for the bird category, male (47.21) and female (55.46) participants, $U = 1508.5$ $p = .096$, $V = .02$. Conclusively, the findings indicated females had a more biased view of the images of trees, birds, and flowers.

Images selected from each book were analyzed first (e.g., image gendering and image preference level), then book content, and lastly image constructs (e.g., birds, dogs, frogs, food, flowers, transportation vehicles, turtles, fish, numbers, houses, and trees). Descriptive statistics of the category image frequencies for each of the analyzed books were reported (Table 5). As some categories were not observed in some of the selected text, non-normal distributions resulted. Findings from the category analysis were elaborated on after the initial findings for gender and preference of each image and book content analyses were reported.

Image genderization findings. Research questions were answered in part (relating to the image content) with the analysis of the surveyed images. Analysis included participants' identified gender and preference for each of the images. The following research question was addressed with the image analyses:

Research Question #1 (RQ1): Are the STEM children's literature under investigation biased? If the survey interviews and content analysis found the literature to be biased, was one gender represented more than the other?

H_1: Popular-selling, award-winning children's STEM literature contains gender bias content.

H_0: There was no difference detected between how males and females perceive the book content of popular-selling, award-winning children's STEM literature.

To help answer RQ1 a Pearson's Chi-Square test of Independence was performed examining the relationship between the gender of the participant and how the participant gendered the images (e.g., Only male, Only female, Neither male or female, or Both male and female). Significant differences were indicated at the $\alpha = 0.05$ level (Table 6) regarding how the participants gendered the images (e.g., Image numbers 1, 9, 33, 44, 47). Where significance was indicated, an effect size was also reported (Cramer's V). Five additional images were found to have had significance at the $\alpha = 0.10$ level (e.g., Image numbers 21, 22, 25, 45, 46) and were noted. The following table reports the gendering of the images and the narrative that follows details the significant results of images by book (Table 6).

Table 6

Genderization of Images

Image	X^2	*p*	*V*	% Viewed Female		% Viewed Male		% Viewed Either		% Viewed Neither		Total % Gendered		Anthro	Inanimate	Personify
				M	F	M	F	M	F	M	F	Gen	Non-G			
1-Flower	10.42	.015	.32	20.4	45.3	22.4	5.7	20.4	7.8	36.7	34.0	64.7	35.3			
2-Cookie	0.93	.818		57.1	5.7	34.7	35.8	20.4	15.1	36.7	43.4	59.8	40.2		✓	
3-Duck/Bird	3.21	.361		18.4	28.3	28.6	35.8	32.7	22.6	20.4	13.2	83.3	16.7	✓		✓
4-Turtle	3.09	.378		10.2	22.6	36.7	32.1	38.8	35.8	14.3	9.4	88.2	11.8			✓
5- Flower	1.92	.587		34.7	45.3	10.2	11.3	24.5	15.1	30.6	28.3	70.6	29.4			
6-Car	1.06	.786		8.2	13.2	42.9	41.5	18.4	13.2	30.6	32.1	68.6	31.4		✓	✓
7-Robot Dog	3.05	.384		8.2	18.9	49.0	39.6	34.7	30.2	8.2	11.3	90.2	9.8		✓	✓
8-Doughnut	5.31	.151		12.2	15.1	40.8	20.8	16.3	17.0	30.6	47.2	60.8	39.2		✓	
9-Bird	11.69	.005	.34	8.2	35.8	22.4	18.9	51.0	35.8	18.4	9.4	86.3	13.7			✓
10-Flower	3.15	.37		24.5	35.8	8.2	13.2	24.5	15.1	42.9	35.8	60.8	39.2			
11-Car	1.57	.667		10.2	15.1	40.8	37.7	20.4	13.2	28.6	34.0	68.6	31.4		✓	✓
12-Fire Truck	2.32	.509		6.1	11.3	44.9	35.8	14.3	9.4	34.7	43.4	60.8	39.2		✓	
13-Turtle	4.67	.198		4.1	17.0	36.7	32.1	44.9	41.5	14.3	9.4	88.2	11.8	✓		✓
14-Bird	1.34	.720		16.3	22.6	22.4	20.8	38.8	41.5	22.4	15.1	81.4	18.6			✓
15-Dog	3.93	.269		2.0	9.4	44.9	32.1	42.9	45.3	10.2	13.2	88.2	11.8	✓		✓
16-Excavator	5.89	.117		10.2	11.3	36.7	28.3	22.4	9.4	30.6	50.9	58.8	41.2		✓	✓
17-Fire Truck	1.41	.703		12.2	17.0	44.9	34.0	14.3	15.1	28.6	34.0	68.6	31.4		✓	✓
18-Bird	3.19	.363		16.3	28.3	22.4	15.1	40.8	43.4	20.4	13.2	83.3	16.7			✓
19-Turtle	1.13	.77		14.3	13.2	38.8	35.8	30.6	39.6	16.3	11.3	86.3	13.7			✓
20-Flower	1.84	.607		16.3	24.5	18.4	20.8	18.4	11.3	46.9	43.4	54.9	45.1			
21-Dog	6.27	.10	.24	4.1	18.9	40.8	37.7	44.9	37.7	10.2	5.7	92.2	7.8	✓		✓

Image	X^2	*p*	*V*	Viewed Female		Viewed Male		Viewed Either		Viewed Neither		Total % Gendered		Anthro	Inanimate	Personify
				M	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**Gen**	**Non-G**			
22-Hotdog	6.99	.072	.26	16.3	5.7	32.7	18.9	18.4	28.3	32.7	47.2	59.8	40.2		✓	
23-Dog	2.28	.516		24.5	30.2	26.5	15.1	32.7	39.6	16.3	15.1	84.3	15.7		✓	✓
24-Car	4.50	.212		8.2	17.0	38.8	28.3	20.4	11.3	32.7	43.4	61.8	38.2		✓	
25-Number	6.60	.086	.25	6.1	17.0	34.7	18.9	22.4	15.1	36.7	49.1	56.9	43.1		✓	
26-Frog	2.25	.523		6.1	9.4	38.8	26.4	36.7	47.2	18.4	17.0	82.4	17.6			
27-Scorpion	0.83	.843		10.2	11.3	36.7	41.5	34.7	26.4	18.4	20.8	80.4	19.6			
28-Chameleon	0.47	.926		12.2	17.0	38.8	37.7	36.7	34.0	12.2	11.3	88.2	11.8			
29-Car	2.88	.410		14.3	11.3	28.6	32.1	22.4	11.3	34.7	45.3	59.8	40.2	✓	✓	✓
30-Tree Trunk	2.85	.415		14.3	20.8	28.6	22.6	18.4	9.4	38.8	47.2	56.9	43.1			
31-Frog	2.11	.549		10.2	17.0	24.4	30.2	44.9	39.6	20.4	13.2	83.3	16.7			✓
32-Apple	.358	.949		14.3	15.1	22.4	26.4	16.3	13.2	46.9	45.3	53.9	46.1		✓	
33-Tree	7.65	.05	.27	14.3	17.0	32.7	11.3	22.4	22.6	30.6	49.1	59.8	40.2			
34-Car	1.02	.796		12.2	15.1	30.6	26.4	24.5	18.9	32.7	39.6	63.7	36.3		✓	
35-Flower	2.85	.415		30.6	45.3	16.3	15.1	14.3	7.5	38.8	32.1	64.7	35.3			
36-Hamburger	5.80	.122		10.2	1.9	40.8	30.2	20.4	24.5	28.6	43.4	63.7	36.3		✓	
37-House	2.13	.546		14.3	15.1	22.4	24.5	26.5	15.1	36.7	45.3	58.8	41.2		✓	
38-Tree	1.56	.669		12.2	17.0	28.6	18.9	22.4	22.6	36.7	41.5	60.8	39.2			
39-Bird	4.99	.172		30.6	34.0	30.6	13.2	26.5	39.6	12.2	13.2	87.3	12.7	✓		✓
40-House	3.50	.32		16.3	15.1	28.6	15.1	22.4	22.6	32.7	47.2	59.8	40.2		✓	
41-Bird	1.49	.685		20.4	30.2	28.6	22.6	36.7	35.8	14.3	11.3	87.3	12.7			✓
42-Tree	0.91	.822		12.2	15.1	22.4	18.9	24.5	18.9	40.8	47.2	55.9	44.1			
43-Flower	2.90	.407		22.4	35.8	14.3	11.3	18.3	20.8	44.9	32.1	61.8	38.2			
44-Dead Fish	7.82	.05	.28	14.3	7.5	36.7	32.1	34.7	22.6	14.3	37.7	73.5	26.5			✓
45-Fish	7.37	.061	.27	6.1	17.0	44.9	24.5	36.7	50.9	12.2	7.5	90.2	9.8			✓
46-Dolphin	6.46	.091	.25	12.2	28.3	22.4	9.4	51.0	52.8	14.3	9.4	88.2	11.8			✓

Image	X^2	*p*	*V*	Viewed Female		Viewed Male		Viewed Either		Viewed Neither		Total % Gendered		Anthro	Inanimate	Personify
				M	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**Gen**	**Non-G**			
47-Fish	8.32	.04	.29	6.1	22.6	38.8	26.4	44.9	32.1	10.2	18.9	85.3	14.7		✓	✓
48-Fish	1.64	.65		14.3	22.6	26.5	18.9	44.9	45.3	14.3	13.2	86.3	13.7	✓		✓
49-Stingray	0.60	.90		6.1	9.4	38.8	34.0	38.8	41.5	16.3	15.1	84.3	15.7			✓
50-Number	3.72	.294		14.3	24.5	24.5	30.2	22.4	11.3	38.8	34.0	63.7	36.3		✓	

***(*N* = 102, df =3)**

The following narrative reports on the significant findings from the individual image analysis which helped to determine image category bias and book content bias.

Book #1: The Great Graph Contest

A Pearson's Chi-Square analysis of five images (Images 1 through 5) selected from the math book *The Great Graph Contest*, written and illustrated by Loreen Leedy, indicated a significant difference, with a large effect size, between how male and female participants viewed the gender of one of the five images selected from the book (e.g., Image #1), χ^2 (3, n = 102) = 10.42, p = .015, V = .320 (Figure 13). All other images from the math book *The Great Graph Contest* indicated no significant difference between male and female participants' gendering of images.

Image #1, Leedy (2005)

Figure 13: Image #1

Book #2: Robots, Robots Everywhere

An additional six images (Images six through 11) from the technology and engineering book *Robots, Robots Everywhere*, authored by Sue Fleiss and illustrated by Bob Staake, were analyzed. The Pearson's Chi-Square analysis indicated a significant difference, with a strong effect, between how male and female participants viewed the gender of one of the six images selected from the book (e.g., Image #9), χ^2 (3, n = 102) = 11.65, p = .009, *V* = .338 (Figure 14). The additional five images analyzed from the book indicated no significant difference between male and female participants in how they gendered the images.

Figure 14: Image #9

Book #3: Digger, Dozer, Dumper

Analysis of the images #12-17 & 29-31 from the engineering book *Digger, Dozer, Dumper*, authored by Hope Vestergaard and illustrated by David Slonim, indicated no significant differences between the gender of the participant and how they gendered the selected book images.

Book #4: Ada Twist Scientist

Of the nine images (# 18-25 & 50) selected from the science book *Ada Twist Scientist*, authored by Andrea Beaty and illustrated by David Roberts, one third of the images discovered an association between participant gender and how the participants gendered the images; however, none of the associations were significantly different at the 0.05 level. Image #21, χ^2 (3, n = 102) = 6.26, p = .09, *V*= .238, indicated female participants were almost five times more likely to gender the image of the dog as only female as compared to their male counterparts (Figure 15). Analysis of the food item/hotdog image (#22), χ^2 (3, n = 102) = 6.99, p = .072, *V* = .262, discovered participants were giving gender to non-personified/non-anthropomorphized objects (Figure 16). Another non-personified object, image #25 (the green, number 3), χ^2 (3, n = 102) = 6.60, p = .086, *V* = .254 was not significantly different at the 0.05 level; however, the findings were worth noting at the α=0.10 (Figure 17). Interestingly, image #50 of the number two was not significantly different at either the 0.05 or 0.10 levels. The finding at the α=0.10 helped to support the hypothesis, *H_3: Inanimate objects will be personified (given gender identity).* Thus, test findings would imply readers were gendering some non-personified or inanimate objects and further investigation may be justified.

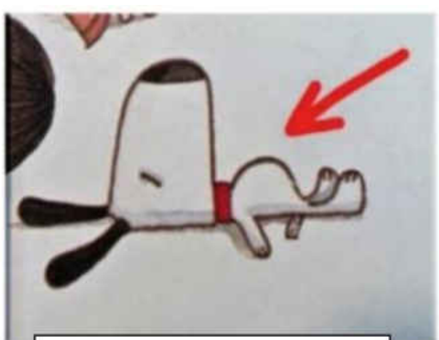


Image #21, Beaty (2016)

Figure 15: Image #21

Image #22, Beaty (2016)

Figure 16: Image #22

Image #25, Beaty (2016)

Figure 17: Image #25

Book #5: Chameleon, Chameleon

The other science book included in the study, and the only book with photographic images to be analyzed, *Chameleon, Chameleon*, authored by Joy Cowley and illustrated by Nic Bishop (male), had three photographic images analyzed (i.e., frog - #26, scorpion - #27, chameleon - #28). None of the book images were found to have had a significant difference between the gender of the participant and how the participant gendered the images from the book. In fact, the images of the scorpion, χ^2 (3, n = 102) = .826, p = .843, and the chameleon, χ^2 (3, n = 102) = .470, p = .926, were some of the least associated images in the study.

Book #6: Simple Machines: Wheels, Levers, and Pulleys

Analysis of book images (numbers 32-38) from the children's STEM book, *Simple Machines: Wheels, Levers, and Pulleys,* a technology and engineering book authored by David Adler and illustrated by Anna Raff, was conducted. Of the seven images selected for analysis from the book, only one image (#33 - Tree) was found to have had a significant difference between participant gender and how the participant gendered the image, χ^2 (3, n = 102) = 7.84, p = .05, V = .274 (Figure 18). The finding further supported the hypothesis of readers gendering non-personified objects.

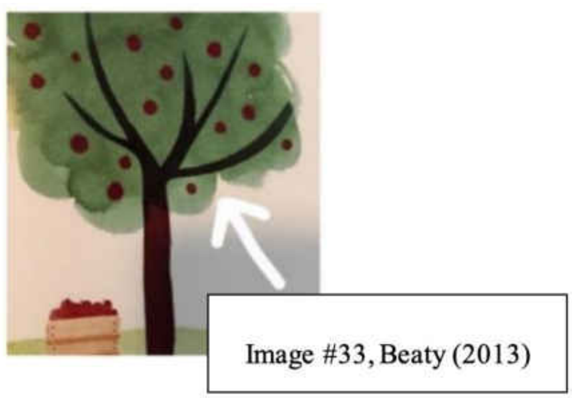


Figure 18: Image #33

Book #7: Rosie Revere, Engineer

The engineering book authored and illustrated by Andrea Beaty, *Rosie Revere, Engineer*, found one of the seven selected book images (numbers 39-44) to be significantly different between the gender of the participant and how they gendered the image (e.g., predominately male by male participants and either male or female by female participants). Analysis of Image

#44 (e.g., a dead fish on a plate), which could be categorized as food or as a dead fish (anthropomorphic), indicated a significant difference existed, χ^2 (3, n = 102) = 7.82, p = .05, *V* = .277 (Figure 19).

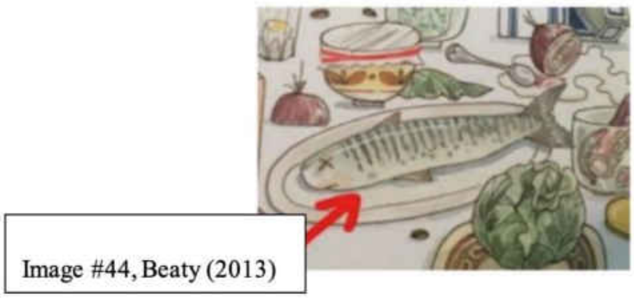


Figure 19: Image #44

Book #8: Over the Ocean: In a Coral Reef

The last book to have had images analyzed was the children's book *Over the Ocean: In a Coral Reef*, authored by Marianne Berkes and illustrated Jeanette Canyon. The book had five selected images (numbers 45-49), of which one image (number 47) indicated a significant difference between participant gender and how images were gendered by the participants at 0.05 alpha level, χ^2 (3, n = 102) = 8.32, p = .04, *V* = .286 (Figure 22) , and two images (number 45, Figure 20), χ^2 (3, n = 102) = 7.37, p = .061, *V* = .269, and (number 46, Figure 21), χ^2 (3, n = 102) = 6.46, p = .091, *V* = .252 were significant at the .10 level.

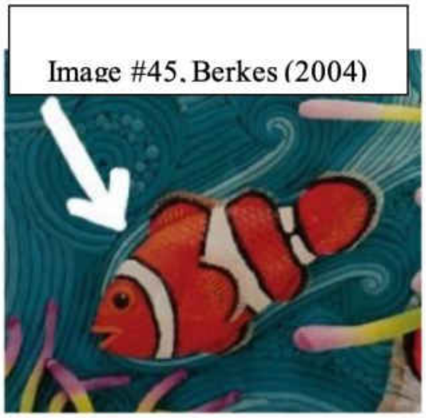


Figure 20: Image #45

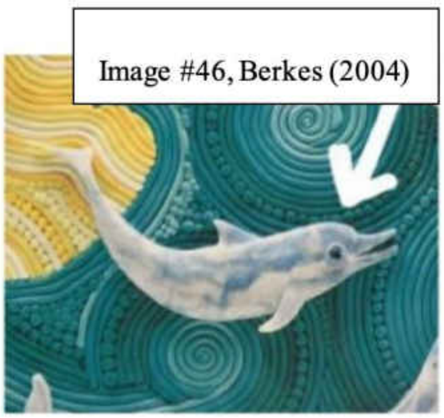


Figure 21: Image #46

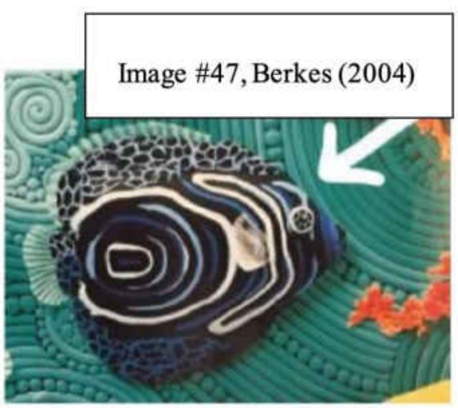


Figure 22: Image #47

The findings (Table 6) from the Pearson's Chi-Square test of Independence identified several significant differences between male and female participants in how they gendered the images which helped to support the H_1 hypothesis. Based on findings on gendering images, the null hypothesis was rejected. According to the findings from these 102 participants, the eight popular-selling award-winning children's STEM literature examined in this study did appear to contain gender biased images and further investigation of additional children's literature would be warranted.

Research Question #3 (RQ3): Do readers gender images not expected to be gendered?

H_2: Anthropomorphic images will be gendered more than non-anthropomorphic images.

H_o: No difference was discovered in how children gender anthropomorphic compared to non-anthropomorphic images.

The 50 images tested in this study consisted of seven anthropomorphic and 43 non-anthropomorphic images, 25 personified images and 25 non-personified, 20 inanimate images and 30 animate images. Analysis of anthropomorphic and non-anthropomorphic images was conducted and was presented (Table 6). The findings reported in Table 6 did not indicate any anthropomorphic images being gendered significantly differently at the 0.05 level. One image (number 21-Dog, Figure 15) was significantly different at the 0.10 level (χ^2 (3, n = 102) = 6.26, p = .09, V = .238). To determine if a difference existed in the gendering of anthropomorphic versus non-anthropomorphic images, the researcher first coded all images as being non-gendered (0 = neither male nor female) or gendered (1 = male or female or both). Then, a Wilcoxon Signed Ranks test was conducted to compare the means of the two groups. The results of the test supported the hypothesis of anthropomorphic images (*M*=.83) being gendered more than non-anthropomorphic images (*M*=.71), z = -6.10, p<.001, r=0.6 . Findings identified a significant difference between the means, with a large effect size. Therefore, the null hypothesis (H_2) was rejected.

Research Question #2 (RQ2): Do sociocultural factors of readers (e.g., gender or language) affect a reader's perception of images in STEM literature?

RQ2-a. Does readers' gender affect how they perceive an image?

H_4: Images perceived as matching the gender of the reader in popular selling, award winning children's STEM literature will be preferred more by the reader than those not matching the reader's gender.

H_o: There was no difference found related to a reader's gender and how they perceive the gender of images.

Initial examination of the data revealed non-normative data; thus, resulting in implementation of non-parametric testing. The Pearson's Chi-Square analysis determined significant differences were apparent in the participant preference levels for the images (Table 7). Where significance was indicated (either at 0.05 or 0.10), an effect size was reported (Cramer's *V*). Table 7 presents findings which indicate statistically significant differences between the male and female participants in the preference levels for 18 of the 50 images at the α=0.05 level (numbers 1, 4, 5, 6, 7, 10, 12, 14, 23, 24, 27, 28, 33, 35, 38, 43, 44, and 46) and two of 50 images at the α=0.10 level (numbers 16 and 41).

Table 7

Preference Level of Images

Image	X^2	***p***	***V***	**%Highly Dislike**		**%Dislike**		**%Neutral (Ok)**		**%Like**		**%Love**	
				M	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**
1-Flower	26.65	***.000***	.488	18.4	1.9	12.2	3.8	20.4	1.9	10.2	17.0	38.8	75.5
2-Cookie	4.73	.317		16.3	9.4	2.0	5.7	8.2	9.4	16.3	30.2	57.1	45.3
3-Duck/Bird	2.23	.694		26.5	32.1	10.2	13.2	16.3	20.8	20.4	11.3	26.5	22.6
4-Turtle	10.05	***.04***	.314	8.2	7.5	6.1	18.9	20.4	3.8	18.4	26.4	46.9	43.4
5- Flower	17.03	***.002***	.409	22.4	3.8	8.2	3.8	24.5	9.4	8.2	17.0	36.7	66.0
6-Car	17.38	***.002***	.413	18.4	37.7	8.2	17.0	10.2	15.1	12.2	17.0	51.0	13.2
7-Robot Dog	21.7	***.000***	.451	16.3	39.6	4.1	15.1	12.2	20.8	6.1	5.7	61.2	18.9
8-Doughnut	5.32	.256		10.2	3.8	4.1	11.3	16.3	11.3	16.3	9.4	53.1	64.2
9-Bird	4.25	.374		16.3	9.4	2.0	7.5	18.4	15.1	26.5	18.9	36.7	49.1
10-Flower	23.95	***.000***	.485	22.4	1.9	6.1	7.5	24.5	3.8	10.2	28.3	36.7	58.5
11-Car	7.54	.11		10.2	28.3	6.1	9.4	22.4	24.5	14.3	9.4	46.9	28.3
12-Fire Truck	9.67	***.047***	.308	16.3	22.6	10.2	17.0	24.5	15.1	10.2	26.4	38.8	18.9
13-Turtle	6.63	.157		6.1	17.0	10.2	17.0	14.3	20.8	16.3	11.3	53.1	34.0
14-Bird	10.75	***.030***	.325	12.2	20.8	8.2	3.8	20.4	7.5	14.3	35.8	44.9	32.1
15-Dog	2.74	.603		12.2	24.5	8.2	5.7	10.2	9.4	12.2	9.4	57.1	50.9
16-Excavator	9.13	**.058**	.297	18.4	34.0	12.2	13.2	14.3	24.5	8.2	7.5	46.9	20.8
17-Fire Truck	2.61	.625		26.5	26.4	4.1	9.4	10.2	17.0	16.3	13.2	42.9	34.0
18-Bird	3.61	.462		14.3	11.3	8.2	9.4	18.4	7.5	14.3	22.6	44.9	49.1
19-Turtle	3.06	.548		14.3	26.4	8.2	11.3	18.4	17.0	14.3	11.3	44.9	34.0
20-Flower	4.67	.323		34.7	18.9	6.1	5.7	18.4	17.0	16.3	17.0	24.5	41.5
21-Dog	3.94	.415		16.3	17.0	4.1	1.9	12.2	5.7	8.2	18.9	59.2	56.6
22-Hotdog	1.94	.75		24.5	28.1	8.2	9.4	8.2	15.1	12.2	9.4	46.9	37.7
23-Dog	10.2	***.037***	.29	12.2	13.2	8.2	5.7	8.2	0.0	18.4	7.5	53.1	73.6

Image	*X2*	*p*	*V*	%Highly Dislike		%Dislike		%Neutral (Ok)		%Like		%Love	
				M	F	M	F	M	F	M	F	M	F
24-Car	12.03	***.017***	.343	12.2	32.1	6.1	18.9	20.4	13.2	10.2	7.5	51.0	28.3
25-Number	0.97	.915		26.5	28.3	10.2	5.7	24.5	28.3	6.1	7.5	32.7	30.2
26-Frog	4.09	.395		24.5	37.7	8.2	7.5	12.2	17.0	16.3	7.5	38.8	30.2
27-Scorpion	14.12	***.007***	.367	28.6	60.4	8.2	11.3	12.2	5.7	6.1	5.7	44.9	17.0
28-Chameleon	15.38	***.004***	.388	6.1	37.7	10.2	9.4	20.4	11.3	16.3	7.5	46.9	30.4
29-Car	7.35	.118		28.6	30.2	10.2	13.2	14.3	20.8	8.2	18.9	38.8	17.0
30-Tree Trunk	2.23	.693		30.6	34.0	10.2	18.9	14.3	11.3	14.3	9.4	30.6	26.4
31-Frog	4.38	.357		26.5	24.5	8.2	15.1	18.4	20.8	4.1	11.3	42.9	28.3
32-Apple	4.47	.346		18.4	24.5	18.4	7.5	14.3	17.0	14.3	7.5	34.7	43.4
33-Tree	10.57	***.032***	.316	12.2	7.5	4.1	11.3	26.5	7.5	22.4	18.9	34.7	54.7
34-Car	7.72	.102		16.3	18.9	4.1	11.3	26.5	13.2	12.2	26.4	40.8	30.2
35-Flower	36.74	***.000***	.572	32.7	3.8	6.1	1.9	22.4	1.9	6.1	15.1	32.7	77.4
36-Hamburger	3.96	.411		12.2	26.4	6.1	7.5	12.2	9.4	16.3	17.0	53.1	39.6
37-House	2.93	.569		14.3	11.3	8.2	13.2	22.4	18.9	24.5	15.1	30.6	41.5
38-Tree	13.14	***.011***	.353	18.4	13.2	6.1	13.2	32.7	9.4	18.4	15.1	24.5	49.1
39-Bird	7.38	.117		20.4	17.0	8.2	1.9	18.4	13.2	18.4	9.4	34.7	58.5
40-House	4.32	.365		14.3	9.4	14.3	5.7	16.3	11.3	14.3	17.0	40.8	56.6
41-Bird	8.90	**.064**	.280	10.2	9.4	4.1	0.0	18.4	5.7	24.5	20.8	42.9	64.2
42-Tree	5.06	.281		14.3	11.3	2.0	7.5	28.6	17.0	20.4	15.1	34.7	49.1
43-Flower	27.08	***.000***	.493	24.5	1.9	10.2	7.5	18.4	3.8	12.2	7.5	34.7	79.2
44-Dead Fish	12.47	***.014***	.493	24.5	50.9	6.1	13.2	12.2	9.4	14.3	9.4	42.9	17.0
45-Dolphin	1.43	.839		14.3	7.5	4.1	5.7	8.2	7.5	20.4	24.5	53.1	54.7
46-Fish	12.70	***.013***	.341	8.2	1.9	2.0	0.0	16.3	3.8	20.4	11.3	53.1	83.0
47-Fish	1.65	.801		16.3	22.6	8.2	7.5	10.2	15.1	16.3	11.3	49.0	43.4
48-Fish	2.71	.607		22.4	22.6	4.1	9.4	16.3	11.3	16.3	9.4	40.8	47.2
49-Stingray	3.74	.452		16.3	22.6	6.1	13.2	12.2	5.7	16.3	18.9	49.0	39.6
50-Number	3.56	.469		28.6	26.4	8.2	18.9	18.4	22.6	12.2	7.5	32.7	24.5

***Notes: df*=4, *N*=102; p < .05 *italicized* and bold, p < .10 bold**

The Mann Whitney U - Wilcoxon Rank Sum test determined significant differences in the mean ranks between the male and female participants' preference levels of the images (Table 8). Where significance was indicated either at 0.05 or 0.10, an effect size was reported. Table 8 reports the preference levels of male and female participants compared, 19 of 50 images were statistically significantly different at the $\alpha=0.05$ level (numbers 1, 5, 6, 7, 10, 11, 13, 16, 20, 24, 27, 28, 35, 38, 39, 41, 43, 44, and 46) and four of 50 images at the $\alpha=0.10$ level (numbers 23, 33, 36, and 40).

Table 8

Mean Rank Difference Between Male and Female Preference Levels

Image	***U***	*z*	***p***	η^2	**Mean Ranks**		**Sum of Ranks**	
					***Males* (*n* = 49)**	**Females (*n* = 53)**	**M**	**F**
1-Flower	721	4.32	***.000***	.43	39.71	62.4	1946	3307
2-Cookie	1212.5	0.62	.533		53.26	49.88	2609.5	2643.5
3-Duck/Bird	1157	0.97	.330		54.39	48.83	2665	2588
4-Turtle	1250.5	0.34	.734		52.48	50.59	2571.5	2681.5
5- Flower	794	3.66	***.000***	.36	41.2	61.02	2019	3234
6-Car	757.5	3.74	***.000***	.37	62.54	41.29	3064.5	2188.5
7-Robot Dog	691.5	4.26	***.000***	.42	63.89	40.05	3130.5	2122.5
8-Doughnut	1171	0.96	.337		48.9	53.91	2396	2857
9-Bird	1150	1.05	.295		48.49	54.3	2375	2878
10-Flower	834	3.32	***.001***	.33	42.02	60.26	2059	3194
11-Car	920.5	2.63	***.009***	.26	59.21	44.37	2901.5	2351.5
12-Fire Truck	1074.5	1.54	.124		56.07	47.27	2747.5	2505.5
13-Turtle	951.5	2.44	***.015***	.24	58.58	44.95	2870.5	2382.5
14-Bird	1201.5	0.68	.498		53.48	49.67	2620.5	2632.5
15-Dog	1160.5	1.01	.312		54.32	48.9	2661.5	2591.5
16-Excavator	914	2.66	***.008***	.26	59.35	44.25	2908	2345
17-Fire Truck	1179.5	0.83	.406		53.93	49.25	2642.5	2610.5
18-Bird	1199	0.71	.479		49.47	53.38	2424	2829
19-Turtle	1067.5	1.61	.107		56.21	47.14	2754.5	2498.5
20-Flower	993	2.12	***.034***	.21	45.27	57.26	2218	3035
21-Dog	1298	0.01	.997		51.51	51.49	2523	2730
22-Hotdog	1169	0.93	.361		54.14	49.06	2653	2600

Image	*U*	*z*	*p*	η^2	Mean Ranks		Sum of Ranks	
					***Males* (*n* = 49)**	**Females (*n* = 53)**	**M**	**F**
23-Dog	1074	1.75	***.080***	.17	46.92	55.74	2292	2954
24-Car	857.5	3.08	***.002***	.31	60.5	43.18	2964.5	2288.5
25-Number	1286	0.09	.931		51.76	51.26	2536	2717
26-Frog	1083	1.50	.133		55.9	47.43	2739	2514
27-Scorpion	801.5	3.55	***.000***	.35	61.64	42.12	3020.5	2232.5
28-Chameleon	898.5	2.80	***.005***	.28	59.66	43.95	2923.5	2329.5
29-Car	1110.5	1.30	.195		55.34	47.95	2711.5	2541.5
30-Tree Trunk	1184.5	0.80	.430		53.83	49.35	2637.5	2615.5
31-Frog	1180.5	0.82	.412		53.91	49.27	2641.5	2611.5
32-Apple	1245.5	0.37	.712		50.42	52.5	2470.5	2782.5
33-Tree	1045.5	1.74	**.073**	.17	46.34	56.27	2270.5	2982.5
34-Car	1197.5	0.70	.484		53.56	49.59	2624.5	2628.5
35-Flower	606	5.13	***.000***	.51	37.37	64.57	1831	3422
36-Hamburger	1059	1.70	**.089**	.17	56.39	46.98	2763	2490
37-House	1211	0.61	.544		49.71	53.15	2436	2817
38-Tree	1014	1.98	***.048***	.20	45.69	56.86	2239	3014
39-Bird	1017.5	2.00	***.045***	.20	45.77	56.88	2242.5	3010.5
40-House	1040.5	1.85	**.064**	.18	46.23	56.37	2265.5	2987.5
41-Bird	999	2.20	***.028***	.22	45.39	57.15	2224	3029
42-Tree	1142	1.10	.271		48.31	54.45	2367	2886
43-Flower	673	4.68	***.000***	.46	38.73	63.3	1898	3355
44-Dead Fish	815	3.38	***.001***	.34	61.36	42.39	3006.5	2246.5
45-Dolphin	1237	.452	.651		50.24	52.66	2462	2791
46-Fish	885	3.38	***.001***	.34	43.06	59.3	2110	3143
47-Fish	1181	0.83	.404		53.9	49.28	2641	2612
48-Fish	1269	.21	.835		50.90	52.06	2494	2759
49-Stingray	1143	1.10	.274		54.66	48.58	2678.5	2574.5
50-Number	1181	0.81	.418		53.9	49.28	2641	2612

Notes: N **= 102; p < .05 *italicized* and bold, p < .10 bold**

Lastly, Table 9 reports the findings of analyzing the preference level of participants for those images perceived as matching the male and female participants. Findings indicate 26 of the 50 images (numbers 1, 2, 3, 5, 6, 7, 11, 13, 16, 19, 21, 23, 25, 27, 28, 32, 34, 39, 41, 43, 44, 46, 47, 48, and 50) were statistically significantly different in the mean ranks between male and female participants at the α=0.05 level, and four of the 50 images at the α=0.10 level (numbers 20, 30, 38, and 49). Where significance was indicated (either at 0.05 or 0.10), an effect size was also reported. The effect size in Table 9 indicates the amount of variability found in the ranks accounted for by the participant's perceived gender of images matching their own gender. Findings would support the alternative hypothesis suggesting images perceived as matching the gender of the reader were preferred more than those not matching the reader's gender. Mean rankings for all but one of the images (number 10-Flower) were higher ranked when the images matched the gender of the participant as compared to those that did not match (Table 9). Therefore, the H_4 null hypothesis was rejected.

Table 9

Mean Ranks Participant Gender Matches the Perceived Image Gender

Image	*U*	*z*	*p*	*n*^{2}	Mean Ranks Matching		Mean Ranks Non-Matching		Sum of Ranks	
						n		***n***	**Matching**	**Non-Matching**
1-Flower	1023	2.06	***0.04***	.03	56.70	53	45.88	49	3005	2248
2-Cookie	895.5	2.40	***0.02***	.07	59.93	38	46.49	64	2277.5	2975.5
3-Duck/Bird	789.5	3.41	***.001***	.11	60.15	57	40.54	45	3428.5	1824.5
4-Turtle	1076.5	0.60	0.55		52.67	68	49.16	34	3581.5	1671.5
5- Flower	898	2.91	***.004***	.07	59.67	49	43.94	53	2924	2329
6-Car	991	1.99	***0.05***	.04	57.98	44	46.59	58	2551	2702
7-Robot Dog	823	2.26	***0.01***	.10	57.34	67	41.24	35	3757	1496
8-Doughnut	1132	1.14	0.25		54.84	45	48.86	57	2468	2785
9-Bird	880.5	1.23	0.22		53.60	74	45.95	28	3966.5	1286.5
10-Flower	1121	0.47	0.89		50.97	43	51.75	59	2279.5	2973.5
11-Car	883.5	2.80	***.005***	.08	60.37	45	44.5	57	2716.5	2536.5
12-Fire Truck	1180.5	0.42	0.68		52.99	40	50.54	62	2119.5	3133.5
13-Turtle	684.5	3.18	***.001***	.17	57.36	71	38.08	31	4072.5	1180.5
14-Bird	1070.5	1.05	0.29		53.77	64	47.67	38	3441.5	1811.5
15-Dog	373	1.30	.19		44.32	72	35.69	13	3191	464
16-Excavator	969	1.92	***0.05***	.05	58.28	40	47.13	62	2331	2922
17-Fire Truck	1144.5	1.01	0.31		54.62	46	48.94	56	2512.5	2740.5
18-Bird	987	1.15	0.25		53.70	69	46.91	33	3705	1548
19-Turtle	858	2.73	***.006***	.09	57.66	62	41.95	40	3575	1678
20-Flower	939.5	1.89	**0.06**	.06	58.61	37	47.45	65	2168.5	3084.5
21-Dog	834	2.02	***0.04***	.10	54.92	72	43.30	30	3954	1299
22-Hotdog	1055.5	1.52	0.13		56.45	43	47.89	59	2427.5	2825.5
23-Dog	795	3.21	***.001***	.11	57.45	66	40.58	36	3792	1461
24-Car	1075.5	1.41	0.16		56.06	44	48.04	58	2466.5	2786.5
25-Number	999	1.98	***0.05***	.04	57.80	45	46.53	57	2601	2652

Image	*U*	*z*	*p*	n^2	Mean Ranks Matching		Mean Ranks Non-Matching		Sum of Ranks	
						n		***n***	**Matching**	**Non-Matching**
26-Frog	655	0.50	0.62		45.22	67	42.19	21	3030	886
27-Scorpion	728.5	4.04	***.000***	.14	61.75	55	39.5	27	3396.5	1856.5
28-Chameleon	904.5	2.25	***0.02***	.07	56.37	64	43.3	38	3607.5	1645.5
29-Car	1091.5	0.80	0.43		54.50	37	49.79	65	2016.5	3236.5
30-Tree Trunk	971	1.83	**0.07**	.05	58.10	39	47.41	63	2266	2987
31-Frog	1011	1.47	0.14		54.70	64	46.11	38	3501	1752
32-Apple	896	1.92	***0.05***	.07	59.15	34	47.68	68	2011	3242
33-Tree	1109.5	1.32	0.19		55.39	48	48.05	54	2658.5	2594.5
34-Car	863.5	2.92	***.003***	.08	60.81	45	44.15	57	2736.5	2516.5
35-Flower	1105	1.23	0.22		55.30	43	48.73	59	2378	2875
36-Hamburger	1090.5	1.33	0.18		55.72	44	48.30	58	2451.5	2801.5
37-House	1131.5	0.77	0.44		54.21	40	49.75	62	2168.5	3084.5
38-Tree	1027.5	1.82	**0.07**	.03	57.16	46	46.85	56	2629.5	2623.5
39-Bird	781.5	2.93	***.003***	.12	57.34	67	40.33	35	3841.5	1411.5
40-House	1097.5	1.33	0.18		55.61	45	48.25	57	2502.5	2750.5
41-Bird	748	3.29	***.001***	.13	57.84	67	39.37	35	3875	1378
42-Tree	1088.5	1.16	0.25		55.45	41	48.84	61	2273.5	2979.5
43-Flower	813.5	3.56	***.000***	.10	61.82	46	43.03	56	2843.5	2409.5
44-Dead Fish	947.5	2.47	***.014***	.05	58.42	51	44.58	51	2979.5	2273.5
45-Dolphin	882.5	0.89	0.37		52.89	76	47.44	26	4019.5	1233.5
46-Fish	479	4.20	***.000***	.30	56.94	79	32.83	23	4498	755
47-Fish	1086.5	4.29	***.000***	.02	59.52	70	33.95	32	4166.5	1086.5
48-Fish	772.5	2.52	***0.01***	.12	56.12	71	40.92	31	3984.5	1268.5
49-Stingray	949.5	1.86	**0.06**	.05	55.39	65	44.66	37	3600.5	1652.5
50-Number	972	2.02	***0.04***	.05	58.36	42	46.70	60	2451	2802

Notes: ***N*** **= 102; p < .05** ***italicized*** **and bold, p < .10 bold**

Research Question #2 (RQ2-b). Does a reader's language affect how they perceive an image?

H_5: ELL (English Language Learner) readers will perceive the gender of images as they relate to the gendered article of the reader's primary spoken language.

H_o: There was no difference indicated in how ELL (English Language Learner) readers perceive the gender of images.

Of the three primary languages analyzed (i.e., English, Spanish, and Portuguese), two languages (i.e., Spanish and Portuguese) gave gender to nouns. The Spanish language used feminine and masculine articles prior to the noun (e.g., *el* for male, *la* for female), and Portuguese used an ending *o* and *a* for most male and female gendering of nouns, respectively. To determine the effect of a reader's language on image gendering, a Pearson's Chi-Square test of Independence was conducted investigating a relationship between how the participants gendered the images in comparison to how their primary language genders the word for the image. Four images (numbers 22, 26, 36, 45) were determined to be significantly different based on the primary language of the participant.

Image #22 (Figure 16, hotdog) was more likely to be gendered male than female. Although 40% of all participants (n=41) gave no gender to the image (number 22), almost a quarter indicated the image could have either gender. Thirty percent of the Spanish speakers (n=6) indicated they viewed the hotdog as male; whereas, the two Portuguese speakers (n=2) indicated female, and neither male nor female by 37% of the English speakers (n=30). Though, Spanish and Portuguese languages gender the word hotdog as male. Image 22 was gendered significantly differently (χ^2 (6, n = 102) = 15.47, p = .02, V = .32), with language having a moderate effect. Likewise, other images were gendered significantly differently.

Image 26 (Figure 23, frog) was viewed as female by all Portuguese participants (*n*=2); 55% of the Spanish speakers (*n*=11) and 40% of English speakers (*n*=32) viewed the image as either male or female, and about one-third of Spanish (*n*=6) and English speakers (*n*=27) viewed the image as male. The word *frog* was gendered female in Spanish and male in Portuguese. The image (number 26) was gendered significantly differently (χ^2 (6, n = 102) = 15.21, p = .02, V = .37), with language having a moderate effect on how the participants gendered the image.

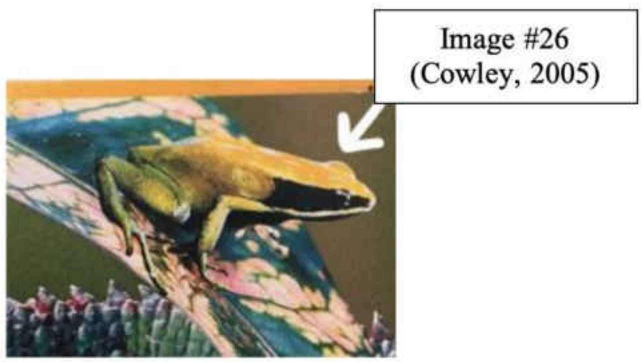


Figure 23: Image #26

Image number 36 (Figure 24, hamburger) was classified as having female gender in Spanish and male in Portuguese. However, about 40% (*n*=8) Spanish speakers and almost one-third of English speakers (*n*=29) determined the image had no gender, and almost one-third of Spanish speakers (*n*=6) and 21% of English speakers (*n*=17) said the hamburger had either gender. Both Portuguese participants gendered the hamburger image as female. One quarter of Spanish speakers (*n*=5) and more than one-third of English speakers (*n*=31) said the hamburger had male gender. The image (number 36) was found to be gendered significantly different based on language (χ^2 (6, n = 102) = 13.58, p = .04, V = .41), with language having a moderate effect on how the participants gendered the image.

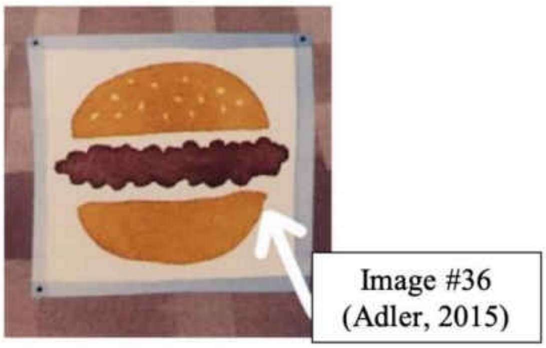


Figure 24: Image #36

Lastly, image number 45 (Figure 20, fish), gendered male in Portuguese and Spanish, was not viewed as male by either of the Portuguese participants and only 10% of Spanish speakers (*n*=2), yet 41% of English speakers (*n*=33) viewed the image as male. Seventy percent of Spanish speakers (*n*=14), 100% of Portuguese speakers (*n*=2), and 36% of English speakers (*n*=29) viewed the gender of the image as being either male or female. Although 44% of the total participants (*n*=45) indicated the fish image had either gender, 34% of the total participants (*n*=35) declared the image to be only male, of which 33 participants were English speakers. Image number 45 was gendered significantly different based on participants' language (χ^2 (6, n = 102) = 12.98, p = .04, V = .24). Although significant differences existed between how participants gendered the images, the difference does not appear to be related to how the participants' primary language genders them in this study.

The difference appears to be related to the gender of the participant and not the primary language they speak. Thus, the H_5 null hypothesis was not rejected. ELL (English Language

Learner) readers do not appear to perceive the gender of images as they relate to the gendered article of the reader's primary spoken language.

The following section answered RQ1-A & RQ1-B as it relates to the image content.

Research Question #1 (RQ1-A & RQ1-B): Does the perceived bias favor males or females?

RQ1 was answered with the initial analysis, and the null hypothesis was rejected. The analyses of genderization and preference for the images aided in determining if the content favored male or female readers (regarding surveyed image content). How the researcher established the conclusion to the question is presented below.

RQ1-A: If yes, does the perceived bias favor males?

H_{1-A}*: Popular-selling, award-winning children's STEM literature contains gender bias favoring males.*

H_o*: Males were not indicated to have had a higher preference or more likely to view images as matching their own gender as compared to females.*

RQ1-B: If yes, does the perceived bias favor females?

H_{1-B}*: Popular-selling, award-winning children's STEM literature contains gender bias favoring females.*

H_o*: Females were not indicated to have had a higher preference or more likely to view images as matching their own gender as compared to males.*

To determine if the perceived bias was more likely to favor male or female participants in the study, a Pearson's Chi-Square test of Independence was conducted to separately analyze male and female participants' gendering of the images. Table 10 showed the results of examining how male and female participant groups gendered the images, and which images were gendered significantly differently by each group. Significance was recorded, in addition to which group was more likely to have had a biased viewed of the image favoring the opposite sex.

Females were more likely to have had a significantly different perception of the images than male participants. Both male and female participants were found to have had significantly different perceptions of the images; females for 48 of the 50 images and males for 38 of the 50 images (Table 10). Moreover, more female participants were more likely to view images opposite of their own gender than the male participants. For all but four of the images, where female participants were most likely to identify the perceived gender of the image as neither OR both male/female, the perception of male gender ranked second most likely, meaning for those females who didn't view the image as gender neutral or non-gendered, they would most likely have perceived the image as opposite their own (i.e., male). Conversely, for those males who didn't view the image as gender neutral or non-gendered, they would most likely perceive the image like themselves, as a male. Females were found to likely view 39 of the 50 images as opposite their own gender, whereas males viewed only 10 of the images as opposite their own gender. Results of the Pearson's Chi-Square analysis support the hypothesis that the biased images favor males more than females.

Table 10

Sex Most Affected By Their Perception of Images

	Chi-Square Female *n=53*	**Significance Female**	**Females most likely to Gender**	**Chi-Square Male *n=49***	**Significance Male**	**Males most likely to Gender**	**Gender more likely to view opposite their own gender**
1-Flower	20.43	.000	Female	36.53	.301	Neither	Female
2-Cookie	19.68	.000	Neither	10.51	.015	Neither	Female
3-Duck/Bird	5.79	.122	Male	2.67	.445	Either	Female
4-Turtle	8.81	.032	Either	12.96	.005	Either	Male
5- Flower	15.00	.002	Female	6.76	.080	Female	Male
6-Car	12.74	.005	Male	13.29	.004	Male	Female
7-Robot Dog	9.87	.020	Male	24.22	.000	Male	Female
8-Doughnut	14.25	.003	Neither	10.84	.017	Male	Female
9-Bird	10.93	.012	Female/Either	19.82	.000	Either	Male
10-Flower	10.10	.018	Female/Neither	11.82	.008	Neither	Male
11-Car	10.17	.017	Male	9.86	.020	Male	Female
12-Fire Truck	18.77	.000	Neither	18.84	.000	Male	Female
13-Turtle	13.34	.004	Either	21.29	.000	Either	Female
14-Bird	8.36	.039	Either	5.45	.142	Either	Female
15-Dog	17.87	.000	Either	28.63	.000	Male	Female
16-Excavator	23.60	.000	Neither	7.74	.052	Male	Female
17-Fire Truck	6.85	.077	Male/Neither*	13.45	.004	Male	Female
18-Bird	12.43	.006	Either	6.92	.075	Either	Female
19-Turtle	13.94	.003	Either	8.06	.045	Male	Female
20-Flower	11.53	.009	Neither	12.63	.006	Neither	Male
21-Dog	15.60	.001	Male/Either*	25.53	.000	Either	Female
22-Hotdog	19.38	.000	Neither	4.63	.201	Male/Neither*	Female
23-Dog	9.26	.026	Either	2.67	.445	Either	Female
24-Car	12.74	.005	Male	10.84	.013	Male	Female
25-Number	16.51	.001	Neither	11.65	.009	Neither	Female
26-Frog	16.96	.001	Either	14.27	.003	Male	Female
27-Scorpion	10.17	.017	Male	9.69	.021	Male	Female
28-Chameleon	10.47	.015	Male	12.80	.005	Male	Male
29-Car	17.72	.001	Neither	17.71	.215	Male	Female
30-Tree Trunk	16.06	.001	Male	7.08	.069	Male	Female

	Chi-Square Female *n=53*	Significance Female	Females most likely to Gender	Chi-Square Male *n=49*	Significance Male	Males most likely to Gender	Gender more likely to view opposite their own gender
31-Frog	9.42	.024	Either	12.47	.006	Either	Female
32-Apple	13.79	.003	Neither	13.29	.004	Neither	Female
33-Tree	17.72	.001	Neither	4.14	.246	Male	Female
34-Car	7.45	.059	Neither	4.96	.175	Neither	Female
35-Flower	8.32	.000	Female	8.06	.045	Neither	Male
36-Hamburger	19.08	.000	Neither	9.86	.020	Male	Female
37-House	12.89	.005	Neither	5.12	.163	Neither	Female
38-Tree	8.06	.045	Neither	6.27	.099	Neither	Female
39-Bird	12.13	.007	Either	4.67	.215	Male/Female*	Male
40-House	14.70	.002	Neither	3.00	.392	Neither	Female
41-Bird	7.15	.067	Either	5.61	.132	Either	Male
42-Tree	14.09	.003	Neither	8.22	.042	Neither	Female
43-Flower	7.90	.048	Female	11.00	.012	Neither	Male
44-Dead Fish	11.08	.011	Neither	9.04	.029	Male	Female
45-Fish	22.09	.000	Either	20.63	.000	Male	Female
46-Dolphin	26.93	.000	Either	18.84	.000	Either	Even
47-Fish	2.02	.568	Either	22.76	.000	Either	Female
48-Fish	12.59	.006	Either	12.31	.006	Either	Female
49-Stingray	14.70	.002	Either	15.90	.001	Male/Either*	Female
50-Number	6.25	.100	Neither	6.10	.107	Neither	Female

***Notes: N* = 102; p < .05 *italicized* & bold, p < .10 bold; *Tied**

Additionally, the analysis conducted implementing a Mann Whitney U - Wilcoxon Rank Sum test showed participants' biased preference of the images to be significantly different (Table 8). The analysis indicated 30 mean ranks were higher for males, whereas the remaining 20 were higher for females, indicating female participants were less likely to perceive the book images as positively as males. Therefore, females were less likely to prefer the image AND they were more likely to gender images, specifically opposite their own gender. The $H_{1\text{-}A}$ null hypothesis was rejected, and the $H_{1\text{-}B}$ null hypothesis cannot be rejected; thus, the alternate hypothesis of $H_{1\text{-}B}$ was retained. Popular selling, award winning children's STEM literature contains gender-biased images favoring males more than females.

Lastly, when the genderization and preference of the images was combined to establish a biased or non-biased view of the images, a Mann Whitney U - Wilcoxon Rank Sum test found four images (numbers 10, 18, 28, and 43; Appendix E) had a statistically significantly different biased view between males and females at the 0.05 level, with one additional image (image 21, Figure 17) at the 0.10 level (Table 11). Females were indicated as having a significantly different higher mean biased view for all five of the images.

Table 11

Statistically Different Biased Images

Image	10-Flower	18-Bird	21-Dog	28-Chameleon	43-Flower
U	1084.5	1164	1219	1113	1137.5
z	2.78	2.06	1.82	2.84	2.32
p	.005	.040	.069	.005	.021
Male (*M*)	47.13	48.76	49.88	47.71	48.21
Female (*M*)	55.54	54.04	53.00	55.00	54.54

RQ3: Do readers gender images not expected to be gendered?

H_3: Inanimate objects will be personified (given gender identity).

Ho: Inanimate objects will not be personified (given gender identity).

Twenty of the 50 images were of inanimate objects, of which eight were personified by the illustrators of the STEM books (Table 6). All 50 images analyzed found participants were more likely to give gender to the images (i.e., personify) than to non-gender them (Table 6). Image number 32 of a partially eaten apple was the least likely to be given gender by participants, and image number 21 (a dog) the most. Inanimate images, number 1 (flower) and number 33 (apple tree) were significantly different between male and female participants at the .05 level. Furthermore, inanimate images number 22 (hotdog) and number 25 (number) were significantly different at the .10 level.

Additionally, a Wilcoxon Signed Ranks test conducted to compare the means of the two groups (e.g., personified inanimate images and non-personified inanimate images) found the mean differences between the personified inanimate images and the non-personified inanimate images to be significantly different, $z = -6.55$, $p<.001$, $r=0.65$. The significant finding indicates personified inanimate objects had a much larger effect than non-personified inanimate objects, and therefore were more likely to be gendered male and/or female. Hence, participants were more likely to give gender to personified inanimate images than non-personified inanimate images. It was noteworthy a Mann Whitney U - Wilcoxon Rank Sum analysis comparing male to female participants did not show any significant mean difference between the two groups for either personified inanimate images or non-personified inanimate images; thus, males ($n = 49$) and females ($n = 53$) were equally likely to give gender to images of inanimate objects, whether they were personified, $z = 1.283$, $p = .200$, or not personified, $z = 1.347$, $p = .178$. The analysis findings above results in the H3 null hypotheses being rejected.

Book Content Analyses Findings

The following sections present the content analysis and findings of the STEM books analyzed for lexical and illustrative content.

Content analysis reviewers. The content of the STEM children's books was examined by six university research assistants using the designated coding sheet (Appendix D). The research assistants varied in gender, age, ethnicity, primary language, and familial status. The five female reviewers (four graduate and one undergraduate), and one male reviewer (undergraduate) had a mean age of 22.2 years and a range age of 35 years. Two reviewers were fluent in Spanish and one was an intermediate Spanish speaker. Three reviewers were parents with children and had frequently read young children's literature.

Interrater reliability (IRR). Percentage of agreement between the pairs of coders, based on total frequency counts for each targeted behavior (lexical and visual) indicated an average IRR of 82.6%, a strong IRR (Drost, 2011; Hauch, Sporer, Masip, & Blandón-Gitlin, 2017). Interrater agreement for image content was 79.2% and 86% for lexical content. Prior content analysis researchers of children's literature had used a threshold of 70% for inter-rater reliability (Hamilton et al., 2006).

STEM books. The children's STEM books varied regarding STEM subject, author, illustrator, characters story type (e.g., anthropomorphic vs. non-anthropomorphic, human vs. animal vs. object), and image and lexical content (Table 4). The books analyzed by the reviewers were classified by the reviewers as two science-focused, two math-focused, two engineering-focused, one technology-focused, and one book was classified as a combination of technology and engineering. All the books, except *Chameleon, Chameleon*, which had real-life photographs, had varying levels of animations (i.e., anthropomorphic vs. personified). The books were written by seven authors (six females, one male) and illustrated by seven illustrators (three females, four males). The story characters examined in the selected books were classified by reviewers as human (50%), animal (37.5%), object (37.5%), anthropomorphic (62.5%), and non-anthropomorphic (12.5%) characters. The gender of all main character/s (e.g., human, animal or other) in the books, where gender was identifiable, indicated five of the eight books contained male primary/main character/s (62.5%), and five books had female primary/main character/s (62.5%), either implied or explicit. The perceived ethnicity of the main character/s by the coders were documented as four books with characters that had no identifiable ethnicity, two books with white characters, two books with black characters, one as other (e.g., robots), and no books contained Asian/Pacific Islander characters. The gender and ethnicity of all characters represented in the STEM children's literature was not able to be conclusively determined either in the lexical content or the illustrations. Although the data is reported herein, if lexical or illustrative representation could not conclusively be determined, then it was not included in the analysis. All characters contained in the books, whose gender and ethnicity could be classified, were then analyzed separately as they were divided into child and adult characters.

Content not included in analysis due to inability to classify or identify. Some adult and child characters, which were primarily not human characters (e.g., robots, animals, and/or objects were either anthropomorphized or personified), were not included in the analysis because coders could not be positive as to the characters' gender and/or ethnicity. Seven child characters and ten adult characters reported as appearing to be female, illustrated in three books totaling 17 probable-female characters. In addition, fourteen child characters illustrated in six books, and four adult characters illustrated in three books reported as appearing to be male totaling 18 probable male characters. Additionally, the ethnicity of all but a few of these characters was generally not able to be determined. The reviewers did a "best guess" when possible. They guessed a "female" child might be white (1), an adult "female" might be other (1), the "male" children might be white (2), black (1) and other (1), and the "male" adults might be black (1) and other (1). The ethnicity of all remaining non-gender specific characters were undetermined and not included in analyses.

Furthermore, characters presented in the children's STEM literature were also portrayed as non-gendered or gender neutral in the lexical and illustrative content. One book, *The Great Graph Contest*, referenced eleven child characters and three adult characters as gender-neutral and/or non-gendered in the lexical content. There were 25 illustrations thought to be child characters in three books that were gender neutral and/or non-gendered characters. Additionally, nine illustrations thought to be adult characters in two books were defined as gender neutral and/or non-gendered characters. No ethnicity of the gender-neutral and/or non-gendered characters could be determined. Consequently, 35 characters' ethnicity and/or gender which were mostly secondary characters were not included in the book content analysis of the STEM books due to coders being unable to conclusively determine the gender of the character.

Content included and analyzed. The following content regarding main and secondary book characters was interpreted by the coders as male or female (i.e., definitely, likely) and was analyzed by the researcher.

Gender representation of main character/s. A difference in the amount of main character representation of children versus adults characters, written and pictured, was determined to exist (Table 12). Additionally, three books had more than one main character. A Wilcoxon matched-pairs signed-rank test was performed and the findings were reported.

Female representation (main characters). Analysis of female character representation found adult female characters (*M = 4.13)* were significantly more likely to be referred to in the lexical content than child female characters (*M* = .63), *W* = 15, z = 2.03, p = .042, r = .72. There was no significant difference found in the mean ranks between the number of times female children were portrayed in the books (*M* = 6.00) and the number of times adult females were portrayed (*M* = 3.63), *W* = 7, z = -7.34, p = .463. It was worth highlighting over half of the books had zero observations recorded of female child and/or adult characters in the writing and/or illustrations of the books. In summary, although adult female characters were written about in more books than the child female characters, the female child characters were portrayed more often in the books than the adult female characters. Findings of male characterization differed from the female characterization in the analyzed books.

Male representation (main characters). Findings indicated adult male characters were significantly more likely to be identified characters in books than male child characters (*W* = 21, z = 2.33, p = 0.02, r = .8). Analysis of the lexical content demonstrated main male child character representation in one of the eight books; however, adult male character representation was found in <u>all but one</u> of the books (Table 12). Furthermore, main male characters were found in more book illustrations than written about in the text; thus, male characters were significantly more likely to be seen than read about (*W* = 19.5, z = 1.89, p = 0.058, r = .7). Male child characters were 16 times more likely to be seen in than written about. A Wilcoxon Signed Rank analysis indicated a statistically significant difference in the number of times male child characters were seen versus written about ($W=15$, $z=2.02$, $p = .043$, $r=.7$). Adult male characters were written and illustrated in all but one of the books; however, their illustrative referencing (43) outnumbered their lexical references (11). Adult male characters were almost four times more likely to be illustrated than written about; however, the difference was not statistically significantly different.

Table 12

Character Representation Frequency -- Lexical and Image Content

		Adult Female		Child Female		Adult Male		Child Male		Unable to Determine	
		Gender	Ethnicity	Gender	Ethnicity	Gender	Ethnicity	Gender	Ethnicity	Gender	Ethnicity
1. Ada Twist	Illustrated	SF-2	W-1; B-1	SF-8	W-4; B-2; A-1	MM-1	W-4; B-2; A-1	SM-9	W-7; B-1; A-1	SC-1	NK-1
	Lexical	SF-2	NK-2			SM-1	NK-1			SC-1	NK-1
2. Rosie Revere	Illustrated	SF-5	W-4; B-1	MF-1 SF-8	W-6; B-2; NK-1	SM-2	W-2	SM-8	W-7; B-1	SC-1	NK-1
	Lexical	SF-2	NK-2	MF-1	NK-1	SM-2	NK-2			SC-1	NK-1
3. Digger Dozer	Illustrated	MF-6 SF-1	NK-7	MF-1 SF-2	W-2; B-1	MM-8 SM-8	NK-16	MM-2 SM-4	W-3; B-2; NK-1	SC-9	NK-9
	Lexical	MF-6	NK-6			MM-8	NK-8			MC-2	NK-2
4. Robots Robots	Illustrated			SF-15	W-1; B-3; NK-11	MM-16 SM-2	NK-18	SM-18	W-6; B- 4; NK-9	SC-36	NK-36
	Lexical									MC-16	NK-16
5. Great Graph	Illustrated			MF-1 SF-2	NK-3	SM-1	NK-1			MC-3 SC-16	NK-19
	Lexical	SF-2	NK-2	MF-1	NK-1	MM-1 SM-1	NK-2	MM-2	NK-0	MC-1 SC-14	NK-15
6. Over in the Ocean	Illustrated	MF-9	NK-9			MM-1	NK-1			MC-11 SC-116	NK-127
	Lexical	MF-9	NK-9			MM-1	NK-1			MC-1 SC-11	NK-11
7. Simple Machines	Illustrated	SF-1	NK-1			SM-10	W-2 NK-8	MM-2 SM-2	W-3; B-1	MC-1	NK-1
	Lexical					SM-1	NK-1			MC-13	NK-13
8. Chameleon Chameleon	Illustrated									MC-1 SC-6	NK-7
	Lexical	SF-1	NK-1			MM-1	NK-1			SC-5	NK-5

***Note:* MF=main male character, MF=main female character, SM=male secondary character, SF=female secondary character, MC=main character gender unidentifiable, SC=secondary character gender unidentifiable, W=White, B=Black, A=Asian, NK=not known or does not apply**

Summary of main character gender representation. Consequently, although more of the books under investigation for the study had adult male characters in the lexical content, lexical referencing was limited in comparison to adult female characters; however, not statistically significantly different at the $\alpha = 0.05$ level ($W = 24$, $z = 1.71$, $p = .088$, $r = .4$). Although the analysis indicated the total number of lexical references of child female characters were higher than child male characters in the lexical content, it was not statistically significantly different ($W = 2$, $z = .577$, $p = .564$). When the total number of male and female character lexical references were compared, a Wilcoxon signed ranked test indicated a statistically significant difference ($\alpha = 0.10$) between females (4.75) and males (1.88), W=3.5, z = 1.78, p = .075, r = .6; thus, a statistically significant imbalance existed in the lexical representation of characters analyzed as females were more often written about than males.

Main male characters ($M = 13.38$) were portrayed more often in the STEM book illustrations than female characters ($M = 9.63$) for adult or child characters. Adult males were more likely to be illustrated than the adult females characterized in the same books. In summary, child characters were found to have had a greater illustrated representation than adult characters as well male characters were illustrated more than females in STEM literature.

Gender representation of secondary/minor character representation. Four of the eight books contained 72 secondary/minor characters portrayed as male animals, objects and/or persons in the book illustrations, but only two books (i.e., six instances) contained lexical content of secondary/minor characters (e.g., animals, objects and/or persons) described as male (e.g., Mr. Sir). Female gender of secondary/minor characters was illustrated in the same four STEM books' as well. However, only half as many (36) characters were tallied in the illustrations. A

Wilcoxon Sign Ranked test indicated a statistically significantly difference (α=.10) between male (M = 9.0) and female (M = 4.5) illustrative representations of minor/secondary characters, W = 0, z = 1.83, p = 0.068, r = .65 .

Additionally, three books with 14 female characters were indicated in the lexical content; although secondary/minor male characters were found on six occurrences in two books. No significant difference was determined to exist in the comparison between male and female secondary character representation (lexical content). Secondary/minor male characters were statistically (α = 0.10) significantly more likely to be illustrated than written about in the STEM children's literature analyzed, W = 14, z = 1.76, p = 0.078, r = .62, which was the same as found with major male characters.

Summary of gender representation of secondary/minor characters. Similarly to main character representation, male secondary/minor characters were statistically more likely to be seen in the visual content than written about in the lexical content of the books investigated. As well, male secondary/minor characters were statistically more likely to be seen than female secondary/minor characters.

Ethnic representation of main characters. The ethnicity of all of the characters were analyzed in the STEM book illustrative and lexical content (Table 13). As difficulties existed in determining characters' gender, so existed the issue with ethnicity. For example, coders noted defining *other* as the ethnicity was utilized to describe the ethnicity of some robot characters as the "skin color" of the robots varied (e.g., yellow, blue, brown). In addition, because lexical content and illustrative content were analyzed separately and collectively, the determination to whom the lexical content was referring to became problematic. For example, the lexical content sometimes referred to as *you* (e.g., meaning the reader), but the illustrations aligning with the lexical content portrayed specific ethnic characters that differed from the coder; thus, the lexical content and illustrative content differed in ethnicity and presented an issue as to how the coder should record the data. Smith (1995) reported the issue of “contradictory semiotic systems” present in children’s literature and how the discourse can be problematic (p. 305). Coders were directed when a divisive finding was encountered to record the lexical content as comprehended by the coder (i.e., if the coder was white, the lexical content was recorded as white ethnicity). Illustrative content depicting ethnicity was more easily classified by the coders than in the lexical content, which was mainly absent.

Table 13

Ethnic Representation of All STEM Book Characters

	Can’t tell ethnicity	**White**	**Black**	**Asian**	**Other**
Female – Lexical - Child	6	1	1	0	0
Male – Lexical - Child	6	1	1	0	0
Female – Lexical – Adult	6	2	1	0	0
Male – Lexical – Adult	4	2	1	0	0
Female – Illustrated - Child	4	3	3	2	3
Male – Illustrated - Child	4	4	4	2	2
Female – Illustrated – adult	6	2	2	0	0
Male – Illustrated – adult	4	2	1	0	0
TOTALS	40	17	14	4	5

Coders established the main/title character/s did not have an ethnicity or the character’s ethnicity was not able to be determined in four of the eight books (numbers 4, 5, 6, 8). Further, three books had white main characters (numbers 2, 3, and 7) and three had black main characters (numbers 1, 3 and 7); one book had the ethnicity defined as other (number 4). No main characters were identified as having Asian ethnicity. Table 13 indicated the ethnic representation of the all character representations (i.e., illustrative and lexical; main and secondary; female and male) in the STEM children's books, as analyzed by the content reviewers. The ethnicity of most characters either through the lexical or illustrative content could not be determined ($n = 40$) due to the characters being anthropomorphic and/or not human.

Adult versus child ethnicity of all STEM book characters. Adult character ethnicity was less diverse than child ethnicity in the books' characters. For those characters who were decidedly male (i.e., adult and child), coders reported them being the least ethnically diverse. Furthermore, for those characters whose gender was not definitively apparent to the coders, there existed a difference in the varying of ethnic representation between males and females. Those adult characters who were thought to be male were more ethnically diverse than the characters who were thought to be female. Ethnicity for adult male characters was not able to be determined 57% of the time, and male child ethnicity was not able to be determined 88% of the time in the STEM books.

Adult female ethnicity was less diverse than female child character diversity, with 75% of the book character illustrations unable to be determined and the remaining adult characters evenly split white and black. Similar to the female characters, the male characters' ethnicity was better established in the illustrations, than written about in the lexical content. Male children were illustrated as white or black in 50% of the books, Asian in one book, 25% of the books had ethnicity described as other, and 50% of the book character illustrations had an ethnicity that was indeterminable. Adult male ethnicity was also less diverse than male children. Two of the eight books illustrated white male adults, one book portrayed a black adult male, one book had an ethnicity described as other, no books illustrated Asian males, and 50% of the books contained illustrations of adult male characters where ethnicity was indeterminable.

Occupational roles of main characters. The children's STEM books analyzed for the study presented limited representation of occupational roles. Two main female characters, in two separate books (i.e., science and engineering), were represented as a student engineer or a student scientist, which coders viewed as nontraditional/masculine occupations as defined in the content analysis coding sheet in Appendix D. Two male characters, in two separate books which were both engineering were represented as a lumberjack and a zookeeper, which were viewed by the coders as traditional/masculine occupations. No traditional female occupations were presented in either the lexical or illustrative content for main characters.

Additional character representation. Characters were additionally analyzed by the reviewers regarding the illustrative and lexical representation of the following:

1) *Characters names.* Main characters were primarily named gender neutral or non-gendered names (e.g., the lumberjack, robot, truck/machine, Gonk, Chameleon); however, a few had traditional, feminine names (e.g., Aunt Rosie, Beezy, Rosie, Ada). Those characters with gender neutral or gender non-specific names were not necessarily gender-neutral characters as most all characters with gender neutral or gender non-specific names were portrayed as male.

2) *Active or passive participation.* Main characters were represented in the lexical and illustrative content of all books to be active and energetic participants in the stories. No coder perceived the role of any main character as passive. Main characters were seen/perceived as being involved in almost twice as many outdoor activities, than indoor activities. Active participation was characterized by energetic actions/activities, giving rather than taking

advice/help, and being a decisive leader. Passive participation was characterized by not participating or acting compliant, not showing leadership, following or waiting for other's directions, minimal or no physical movement, (e.g., reading, talking, thinking, daydreaming, watching TV). In addition, male characters were tallied as speaking to other characters (i.e., dialogue) thirty-five times in four separate books; however, female characters were reported to speak to other characters in three books twenty-one times. Although the number of interactions either written or illustrated was greater for male rather than female characters, there was not a statistically significant difference (Table 14). Coders reported participation of characters was less likely to be described in the text as compared to being seen in the illustrations.

Behaviors and qualities including:

3) *Curiosity* in the characterization (e.g., investigates, experiments or questions) of main characters was found in four books (32 times), with characters asking questions versus in five books (8 times) characters were answering questions, and five books (57 times) indicated characters were investigating or experimenting.

4) *Assertiveness/aggressiveness and/or bravery/fearfulness.* Three books (six times) were indicated as having the main characters rescuing others versus being rescued (one time). Two books (five times) main characters were portrayed as acting afraid and two books (four times) they were acting brave. Two books' (14 times) main characters were described in text and/or illustrated as acting aggressive and/or assertive.

5) *Tenacity.* Only one book (twice) indicated the main character giving up or giving in when their objective became difficult.

6) *Collaboration.* Seven books indicated 67 occurrences of main characters working in a group of two or more toward a common goal. Additionally, four of the eight books demonstrated immense conversation between characters.

7) *Toys played with.* When STEM book characters were illustrated as playing with toys, the toys were analyzed and determined to be either stereotypically male or female toys. The coders indicated female characters were portrayed (i.e., lexical, illustrative) as playing with non-stereotypical toys 25% of the time, stereotypical and non-stereotypical toys 37.5% of the time or did not play with any toys 37.5% of the time. Female characters were not portrayed at all as playing with stereotypical female toys such as dolls, kitchen ware, etc. in any of the STEM books. Male characters were depicted as playing with stereotypical toys 37.5%, stereotypical and non-stereotypical toys 37.5%, and 25% of the time they had no toys. Moreover, male characters were never portrayed as just playing with non-stereotypical toys.

8) *Caring and/or nurturing.* Three books (three times) represented main characters acting in a caring or nurturing manner (e.g., hugging, kissing or touching kindly) toward other characters.

9) *Feelings.* Characters expressed happiness in six of the eight books (32 times), whereas three books depicted characters as sad (three times). No characters were portrayed as distraught or crying. Two books (3 times) depicted characters yelling, but not angrily.

10) *Stereotypical behavior.* As defined by coders, characters were described as behaving in a stereotypically (female) incompetent manner in two books (7 times). One book portrayed characters behaving incompetently in a stereotypically masculine manner (3 times). The characters were also assessed for any stereotypical play. Two books reported three incidents of

stereotypical female play. For example, the Great Graph Contest portrays a female anthropomorphic character asking another character (male) if the bathing suit she was trying on "makes me look fat." However, 50% of the books had stereotypical male play (19 incidents).

Character interactions. Findings showed more illustrated interactions between main female characters and other secondary characters (female or male) than main male characters and other secondary characters (Table 14). However, main female and main male characters were illustrated interacting more with secondary male characters, than secondary female characters. In addition, although female characters were represented in all books, the technology and engineering books indicated the least female representation. One engineering book (*Simple Machines*) had only one illustrated occurrence of a female character, in a secondary role, with the character being portrayed in a traditional role (e.g., food sales/server).

Table 14

Interactions Between Characters

Interaction between characters[a]	**# of books finding interactions illustrated**	**# of times illustrated**	**# of books finding interactions written**	**# of times written**
MF-SM	5/8	45	4/8	33
MF-SF	3/8	26	2/8	15
MM-SM	4/8	33	1/8	20
MM-SF	3/8	24	2/8	24

Note[a] MF=main male character, MF=main female character, SM=male secondary character, SF=female secondary character.

Lexical representation of the male/female interactions differed slightly than the illustrative representation. Female (main) characters were written about in more books interacting with other characters (secondary – male and female) as compared to the number of books main male characters were written in interacting with secondary characters (male and female). The number of times the interactions were found (comparing female to male) was nearly equal (Female = 48; Male = 44). Furthermore, the main characters were written about interacting more with the opposite sex secondary characters than same sex characters.

Group interactions as opposed to solitary representation were assessed in the books. The STEM children's books analyzed for the study indicated female characters (main or secondary) were more likely than male characters to be portrayed alone rather than in groups (illustrated or lexical). Four of eight books illustrated female only characters sixteen times, and three of eight books wrote about female only characters fifty times. Male characters were illustrated alone nine times in three of eight books and were written about twenty-three times in two of the eight books.

Lexical content supports the findings from the image analysis. The lexical content analyzed and presented in Chapter 4 further supports the alternate hypothesis of RQ1, as well as indicating the bias favors males more so than females.

RQ1: Are the STEM children's literature under investigation biased? If the survey interviews and content analysis found the literature to be biased, was one gender represented more the other?

H_1: Popular selling, award winning children's STEM literature contains gender biased imaging

H1-A*: Popular selling, award winning children's STEM literature contains gender biased imaging favoring males.*

***H1-B**: Popular selling, award winning children's STEM literature contains gender biased imaging favoring females.*

The content analysis further supports rejecting the $H_{1\text{-}A}$ null hypothesis. Lexical content analyzed from the STEM books provided additional evidence female characters were underrepresented in comparison to male characters. Male main characters were dominant in the STEM literature reviewed. Main male characters were more likely to speak than main female characters, in more of the books analyzed. Six of the eight STEM books had main male characters, but only four of the eight books had main female characters. Two books (both by the same author, Andrea Beaty and illustrator, David Roberts) focused on females as the primary character in their book. Although the two books portrayed the female characters as curious scientists, the books also depicted the girls "getting in trouble" for experimenting, tinkering, and performing commonly expected "STEM" behaviors in the lexis. Some of the children's STEM literature presented female characters as unreliable, less than capable or represents female characters little to none in the content (lexical or illustrative). Improvements were still needed to achieve equitable gender representation in children's STEM literature.

Summary Findings of Lexical and Image STEM Book Content

In Chapter Four, the findings of the exploratory study were presented. Early childhood STEM literature contains gender biased images, as well as having an underrepresentation of female characters and adult characters in the illustrative content. In addition, the anthropomorphic characterization of images limits the representative diversity of ethnic groups in STEM literature. Early childhood populations (i.e., ages four years to seven years) were gendering images the researcher had not expected to be gendered (i.e., non-anthropomorphic, non-personified). Lastly, early childhood readers were more likely to gender images as male than female when assigning gender to STEM book illustrations. Prior research demonstrated children were influenced by their environment, including what they read; thus, altering their behaviors, and transforming their self-identity, and ultimately their STEM identity (Aina & Cameron, 2011; Barthelemy et al., 2016;Eddy & Brownell, 2016; Frawley, 2008; Halim & Ruble, 2010; Herrera et al., 2012; Jackson et al., 2014; Martin & Little, 1990; Milgram, 2011; Skaggs, 2011; Steinke, 2005). Chapter Five provides discussion of the findings.

CHAPTER 5: DISCUSSION

Introduction

Hitchen's razor, an English translation of a 19th century Latin saying, was an epistemological razor which stated, "what can be asserted without evidence, can be dismissed without evidence." As the philosophical intent of the saying was to assert whoever made the claim had the burden of proof regarding its truthfulness, then optimistically the findings of this study are evidence to support the claim unintentional latent bias existed in the children's STEM literature investigated.

In this chapter, the researcher includes a discussion of the major findings related to the images tested and the content analysis conducted on the STEM books examined. The chapter facilitated discussion and future research possibilities related to the research questions and hypotheses. Findings were presented as they relate to the research questions and hypotheses posed previously. A discussion of the limitations of the study, areas for future research, and a brief summary of what the findings meant to STEM education and future children's book publications were presented.

Findings and Implications

The following research findings helped to achieve the two-fold purpose of the study: To investigate how children assigned gender to images and to analyze a subsection of award-winning and popular children's STEM literature.

> **Research Question #1 (RQ1)**: Are the STEM children's literature under investigation biased? If the survey interviews and content analysis find the literature to be biased, is one gender represented more than the other?

Favor males. The findings of this study concluded the STEM literature investigated appeared to be latently biased as females were less likely to perceive images as having female gender as compared to male gender and female characters were less likely to be represented in the image and lexical content. All the images surveyed were more likely to be gendered than non-gendered by males and females, and males and females were more likely to gender most image categories as male rather than female. The books that had more observed images of trees, birds, and flowers may have had a more biased view by females. Although the research findings can report the number of images (i.e., categories) found in the STEM books, the researcher cannot assert if all categorized images (i.e., all trees, all flowers, or all birds) would have been viewed as bias by the participant. Further investigation was needed. Although image and lexical content was found to contain bias, lexical representations were not as biased as illustrative ones.

Research had found young males and females between three and six years old) gendered images differently (Greenberg, 2010). Almeida et al. (2014) found sociocultural variables influenced a participant's perspective of images. Although it was expected children would gender animals, the study findings indicated children gendered some animal images more than others, but an association to a sociocultural influencer was not determined from the demographic information acquired (e.g., gender a dog as female because the family had a female dog). Greenberg (2010) found boys perceived dogs as male and liked the images of dogs more than girls preferred them, and this study reported similar results. It appeared males and females preferred the images of dogs in this study for varied reasons and may have gendered them based on sociocultural beliefs (e.g., image number 15 shows a dog wearing a construction helmet, so it was gendered to be most likely male).

Content analysis of the STEM books further supported males being favored in the imaging through a predominance of perceived male gendering in comparison to the lexical content. If young prereaders were prone to attending to the imagery of a book more so than the lexical content (i.e., Nodelman [2000] referred to the prereader as an implied reader), then the pervasiveness of male characterization or those perceived as male may have conveyed an unintended, but overt message that males belong in STEM more so than females. As the images surveyed were common images likely found in early childhood literature, one might have speculated if latent (i.e., perceived) gender bias was common in STEM children's literature collectively. The biased female participants had for some images could demonstrate a need for change in the images designed and disseminated in children's literature.

If researchers maintained that females form insights on career choices and interest in STEM fields from the micromessaging during daily commonplace interactions with media (i.e., television, literature, magazines, billboards), then the study findings suggested a lack of daily role model demonstration/s for impressionable young females in the STEM children's literature reviewed in this study (Christidou et al., 2016; Potts & Martinez, 1994). Prior research indicated subtle environmental factors rather than explicit ones were more likely to affect females (Pennington et al. 2016); prompting the concern of this study to investigate the micromessaging conveyed in the eight STEM children's books and its effect on being a positive STEM role modeling related to STEM identity.

Similar to this study's findings, prior research determined males were more likely to be found in the image and lexical content of children's literature than females (Beraud, 1975; Kolbe & LaVoie, 1981; Weitzman et al., 1972). These studies did not report on the types of interactions between males and females in the lexical and image content. Foster (2014) maintained critical discourse of children's literature required researchers to attend to not only what was actually written and illustrated, but the underlying meanings of written and illustrated content. This study looked at interactions between main and secondary, male and female characters instead of just counting the frequency males or females were seen or written about. Although the number of times male or female characters were represented in the STEM books was nearly equal (i.e., female = 48, male = 44), female characters were most likely portrayed as working alone and not in groups. When main female characters were observed interacting with other characters, it was most likely in a secondary status (e.g., as a helper to a male character). The lack of collaborative representation found in STEM books, between opposite genders particularly with those displaying female leadership and males in secondary roles, potentially was sending micromessaging that girls don't want to, or should not, work collaboratively with boys in STEM, and/or girls are not capable of being leaders in STEM. Honey et al. (2014) supported experiences that would encourage collaboration in STEM as they may transform learners' identities, particularly underrepresented STEM participants, and deter the proliferation of negative stereotyping of STEM females. Further, the 2014 U.S. Department of Commerce Issue Brief #04-11 cited gender stereotyping and lack of positive female role models as contributing to the gender discrepancy in STEM jobs; children's literature was considered to be a concern.

Nuanced representations. The character interactions further highlighted the subtle inequities in the STEM books investigated. For instance, although there was one instance of female character representation found in the engineering book *Simple Machines*, the female character was portrayed in a stereotypical manner (e.g., a food server), and the one black male character was often portrayed passively, not actively engaging in STEM activities. The engineering book subtly isolated females and minority members from being active and important STEM participants. Stereotypical imaging similar to this example was a known sociocultural factor found to deter young underrepresented STEM members from identifying themselves with STEM fields and dissuades them from selecting STEM areas of study as career choices (Christidou et al., 2016; Potts & Martinez, 1994; Shapiro et al., 2015; Wang & Degol, 2013; Weitzman et al., 1972). Additionally, whether or not the lack of female and minority representation was common in all engineering focused literature had not been determined, but there was a greater disparity of representation in the technology and engineering books in this study. The discrimination is of concern due to the overall lack of technology and engineering focused books found to be available at the time the researcher surveyed available award winning or popular selling literature. The underlying issues of poor representation and limited selection in the children's STEM literature genre indicated females and minority STEM members had been exposed bias.

McHugh and Hambaugh (2005) maintained the differences in how males and females communicate was due to men viewing interactions in the world competitively, whereas women view them as social (i.e., women want to create community, but men want to create agency and improve their status). The unintentional portrayal of females working as loners in children's STEM literature could have been due to authors and/or illustrators viewing STEM as a competitive, not a collaborative field. However, this was speculation and could be an avenue for future investigation.

Last of all, the discovery of latent bias may have helped to contribute to the discussion for changing the tone of STEM so men and women are seen as equal STEM participants. Researchers have argued sex role socialization was strongly associated with harassment (Barthelemy et al., 2016; Campbell, Truitt, Herlihy, & Plante, 2017; McLaren & Gaskell, 1995; O'Hare and O'Donohue, 1998; UNESCO, 2017). The finding of inequitable gender representation in STEM literature, particularly books that are common in elementary school libraries and children's homes, may have helped to facilitate the conversation of what was one potential cause of gender role misrepresentation in STEM. Discovering potential causes for bias in STEM areas may help enable changes to be made.

Even with the findings of latent bias in the books, sociocultural nuances should be considered before any comprehensive assertion of intentional bias on the part of publishers, authors, or illustrators. As to why a child was giving gender to a hotdog or a number, these reasons were not answered. Author and/or illustrator intent (i.e., did they intend to have an image perceived as male vs. female) was not known and not considered in the investigation of the images examined in this study. As sociocultural factors were known to affect STEM membership, future inquiry to identify possible sociocultural influencers was needed, as well as additional books needed to be analyzed. The findings of the study speak to the hidden and explicit bias found in the books investigated in this study, not why or how the bias transpired.

Inequitable representation – anthropomorphism. Past research had established the presence of overt and hidden messaging with stereotype bias in historical children's literature (Clark et al., 1993; Ford et al., 2006; Smith, 1995). The response was for publishers, authors and illustrators to negate the gender issues through the use of more "gender neutral" and/or gender balanced imaging and text. Stitt et al. (1988) maintained the changes had not been substantial enough to make a difference in the level of biased content. The findings of this study (i.e., images were likely to be perceived as male), as well as other studies reported a prevalence of biased attitudes toward female and minority representation in STEM fields (Herlihy & Campbell, 2106; Stitt et al.,1988).

If recent reports had indicated trivial improvement in female and minority membership in STEM (Cardno, 2014; Hansen, 2017), one could reason the efforts to provide more equitable STEM media, with the hopes of encouraging inclusiveness and increasing career participation in STEM, were NOT working to support a change in attitudes and inclusiveness of underrepresented STEM populations. The research findings from this study support latent bias was present in the early award-winning and popular STEM childhood literature under investigation; however, the presence of explicit bias was absent. The findings from this study pointed to a different perspective as to what may be the basis for the implicit bias (i.e., the bias was not intentional, it was inherent).

McCreary & Crisler (2005,) supported "the psychology of men is as influenced as the psychology of women by the society and culture in which people live, as well as by the social interactions of everyday life" (p. 2). If Sue (2010) was correct in the assessment of how microaggressive messaging effects an individual and Rahm (2016) asserted picturebooks were a source of practicing stereotype bias and outgroup messaging on a daily basis, then the findings which highlighted the lack of strong female and minority lexical and illustrative representation in children's STEM literature supported the hypothesis of early childhood STEM literature being a source of early childhood development of a stereotyped belief (e.g., women and/or minorities were not good at STEM and/or they do not make good STEM leaders). The connection of how the stereotyped content effected STEM identity was not established from the study. The study established children were perceiving the STEM content as gender biased, not that their STEM identity was lessened. Further inquiry was required to ascertain how the content affects STEM identity.

Children's STEM literature and STEM identity. Prior research found young readers interpreted gender based on their own stereotypical beliefs of what constitutes gender (i.e., what a character wears, or how the character looks or acts), not by the narrative or image content contained in the picture book, thus identity (e.g., gender, STEM) was constructed through a shared belief system which was personalized by varied sociocultural factors (Lave, 1991; Smith, 1995). Findings indicated females and males were most likely to gender the surveyed images as male (Table 10) and content analysis coders perceived the content as having more white male character representation; thus, there appeared to exist a shared belief system as to what constituted male and female gendering and ethnic representation, not necessarily who belonged as members of STEM. Through the shared practice of reading, and potentially rereading, early childhood STEM literature, and learning about what STEM is and who participates via perceived interpretations, young readers of STEM literature may have a biased view of what it means to be a member of the STEM community. How those factors were constructed was complex, but just as children constructed gender identity, they may have constructed STEM identity. Lave (1991) supported the idea of shared community of practice. "Developing an identity as a member of a community and becoming knowledgeably skillful are part of the same process, with the former motivating, shaping, and giving meaning to the latter, which it subsumes" (Lave, 1991, p. 65).

Through discipline-specific representations also known as representational fluency in shared practices such as STEM, children become competent members of the community (Honey et al., 2014). One possibility of the stereotyped construction and/or reinforcement of what it meant to be a member of STEM was through biased children's STEM literature (i.e., shared social construction). There existed a compound bias which may have been damaging STEM identity formation in the underrepresented STEM populations (Figure 25). O'Shannessy (2015) supported the concept of a shared community of practice or a social practice where identity construction was developed through words. Thus, biased media content developed via unintentionally biased societal beliefs, such as males are better at STEM, could have resulted in weaken STEM identity for female and minority members, who then reinforce the social belief/practice through avoiding, not liking and/or failing in STEM fields. Images in the study found to be better preferred by the participants (Table 7) could have been a result of the social practice (i.e., the constructed image representation by the illustrator or the constructed belief by the reader). Social groups (e.g., gender, ethnicity) constructing their appropriate social practice could have identified those images deemed socially acceptable/unacceptable to their group. Thus, if participants did not prefer the image as well or potentially gendered the image based on their shared social belief, then that could have skewed the characters (i.e., more male) presented in the literature making them weak STEM role models. Conversely, the creators of the book content could have created gendered content based on their shared social beliefs, which could have influenced the manner in which the content was presented (e.g., how many or what type of STEM members were written or illustrated and in what manner). As to which, or both, are responsible for the biased content is not known based on the investigation conducted; however, research supports the social practice of reading biased materials may have damaged STEM identities of underrepresented STEM populations (Honey et al., 2014; Lave, 1991; O'Shannessy 2015; Smith, 1995).

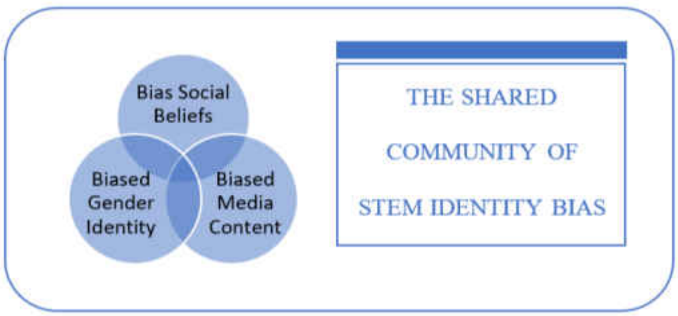


Figure 25: STEM identity bias in a shared community of practice

The findings presented in this study (Tables 4 through 14) supported the existence of latent stereotype bias in the imaging and lexis of early childhood STEM literature. The identification of the bias in early childhood literature was significant due to previous research reporting stereotype bias formation having occurred much earlier than previously identified (Mulvey et al., 2010), and stereotype bias was shown to be a principal factor for the existing gender issues in the STEM pipeline (Aina & Cameron, 2011; Steinke, 2017). Additional research supported stereotype bias was not beneficial to fostering an individual's STEM identity, particularly females who were more affected by implicit messaging (Pavlova et al., 2014). Thus, the implicit messaging shown to exist in the literature investigated (e.g., you are absent, and/or if you are present, then act passively) would not be conducive to fostering STEM membership or a strong STEM identity. Therefore, if females were going to be seen as "ingroup" members of STEM, then stereotyped messaging, either latent or explicit, needed to abate. A first step in aiding in the reduction of the stereotyped messaging in STEM was to identify the existence of such bias in a child's early childhood, and that was realized through this investigation. Additional research may help to ascertain how to overcome the existence of latent bias, as well as additional sources.

In summary, the findings established the children's STEM literature reviewed in this study contained biased image and lexical content. Adults were more likely to be seen than children, the frequency of male characters was higher than female characters, and there was a scarcity of ethnic representations. The lack of relatable STEM role model representation found to exist in the investigation could have been initiating and/or reinforcing STEM stereotype bias and damaging STEM identity through the shared practice of reading early childhood literature. The biased content could have been a possible contributing factor to stereotype threat influencing children to believe STEM was not for girls or minority populations.

Research Question #2 (RQ2): Do sociocultural factors of readers (e.g., gender or language) affect a reader's perception of images in STEM literature?

Findings from the analysis of the data which investigated a relationship between perception of gender for an image, the gender of the participant, and how much they preferred the image indicated 60% of the images matching the gender of reader were preferred significantly more than ones perceived as not matching the participant's gender. The importance of this finding, in addition to discovering children were gendering images in unexpected ways, was the message this study conveyed to the creators of STEM content for young learners. There was a need to take into consideration how the child reader interpreted the content, not only what the creator intended.

The unexpected finding related to gendering of images by ELL participants was there was not an association between language and genderization of images for most all the images surveyed. Sato et al. (2016) found readers did gender literary content dependent on their native language, not based on lexical or image content. However, the participants in the Sato study were older (*M* = 22) and the study considered German and French languages. Thus, age and/or language may have an effect on how images were gendered.

In this study, although statistically significant differences were found with the specific images tested, the significance does not appear to be related to the language the participant speaks. For example, although Spanish and Portuguese speakers gendered the word *hotdog* as male, 20% of Spanish speaking participants gave no gender to the image and the two Portuguese speakers gendered the image female. The images were not gendered as defined by the gendered article of the noun/word and language did not seem to dictate how the image was gendered in this study. Portuguese speaking participants predominantly found the food or food type images (i.e., fish) to be gendered female, even when the gendered article for the word was male. Perhaps the genderization of the images may be associated with sociocultural influencers such as, food words/images with a mother's cooking, not the participants' primary spoken language. Another explanation for this finding may be developmental the article differences in these languages may not be known at the developmental age of the participants in this study. Flaherty (2001) contended "in a language with a grammatical gender system, such as Spanish, the gender system creeps into perception *after* the gender tags have been acquired" (p. 1). Further research is needed to determine genderization based on language.

Research Question #3 (RQ3):

Do readers gender images not expected to be gendered?

All images tested, which included anthropomorphic and inanimate objects, were significantly more likely to be assigned gender (e.g., male and/or female) than to not be assigned a gender. Shutts et al. (2010) found children categorized objects (e.g., food, numbers, houses, flowers, vehicles) based on the gender role of the individual who stereotypically used the object (i.e., a female uses dishes to cook so the dishes are for females, not males). Where Shutts et al. found children were influenced by people who were interacting with the male or female objects, this study did not include characters with the image of inanimate objects, thereby character or human influence was removed as an influencer. In this study, children were gendering inanimate objects. One possible conclusion as to why they may be assigning gender to inanimate objects may be that the children associated the object with a particular gendered individual (e.g., mom or dad). For example, two houses (image numbers 37 and 40) were gendered by participants. Children may be associating the house with the person (i.e., parent or guardian) with which they lived. Further investigation and analysis of sociocultural influencers could be considered in future studies. What can be defended from the findings of this study was children were gendering inanimate objects; thus, the STEM children's books considered in the study may have communicated outgroup messaging to readers due to how the image and lexical content were being perceived. Children's sociocultural differences should be considered when creating and disseminating children's STEM literature. As to how those differences should be addressed is not yet answered from this study.

Likewise, anthropomorphic images were gendered more than non-anthropomorphic images, which was expected based on prior research (Smith, 1995). In addition, research reported participants preferred anthropomorphic images (Plass et al., 2014). This study had similar findings. The STEM books contained more personified (n = 25) than anthropomorphic (n = 7) imaging and indicated personified and anthropomorphic imaging was gendered more than non-personified and non-anthropomorphic imaging (e.g., photograph of a frog in image 26 – non anthropomorphic – compared to a personified frog in image 31). In addition, Smith (1995) found young readers gendered anthropomorphic characters based on sociocultural factors, regardless of lexical content; however, the content analysis of this study did not examine the same comparisons. This study extended Smith's research to identify children's perceptions of non-anthropomorphized characters or inanimate images; a comparison Smith did not address. Other research discovered readers' misrepresentation concerning recall of factual story information was due to existing gender bias (Frawley, 2008). The discovery from this study of children gendering objects not expected to be gendered (e.g., inanimate, non-anthropomorphic, and non-personified) could shed light on why children were misremembering factual lexical content from a narrative, as was found in Frawley's 2008 study. Anthropomorphic imaging, particularly expected gender-neutral characters (i.e., fish, turtles and dogs) were quite common in early childhood literature, but the findings herein did not support those images being gender-neutral.

Anthropomorphic characterization. Researchers have maintained role models are necessary for female and minority STEM participants (Ertl et al., 2017). As researchers have maintained real life images versus caricature type images (i.e., anthropomorphic or personified) gave stronger meaning (i.e., role modeling) to the reader (Nikolajeva, 2010), the findings from the literature analyzed for this study did not appear to support the STEM literature as providing good role modeling for underrepresented STEM populations (i.e., female participants perceived surveyed images as male and the coders identified a lack of equal minority and gender representation in the STEM books). Only one of the STEM books analyzed (*Chameleon, Chameleon*) contained real-life photo imaging, and the book contained animals, not humans. Cowley's book was the only book investigated that found no significant difference in the images when analyzing a relationship between the gender of the participant and the perceived gender of the image. Additionally, of the books analyzed, six coders could not conclusively determine the ethnicity and/or gender in mostly secondary characters of 35 book characters. The researcher argued since coders were unable to determine the gender and/or ethnicity of many book characters, it was not surprising children surveyed in this study did not also. What kind of role model could anthropomorphic or personified characters have been to the underrepresented STEM populations? STEM readers needed STEM role models that looked like them. However, over half of the books analyzed in this study had zero observations recorded of perceived female characters and half of the books had no identifiable ethnicity in the writing and/or illustrations of the books, as evidenced in the content analysis Stitt et al. (1988) contended that this type of perceived bias was a form of *fragmentation and isolation*-type bias. Underrepresented STEM populations which did not perceive the image as looking or acting like they do may not see themselves as potential STEM members (Dagley et al., 2016; Eddy & Brownell, 2016; Milgram, 2011; PCAST, 2012; Simon, et al., 2015; Vezeau et al., 2000; Watson et al., 2000). This researcher argues if the intention of STEM children's literature included building a stronger

STEM identity in young children and research has shown real life imaging provided strong role modeling to underrepresented STEM populations, then the use of anthropomorphic characters in early childhood STEM literature should be diminished and replaced by more beneficial real-life role model images (Ertl et al., 2017; Ganea et al., 2014; Liben et al., 2002; Nikolajeva, 2010). Liben et al. (2002) supported real life imaging as their research maintained that children create and/or sustain occupational stereotypes based off of their sensitivities to narrative and image content (i.e., their sociocultural developed biases). Through the implementation of real-life role models and not anthropomorphized characters, children may develop an awareness for the diversification of what the STEM society looked like worldwide, and ultimately have seen themselves and others, particularly underrepresented populations, as members of the STEM community (Ertl et al., 2017; Ganea et al., 2014; Liben et al., 2002; Nikolajeva, 2010).

Inequity in female and ethnically diverse roles. Although no significant differences in gender representation were found to exist in the lexical content of the books examined, issues needed to be addressed. For those characters whose gender was able to be determined by coders in the illustrative content, the researcher found that perceived male characters were statistically significantly more likely to be seen in the STEM books than female characters. If perceived primary and secondary male characters were statistically more likely to be "seen" in early childhood STEM literature and considering Nodelman (2010) asserted pre-readers will often "read" books by scanning through the images due to their inability to read the lexical content, then girls may be getting the message STEM was for boys and not girls, even if the lexical content was nonbiased.

Ethnic diversity was lacking in the STEM literature analyzed due to the use of anthropomorphic characterization. Adult character ethnicity was less diverse than child ethnicity in the books' characters. Characters perceived as male were reported to be the least ethnically diverse. Thus, the perception of characters was male dominated in the illustrations as well as coders being unable to ascertain ethnicity of more than half the character representations due to the anthropomorphic and personified characterizations. The books analyzed lacked ethnic diversity. For example, one of the engineering books (*Simple Machines*) had two main characters (e.g., one black and one white, both male) represented in the engineering book, and a frequently seen secondary animal character whose gender was unable to be determined. Although, the book attempted to represent more than one ethnicity, all characters in the book, except for the one black character, were portrayed as white. The analysis revealed not only was the black character only seen nine times as compared to the 21 times of white characters, but more active participation was exhibited by the white main character in comparison to the black main character. Based on these findings the latent messaging was white males are more likely to be engineers. Thus, just as females were receiving micromessaging that males belong in STEM more than females, minorities may be receiving biased micromessaging based on underrepresentation of ethnicity and culture. The disparity of gender and ethnic representation in this study confirmed Miller and colleagues' metanalysis and others' research for the need of better representation (Kunjufu, 2014; McIntyre, 2017; Miller et al, 2018; Varelas, Kane, and Wylie, 2012)

The books analyzed for this study showed a lack of minority characterization, particularly of the adult characters who may have been role models to readers. The biased belief that scientist were white men, particularly from young boys, could be reinforced by the repeated exposure to early childhood STEM literature perceived as biased by the child. Varelas et al. (2012) supported the need for better representation of black role models for young black scientist. Kunjufu (2014) maintained young minority males and females need strong adult role models in STEM to perceive themselves as ingroup members of STEM. To help overcome the incongruity dilemma reported by Ford et al. (2006) placed on young minority and female STEM participants to either be smart or be popular required a decrease in the usage of anthropomorphic imaging, and an increase of real-life adult STEM role models. Less than half of the adult characters' ethnicity in the books analyzed for this study could be determined due to the use of anthropomorphic characters. Thus, there appeared to be a lack of role models for young underrepresented minority STEM members in early childhood STEM literature. Considering Mayer's (2009) multimedia signaling principle, learners attend better when text was combined with visuals. Further, if the message being signaled to young future STEM members was girls and ethnically diverse people were absent or stereotyped in the narrative or the images, then the message being delivered may be that people who are not male and/or are not white do not belong in STEM (Ambady et al., 2004; Ambady et al., 2001; Davies et al., 2002; Eddy & Brownell, 2016; Good et al., 2008; Hill, Corbett, St. Rose, & American Association of University Women, 2010; Shih, Pittinsky & Ambady, 1999; Steinke, 2017).

Improvements made in children's literature. A few areas of children's literature seemed to be improving. The first improvement in comparison to prior content analysis studies of children's literature was the occupational roles of main characters (e.g., stereotypical occupational roles for females characters; Liben et al., 2002). Occupational stereotyping in the early childhood STEM literature analyzed herein was almost non-existent. The current study found that although there was limited representation of occupational roles for females in general, no traditional female occupations portrayed in either the lexical or illustrative content for the stories' main characters were reported. Two relevant examples of STEM occupational roles presented in the books were the characters were represented as a student engineer and a student scientist. One secondary character in a different engineering book (*Simple Machines*) was portrayed as having a stereotypical job as a food server, but no other stereotypical occupational role was reported being seen in any of the books. Having stereotypically traditional character roles minimized in literature was encouraging, particularly in STEM literature; however, the overall lack of real-life occupational role modeling in the STEM literature was problematic. Researchers cited books as important cultural message transmitters which guide gender role career aspirations (Shapiro et al., 2015). This deficit of positive, real-life STEM role models was viewed as a concern in the children's STEM literature genre.

Secondly, Weitzman et al. (1972) and Foster (2014) found female characters were often portrayed as inactive/passive, relegated to indoor activities, and less likely to speak. Main characters in all lexical and illustrative content were presented as active and energetic characters, with the characters being almost twice as likely to be involved in outdoor activities, than indoor activities. As many science and engineering fields require outdoor behaviors, the role modeling of characters working and/or playing outside may have aided readers to perceive the behavior as acceptable. Smith (1995) supported positive female image representations for children. Although the books analyzed showed male characters having a greater dialogue than female characters, there was not a statistically significant difference. The content analysis indicated verbal or physical character participation was less likely to be described in the text as compared to being seen in the illustrations. Implications of this finding confirm Nikolajeva (2010) assertion that images were two dimensional representations of a three-dimensional world. Further, she and Smith (1995) noted that images and narrative were critical in developing identity. Therefore, the lack of positive real-life role models may deter females and minorities from developing a strong STEM identity.

Lastly, females had an increased presence as title characters, main characters and frequency in illustrations. The improvement resulted in a better ratio of male to female character representation in the literature. However, male main characters were still reported as being dominant in the literature. In spite of the improvements perceived, the combining of the content analysis findings from the coders, with the findings of children's perceived genderization of the images, produced a worrisome assessment of the current state of gender representation in children's STEM literature. Improvements in the representation of female and minority populations in early childhood STEM literature as a sociocultural role model may be essential to the development of a diversified STEM community.

Limitations of the Study

The study contained limitations that incumbered the investigation. The first limitation related to the study design itself. The mixed methods, exploratory, sequential research design was considered limiting due to its complexity of evaluations and increased data collection (Wisdom & Creswell, 2013). The deductive process of the design was unable to produce any "truth." However, the findings could guide the researcher. The exploratory research assisted in the discovery that children may have gendered images that adults didn't think they would. The discovery of a new construct (i.e., genderization of images) now allows researchers to design and develop more rigorous research projects to better investigate the phenomenon.

The method of analyzing the data was a limitation. The researcher did not analyze the type of interaction between characters, only a frequency count of these interactions. Foster (2014) identified female characters as having restrictions to gendered ways of being, such as being told to behave calmly, speak softly, and not act wildly or be explorative. The semiotics of story were as important as frequency and were not assessed for the study. Future analyses could consider the character interactions as a sign of how someone in STEM behaved.

Next, the anthropomorphic images made content analysis difficult to interpret. For example, the coders were not capable to assign gender and/or ethnicity to 35 book characters. Additionally, 25 characters' genders were ambiguous enough to be labelled gender neutral/nongendered. The result was the data findings and conclusions may have been wrong. Due to the nature of the content being analyzed, the research could not control for the limitation.

There was a chance that participants did not respond to the interviewing of the images accurately or truthfully due to their age of between four and seven years old (Krahenbuhl & Blades, 2006). If the data collected were not accurate, then the data findings and ultimately conclusions would be misguided. Although there was the potential of unforeseen factors having altered the participants responses, the researcher contended further investigation was needed. As it was necessary to attain children's perspectives of the image content, the limitation cannot be overcome.

Additionally, the use of the pictorial Likert scale had been contended in the literature (Laerhoven & Douven, 2004). Some researchers maintained that Likert-type scales were weak and an inaccurate means of assessment (Laerhoven & Douven, 2004). Krahenbuhl and Blades (2006) supported interview techniques that provided protocol for the child and would put a child at ease. Therefore, as children between four and seven years old) were considered to be familiar with what a happy or sad face signified, the use of a Likert pictograph was deemed appropriate and considered to be the best method for obtaining authentic responses as supported by the child development specialist advising in the designing of the study.

Next, there could be confounding variables in the study which could have changed the results. Image number 44, a dead fish on a plate, could have been viewed by some participants as an animal but by others as food. The researcher categorized the image as a fish, but the designation may not have been accurate. Additionally, two of the books had the same author/illustrator. The images of the two books were “reused” by the author/illustrator, thus the images could be accused of being double counted. The reuse of images via either type and/or likeness by the book creators was a common occurrence in children’s literature and was a basis of the researchers argument for the need to identify biased-content in children’s literature.

Lastly, the STEM books may have been written for content and no other purpose, but author and/or illustrator intent was not an element of this study. Since the books may be for entertainment purposes and not for fostering STEM participation, the researcher would argue that the literature should not be marketed as STEM literature. However, Amazon and the CLCD listed the books as STEM literature. The selection of books for analysis, which was the foundation of the study, were arguably a limitation. Amazon and the CLCD lacked technology, engineering, and math STEM literature to analyze. The difficulty was not with the databases presenting the literature, but the deficiency of literature available on the market.

Prior studies had used historically eminent awards such as Caldecott or Newbery to define award-winning books. It could be argued the book awards were not prestigious enough for the books to be considered award-winning literature, thus it could also be argued the books investigated were inferior and were a limitation to the study.

Additionally, no electronic books (eBooks) were included in the investigation due to the fact that book content in eBooks may have been different from those found in print publications (e.g., size, color and/or amount of image content). Lastly, even though the researcher sampled fifty images for child participant survey testing, a sizeable number of images, the exploratory study sampled only eight STEM books by seven illustrators and authors for the content analysis; thereby, making the findings problematic to generalize. Since some of the image survey findings were statistically significantly different, the researcher can only conclude those books investigated and, by extension, the lexical content and/or illustrations found to be significantly different were biased. The generalization of all image and lexical content in the STEM literature investigated should not be considered bias, nor should the eleven image categories. Further investigation of additional images and image types from other media content (e.g., children's books, magazines, TV shows, and movies), however, is merited.

Contributions to the Field

The research design implemented in this study allowed for an investigation which introduced new methods and findings in the field of children's literature content analysis. By first selecting popular *and* award-winning children's STEM literature to investigate, the researcher initiated a contemporary and innovative line of research in children's literature. The progressive examination of the literature content allowed for a novel content analysis method that may be significant to future literary analysis.

The method of analyzing book image content was found effective. Visuals in groupings were not being attended to on an individual level by a reader, even though studies frequently counted images in the traditional manner. Children's books can be reread to children; thus, they attend to a multitude of images within each reading of the book. Coders conducting the content analyses for the study counted each illustration of a male or female in a group individually. Future content analysis studies would benefit with a similar design.

The purpose of this study was to research and identify how children gendered images in children's STEM books, a previously unexamined genre of early childhood literature. The exploration of early childhood STEM literature for latent bias was intended to discover a possible stereotype bias in children's STEM literature. This study identified that children not only gender categories of objects (Shutts et al, 2010), but individual objects as well. The study identified specific image subcategories having latent bias (e.g., trees, birds, flowers), in addition to discovering children gave gender to inanimate, non-anthropomorphized images, which the researcher did not expect children to gender. The discovery of latent bias within the selected image content may help to improve educational and literary image subject matter for future benefits and continue the inquiry into additional sources of bias and stereotype threats in STEM. These discoveries were critical to recognizing children's unique manner of interpreting their world as it relates to STEM role models. A contemporary line of investigation has been identified for further research.

Recommendations

Future research should include child perception/s of gender ambiguous characters. Future investigators of STEM literature might consider a content analysis study to encompass children's complete perceptions of image and lexical content in context as they read books instead of isolated images. If children's pictures books can offer an effective intervention to fight stereotype bias as supported by Anderson (2013), then incorporating the child's perspective may avoid unintentional, yet biased content.

Regarding the instrumentation, acquiring additional socio-cultural information on the parent demographic sheet may support further inquiries of socio-cultural influences. The researchers inability to identify why some images were gendered in unexpected ways may have been due to unknown factors in the child's life. For example, why were children gendering houses? Determining who the child spends most of their time with at home could give some indication. Participants were asked their favorite animals but not if they had pets or the gender of the pet, thus the gendering of the animal images could not be associated with sociocultural factors.

Looking from a sociocultural perspective may help with outgroup identification. Through analysis of the potential sociocultural covariates, social identity theory may explain why one group of participants (e.g., ethnic, gender, religion) viewed an image similarly. Although the research did obtain some sociocultural influencers, the exploratory study better defined new factors to consider for future research including, parent marital status, pets' gender, and the child's favorite colors. These additions may provide answer as to why some of the inanimate objects were gendered. Self-categorization and self-identity theory may aid in understanding why participants gendered and preferred inanimate object images as they did.

Future research could consider authors/illustrator's intent. No published study was found to exist, and no investigation to date focused on the gendering of images and lexical content from the authors/illustrator's perspective. The study would be informative and assist in determining if the bias was indeed purposeful or if the content has not been intentionally biased. Just as the children in this study did not perceive the STEM literature as expected, it is unknown if authors' and illustrators' were aware of the perceived latent bias found in this study.

Lastly, since this study has shown anthropomorphic imaging is not a good means to achieving gender neutrality in the imaging of children's STEM literature, the researcher would discourage the use of anthropomorphic imaging in early childhood STEM literature. The findings from this study supported the argument that anthropomorphic images were not perceived as gender neutral, even when the illustrations seem to be intended to be gender neutral (i.e., a dog not dressed in clothing and no gender or sex was displayed for identification, including lexical content description). If early childhood readers were unable and/or unwilling to consider a character's traits and attributes due to the child's developmental level (Martinez et al., 2002), and the choice of book illustrations in early childhood literature have been acknowledged to give an improper view of people working in the world (Stitt et al., 1988), then there was a high likelihood readers may have formed a specious view of STEM workers in the world due to the use of anthropomorphic characterization in early childhood STEM literature.

Children use role models in their developmental process to learn about their world and by exchange model what they see and perceive. Because of this, the utilization of anthropomorphic characters versus real life representations may have been detrimental to the development of a child, potentially including their STEM identity (Stitt et al., 1988). If young readers were not gendering characters in children's STEM literature as intended by book authors and illustrators (i.e., gender biased findings of this study), then the STEM literature may have inadvertently provided a bad role model. Sadker & Sadker (1994) maintained when females do not see themselves in books, it damaged their self-identity. Nikolajeva (2010) and Ganea et al. (2014) maintained real life images had a stronger degree of fact for the reader as compared to fictional images (i.e., anthropomorphic or personified). Thus, anthropomorphic images were not good role models because readers didn't see them as real, in addition to the potential for the viewer to gender them in unforeseen ways. It is this researchers recommendation to implement real-life images in early childhood STEM literature.

Summary

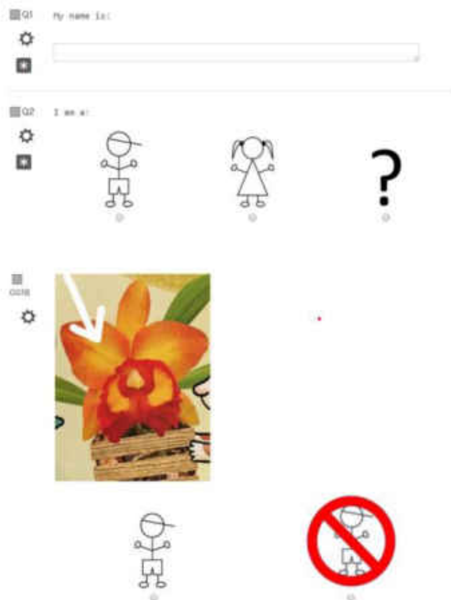
The findings in this study should encourage publishers, authors, and illustrators to consider approaches for dealing with gender and ethnic bias in children's STEM literature, such as the reduction of anthropomorphized and personified imaging, as well as gender neutral lexical content, as in this study children gendered images. In addition, consideration of the findings can be used beyond the books investigated herein and applied to additional supplementary and complementary subject matter (e.g., marketing, publishing, and educational STEM materials). Popular media content had been shown to frequently use anthropomorphized and personified characters, in addition to inanimate objects. The finding of inanimate objects being gendered was novel and significant. Image content should be considered from a child's perspective. Due to the findings of the exploratory study, further inquiry was needed to investigate more and varied types of image book content, particularly with more wide-ranging age groups.

The findings are significant to the future development of media content; however, it was important to acknowledge not all biased content can be controlled. The argument had been made that sociocultural influencers moderate perspective; thus, authors and illustrators of children's literature and academic STEM content, etc. cannot control for all possible perspectives concerning how a viewer might perceive an image or lexical content. Research has supported that the acknowledged sexism, like that reported in this study, has the ability to increase the recognition of future occurrences (Great Schools Partnership, 2015; Sadker & Sadker, 1994).

Additionally, the theoretical framework as shown in Figure 2 applied to this study defined an innovative method of non-biased examination for stereotype and bias content. By including cognitive and behavioral theories in the examination of early childhood STEM literature, probable internal and external influences were included. The framework developed by this research can support a balanced theoretical perspective to apply to future studies in STEM and it may assist with follow up investigations related to stereotype threat.

The study filled a research gap concerning children's perceptions of inanimate objects and gendered view of images. In addition, the study addressed the problem statement: *Do children assign gender to objects themselves?* Participants were found to be more likely to give gender to images than to non-gender them, and prefer those images they perceived as being their same gender. Furthermore, females were found to be most likely to gender images and least likely to prefer them, in comparison to males. The gendering was found to be significantly higher for anthropomorphic images than for non-anthropomorphic images and for personified inanimate images than for non-personified inanimate images. The determination that the images in the literature, which were presumed to be gender-free, were in fact communicating outgroup messaging to the reader, has initiated a new line of stereotype bias research. The identification of children's unconscious, biased perceptions of common children's images may facilitate the production of non-biased imaging in children's STEM literature, marketing, and other imaging products.

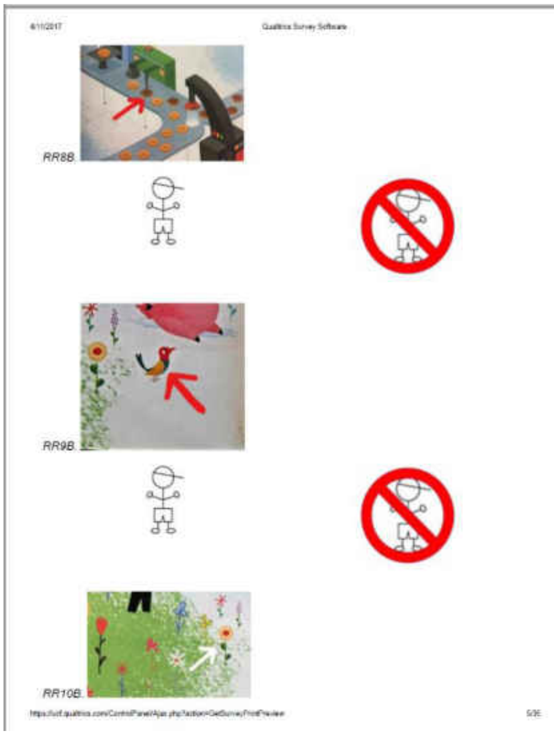
APPENDIX A:
QUALTRICS CHILD SURVEY # 1

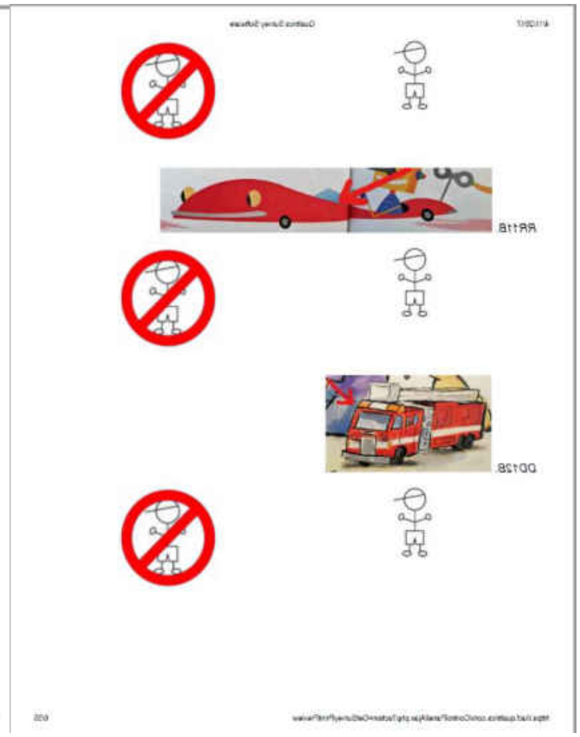

Q1
My name is:
Q2
I am a:
?


GG2B.
GG3B.


GG4B
GG5B


4/11/2017
Qualtrics Survey Software
RR6B.
RR7B.


Qualtrics Survey Software
RR8B.
RR9B.
RR10B.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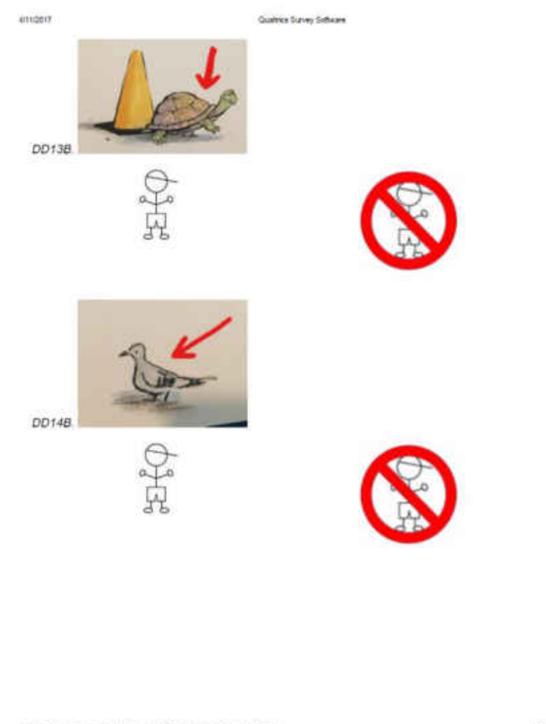
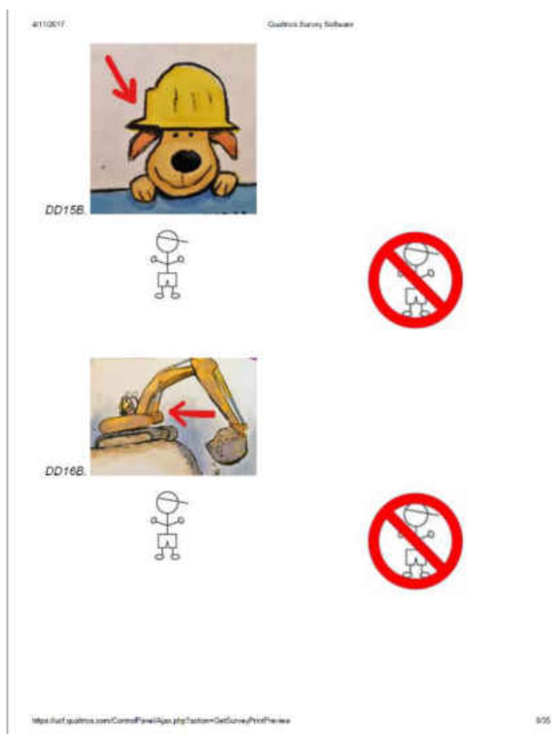
DD12B.


Qualtrics Survey Software
DD13B.
DD14B.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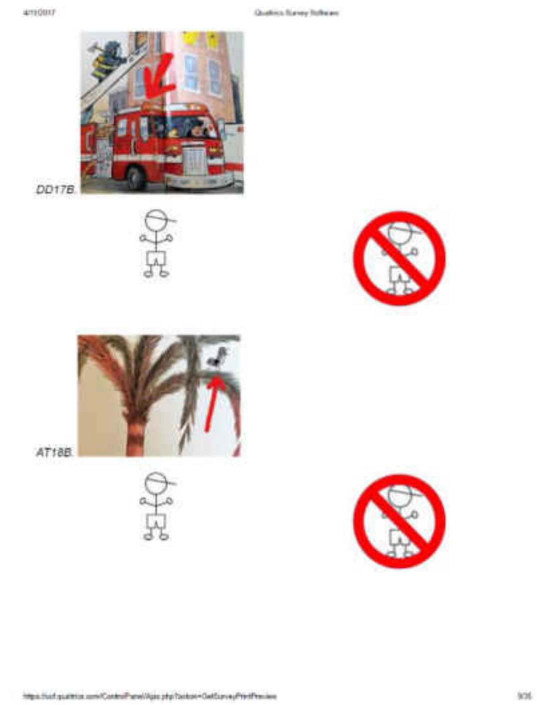
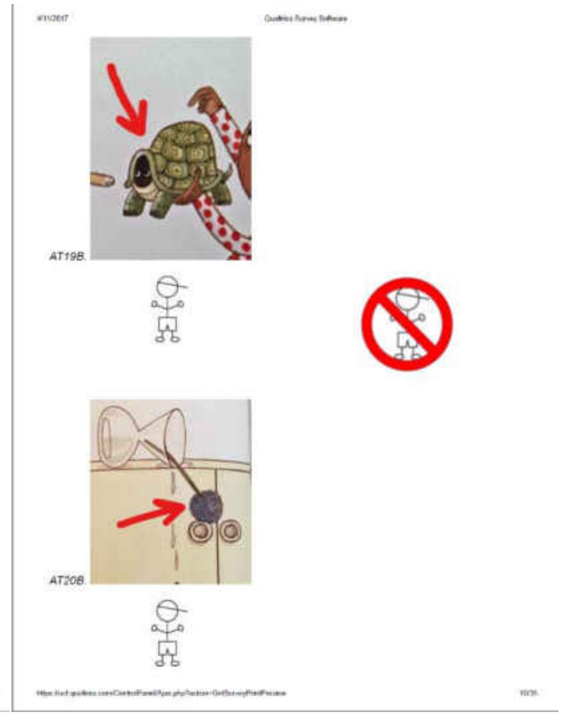
DD16B.


DD17B.
AT18B.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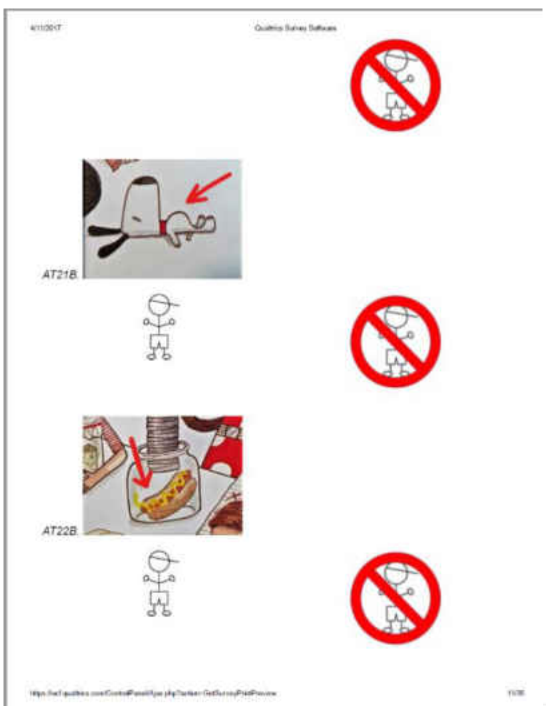
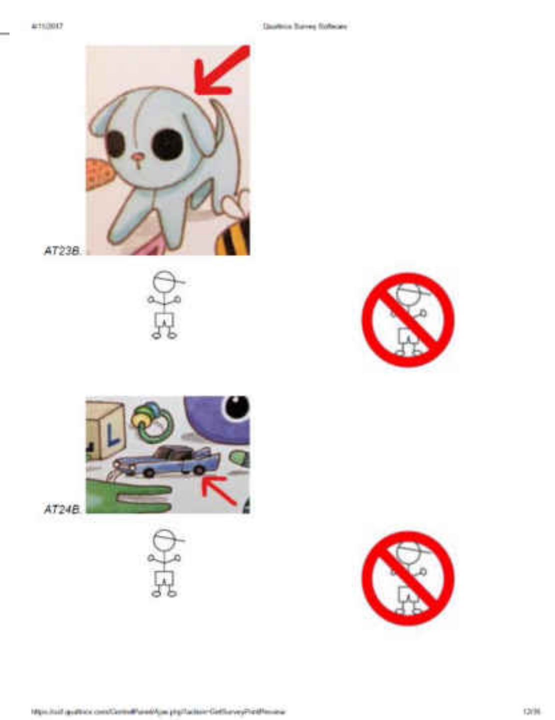
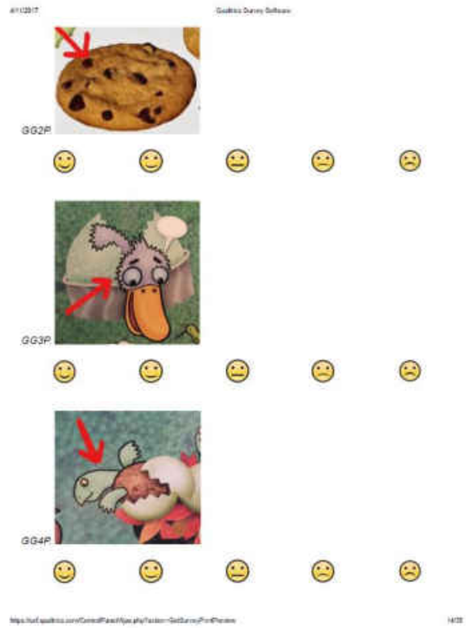
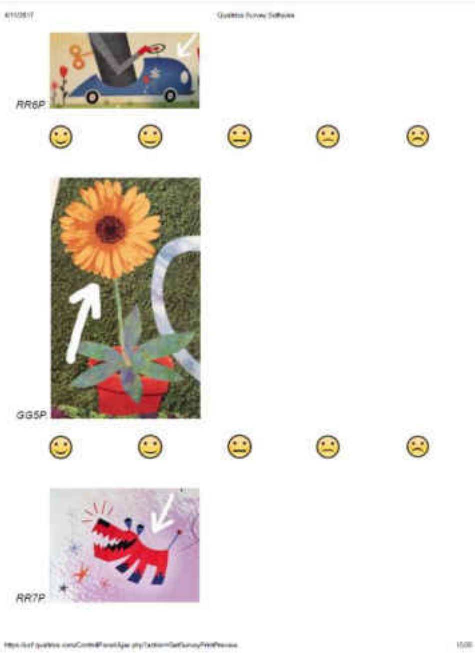
AT20B.

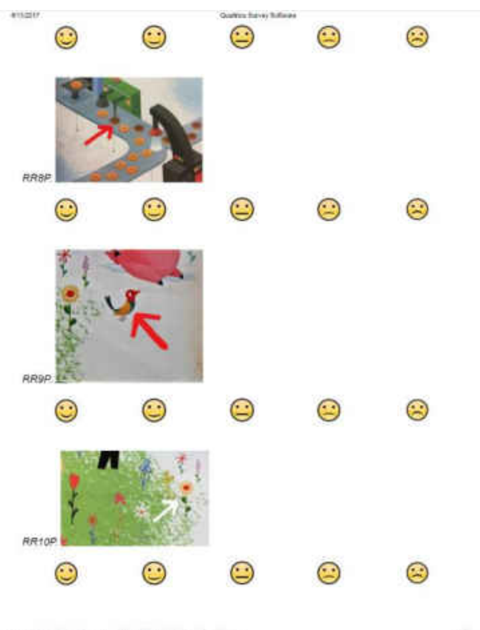

AT21B.
AT22B.


AT23B.
AT24B.


AT25B
GG1P


GG2P
GG3P
GG4P


RR6P
GG5P
RR7P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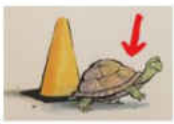
RR9P
RR10P


RR11P


DD12P


DD13P


DD14P

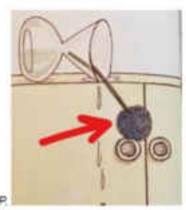

DD15P


DD16P


DD17P


AT18P


AT19P


AT20P


AT21P


AT22P

AT23P.

AT24P.

AT25P.

APPENDIX B:
QUALTRICS CHILD SURVEY # 2

Default Question Block

Q1. My name is:

Q2. I am a:

CC26B.

CC27B.

CC28B.

DD29B.

DD30B.

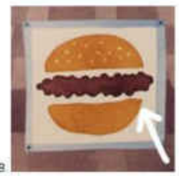
DD31B.

SM32B.

SM33B.

SM34B.

SM35B.



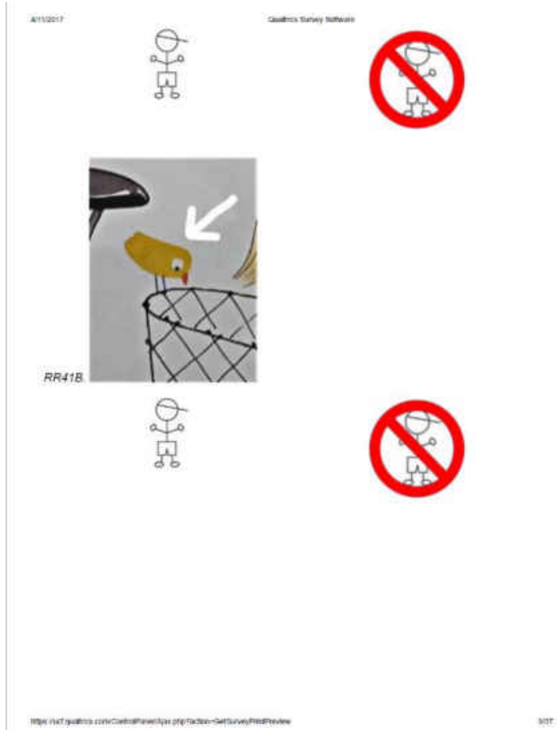
SM36B.

SM37B.

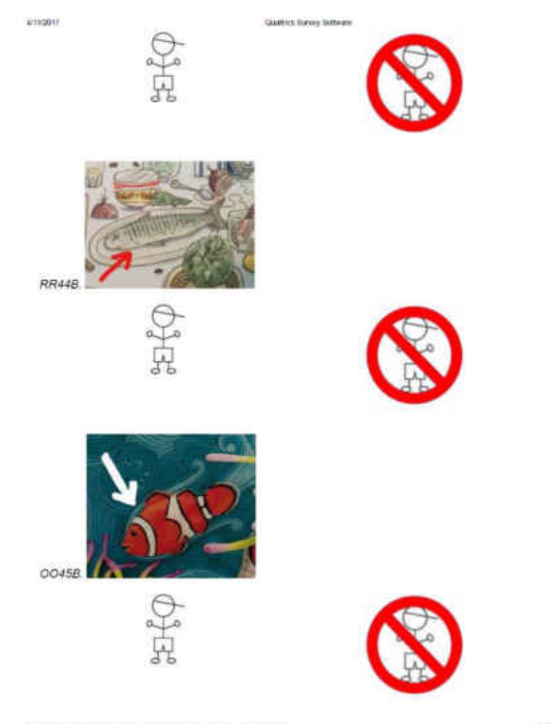
SM38B.

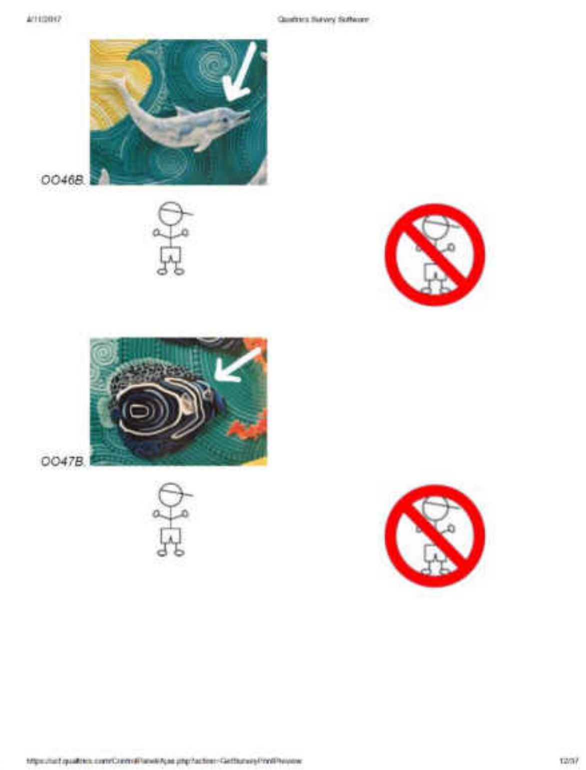
RR39B.

RR40B.


RR41B.


RR42B
RR43B


RR44B.
OO45B.


OO46B.
OO47B.

OO48P.

OO49P.

AT50P.

APPENDIX C:
PARENT SURVEY

Discovering latent gender bias in children's STEM literature images

Parent Survey

1 - Child's Name (First & Last)

2 - Name of child's school

3 - Child's gender (circle one)

Boy Girl Non-Conforming

4 - Primary language spoken at home

5 - Other languages child speaks or child hears daily

6 - Child's date of birth - Month/Day/Year (ex. 12/25/12)

Month Day Year / /

7 - Child's ethnic background (ex. Asian, Hispanic)

8 - Please list any other states or countries in which your child has lived or spent extended time periods during their life.

9 - Please list any of your child's favorite animals

10 - Please list any toys your child plays with frequently (ex. trucks, blocks, dolls)

11 - Please list your child's favorite foods

12 - Which family members live with the child? (ex. Grandmother, sister, uncles)

13 - Parent/s job or occupation - Mother, Father or Guardian/s

14 - Does your child participate in the free or reduced lunch program in school

15 - Please let us know any other information that you feel may help us to understand your child's preference for or against images/pictures.

Optional: Please circle any of the following that might describe your family and better helps us to understand family environmental influences

Conservative	Buddhist
Liberal	Sikh
Progressive	Other religion
Republican	Non-denominational
Democrat	Traditional
Independent	Non-traditional
Libertarian	Other: ________________
Green Party	
Non-voter	
Catholic	
Protestant	
Jewish	
Muslim	
Hindu	

APPENDIX D:
CODING SHEET FOR CONTENT ANALYSIS

Rater Name: ______________________________

Rater's primary language spoken: ________________ other languages: ________________

Book Title: ______________________________

Author/s name/s: ______________________________

Author/s sex: (circle one)

Female Male Both Can't tell

Illustrator/s name/s: ______________________________

Illustrator/s sex: (circle one)

Female Male Both Can't tell

Type of story: (circle all that apply)

Human Animal Object

Anthropomorphic Non-Anthropomorphic

Gender of main/title character(s) (explicit or implied): (circle all that apply)

Female Male No Gender Gender Neutral

Ethnicity of main/title character(s) (explicit or implied): (circle all that apply)

None White Black Asian Other (list): ____________

Count the number of female characters (written as she, her, etc.):

Children ______ Adults ______

Count the number of female characters (pictured in images – no question as to gender):

Age: Children ______ Adults ______

Ethnicity: None/Can't tell ____White _____Black: _____Asian ______Other (list): ____

Count the number of male characters (written as he, him, etc.):

Children ______ Adults ______

Count the number of male characters (pictured in images – no question as to gender):

Children ______ Adults ______

Ethnicity: None/Can't tell ____White _____Black: _____Asian ______Other (list): ____

Count the number of characters you believe to be female, but not positive (pictured in images):

Children ______ Adults ______

Ethnicity: None/Can't tell ____White _____Black: _____Asian ______Other (list): ____

Count the number of characters you believe to be male, but not positive (pictured in images):

Children ______ Adults ______

Ethnicity: None/Can't tell ____White _____Black: _____Asian ______Other (list): ____

Count the number of non-gendered or gender-neutral characters (written as us, we, them, they, it, etc.):

Children ______ Adults ______

Ethnicity: None/Can't tell ____White _____Black: _____Asian ______Other (list): ____

Count the number of non-gendered or gender-neutral characters (pictured in images):

Children ______ Adults ______

Ethnicity: None/Can't tell ____White _____Black: _____Asian ______Other (list): ____

Is there a main female character?

Yes No

If yes, what occupation does character present, if any: ______________________________

Do you consider the occupation to be: (circle all that apply)?

Nontraditional Traditional Neutral

Masculine Feminine Gender Neutral Non-gendered

Is there a main male character?

Yes No

If yes, what occupation does character present, if any: ______________________________

Do you consider occupation to be: (circle all that apply)?

Nontraditional Traditional Neutral

Masculine Feminine Gender Neutral Non-gendered

Some examples of jobs considered traditional for gender – Nontraditional for opposite gender

Men – Doctor, Fireman, Policeman, Computer Programmer

Women – Teacher, Nurse, Secretary, Mother

What is the name of the main character #1 (The character seen the most in the story):

____

What is the role of main character #1: (circle all that apply in story)

Active* Passive* Both

Participates in indoor activities Participates in outdoor activities

* operational definition/s:

Active: Characterized by energetic action or activity; gives rather than takes advice; helps rather than being helped; leading not following; deciding not deferring; doing not waiting; Gross motor physical activity, work, or play.

Passive: Characterized by not participating, acting, or compliant; listens but wants to speak, takes help not give it; not showing leadership; follows other's directions; waits for directions; alert, attentive, activity, but with minimal or no physical movement, (e.g., reading, talking, thinking, daydreaming, watching TV).

How many times in the story does main character #1 exhibit the following behaviors or qualities:

Rescues another character/s (For example: physically or emotionally takes over for another character to save them from worry, danger, etc.) ______________________

Is rescued by another character (For example: physically or emotionally gives over/in to another character to be saved from worry, danger, etc.) ______________________

Asks question/s ______________________

Answer questions ______________________

Acts afraid (For example: cries, cowers, "shivers in fear", sweats, runs away, hides) ____________________

Acts brave (For example: Stands up for themselves or others; not timid or indirect during altercation or dangerous situation) ______________________

Acts curious (For example: Investigates, experiments, or questions) ______________________

Nurture/care for another character (For example: giving physical, emotional, or mental aid, support, or comfort to another; or demonstrates affection or compassion for another) ______________________

Act assertively/aggressively (For example: Physically or emotionally hurting someone; verbal aggression; destroy property; takes charge of a situation without prompting) ______________________

Gives up/gives in ____________________

Works collaboratively (Working in a group of two or more toward a common goal) __________________

What is the name of the main character #2 (The character seen the 2nd most in the story): ____

What is the role of main character #2: (circle all that apply in story)

Active* Passive* Both

Participates in indoor activities Participates in outdoor activities

* operational definition/s:

Active: Characterized by energetic action or activity; gives rather than takes advice; helps rather than being helped; leading not following; deciding not deferring; doing not waiting; Gross motor physical activity, work, or play.

Passive: Characterized by not participating, acting, or compliant; listens but wants to speak, takes help not give it; not showing leadership; follows other's directions; waits for directions; alert, attentive, activity, but with minimal or no physical movement, (e.g., reading, talking, thinking, daydreaming, watching TV).

How many times does main character #2 exhibit the following behaviors or qualities:

Rescues another character/s (For example: physically or emotionally takes over for another character to save them from worry, danger, etc.) ______________________

Is rescued by another character (For example: physically or emotionally gives over/in to another character to be saved from worry, danger, etc.) ______________________

Asks question/s ______________________

Answer questions ______________________

Acts afraid (For example: cries, cowers, "shivers in fear", sweats, runs away, hides) ____________________

Acts brave (For example: Stands up for themselves or others; not timid or indirect during altercation or dangerous situation) ______________________

Acts curious (For example: Investigates, experiments, or questions) ______________________

Nurture/care for another character (For example: giving physical, emotional, or mental aid, support, or comfort to another; or demonstrates affection or compassion for another) ______________________

Act assertively/aggressively (For example: Physically or emotionally hurting someone; verbal aggression; destroy property; takes charge of a situation without prompting) ______________________

Gives up/gives in ______________________

Works collaboratively (Working in a group of two or more toward a common goal)

____

How many animals/objects/persons (minor unidentified character/s) are given a masculine identity (pictured)? ______________________

How many animals/objects/persons (minor unidentified character/s) are given a masculine identity (pronoun/name/title in text, ex: Mr., Sir)? ______________________

How many animals/objects/persons (minor unidentified character/s) are given a feminine identity (pictured)? ______________________

How many animals/objects/persons (minor unidentified character/s) are given a feminine identity (pronoun/name/title in text, ex: Mrs., Lady, Miss)? ______________________

How many animals/objects/persons (minor unidentified character/s) are given a neutral identity (pictured)? ______________________

How many animals/objects/persons (minor unidentified character/s) are given a neutral identity (pronoun/name/title in text, ex: you all, them, it, us, we, people, the dog)?

____

What toys are girls playing with? (circle one)

Stereotypical toys   Non-stereotypical toys   Both   None

What toys are boys playing with? (circle one)

Stereotypical toys   Non-stereotypical toys   Both   None

Stereotypical/non-stereotypical toys lists

Boys – cars, trucks, construction, sports equipment, items from male occupations

Girls – dolls, tea sets, doll houses, jewelry, makeup, dress up items, EZ-bake ovens,

items from female occupations

Neutral – blocks, art, stuffed animals, computer unless it has gendered

How many of the following image/interactions are observed in pictures? (count how many)

Main female-secondary male ____

Main male-secondary female ____

Main female-secondary female ____

Main male-secondary male ____

Just a female but not a male ____

Just a male but not a female ____

Both female and male (main and/or secondary) ____

How many times did you read about the following in the text?

Main female-secondary male ____

Main male-secondary female ____

Main female-secondary female ____

Main male-secondary male ____

Just a female but not a male ____

Just a male but not a female ____

Both female and male (main and/or secondary) ____

Main female character/s' actions (count how many occurrences):

Touches kindly/gently another character ____

Hugs another character ____

Kisses another character ____

Talks another character ____

Mentions money ____

Expresses happiness ____

Expresses sadness ____

Expresses anger ____

Cries ____

Yells ____

Behaves incompetently in stereotypically feminine way____

Behaves incompetently in stereotypically masculine way____

Plays in a stereotypically feminine way ____

Plays in a stereotypically masculine way ____

Disciplines/scolds another character ____

Disobeys another character ____

Other female characters speak/refer to the character____

Other male characters speak/refer to the character____

Performs traditional chore/s or activities*** ____

Performs non-traditional chore/s or activities** ____

Main male character/s' actions (count how many occurrences):

Touches kindly/gently another character ____

Hugs another character ____

Kisses another character ____

Talks another character ____

Mentions money ____

Expresses happiness ____

Expresses sadness ____

Expresses anger ____

Cries ____

Yells ____

Behaves incompetently in stereotypically feminine way____

Behaves incompetently in stereotypically masculine way____

Plays in a stereotypically feminine way ____

Plays in a stereotypically masculine way ____

Disciplines/scolds another character ____

Disobeys another character ____

Other female characters speak/refer to the character____

Other male characters speak/refer to the character____

Performs traditional chore/s or activities*** ____

Performs non-traditional chore/s or activities** ____

Examples of **traditional list for **men** or **Non-traditional** for **women**:

take out garbage	mow the yard	plumbing	climb on ladders
pay bills/handle money	barbecue	paint	move heavy things
carpentry-related activity	work on car	build	creates
manages/directs others	calculate	designs	experiments
clean outside (ex: wash car, clean sidewalk)		works or plays on computers	
questions/ask	explores	competes	

***Examples of **traditional** list for **women** or **Non-traditional** for **men**:

cleans	prepares food	decorates	sew
takes care of children	does laundry	does dishes	takes direction
asks for help	typing	listening	imitates
takes care of people	cooks		

APPENDIX E:
IMAGES TESTED

Image #1
(Leedy, 2005)

Image #2
(Leedy, 2005)

Image #3
(Leedy, 2005)

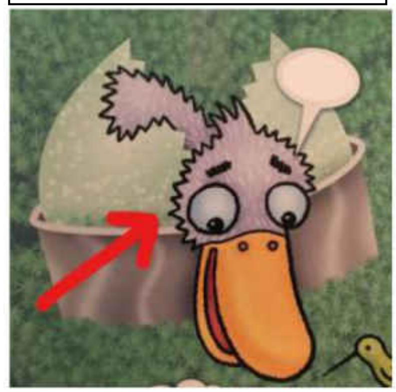


Image #4
(Leedy, 2005)

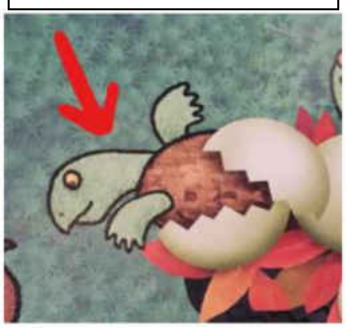


Image #5
(Leedy, 2005)

Image #6
(Fleiss, 2013)

Image #7
(Fleiss, 2013)

Image #8
(Fleiss, 2013)

Image #9
(Fleiss, 2013)

Image #10 (Fleiss, 2013)

Image #11
(Fleiss, 2013)

Image #12
(Vestergaard, 2013)

Image #13
(Vestergaard, 2013)

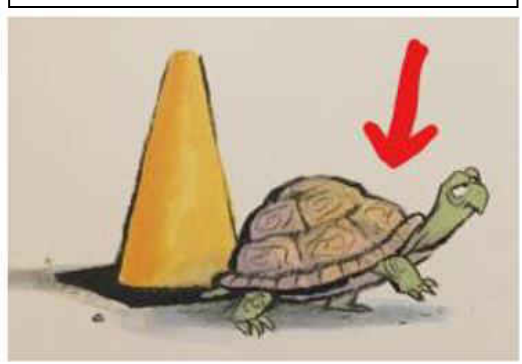


Image #14
(Vestergaard, 2013)

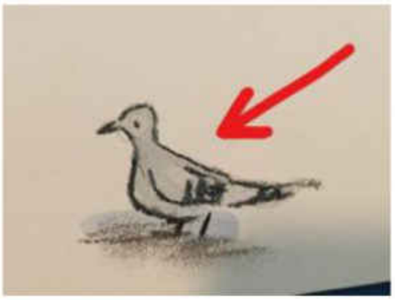


Image #15
(Vestergaard, 2013)

Image #16
(Vestergaard, 2013)

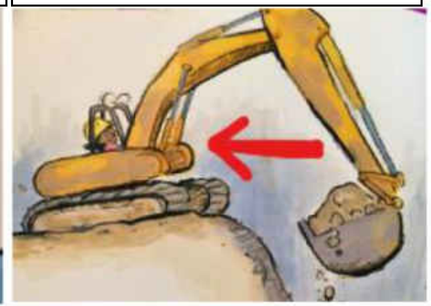


Image #17
(Vestergaard, 2013)

Image #18
(Beaty, 2016)

Image #19
(Beaty, 2016)

Image #20
(Beaty, 2016)

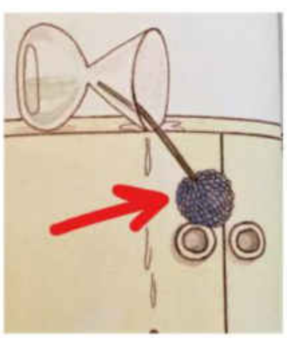


Image #21
(Beaty, 2016)

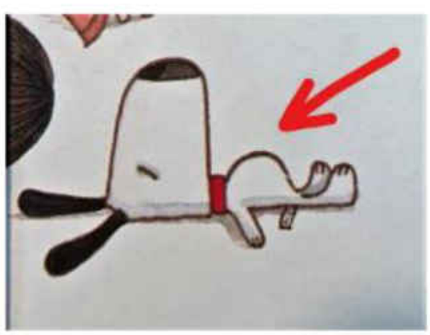


Image #22
(Beaty, 2016)

Image #23
(Beaty, 2016)

Image #24
(Beaty, 2016)

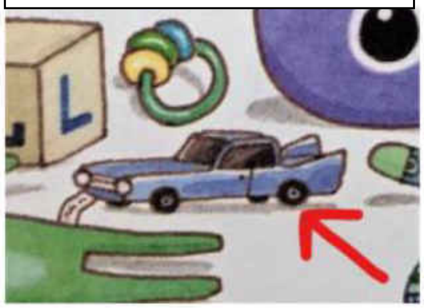


Image #25
(Beaty, 2016)

Image #26
(Cowley, 2005)

Image #27
(Cowley, 2005)

Image #28
(Cowley, 2005)

Image #29
(Vestergaard, 2013)

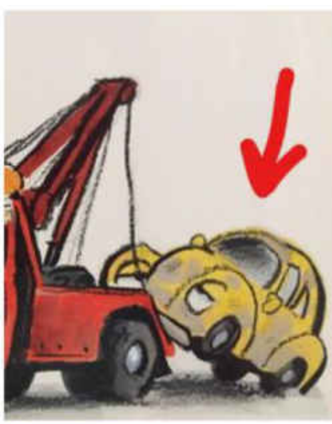


Image #30
(Vestergaard, 2013)

Image #31
(Vestergaard, 2013)

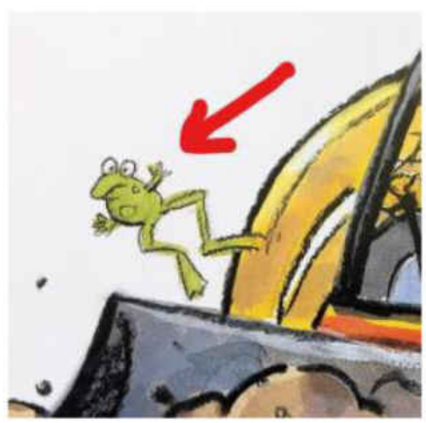


Image #32
(Adler, 2015)

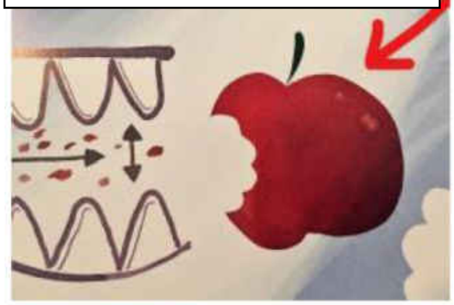


Image #33
(Adler, 2015)

Image #34
(Adler, 2015)

Image #35
(Adler, 2015)

Image #36
(Adler, 2015)

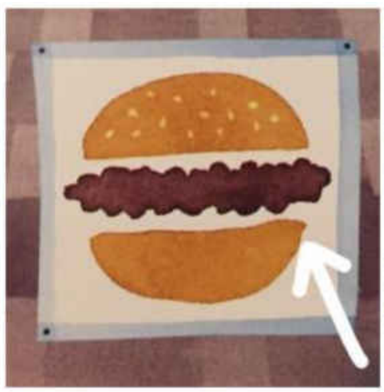


Image #37
(Adler, 2015)

Image #38
(Adler, 2015)

Image #39
(Beaty, 2013)

Image #40
(Beaty, 2013)

Image #41
(Beaty, 2013)

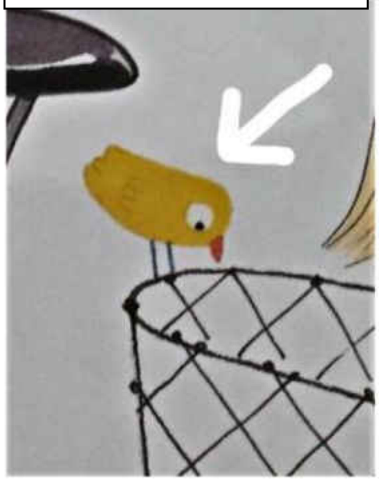


Image #42
(Beaty, 2013)

Image #43
(Beaty, 2013)

Image #44
(Beaty, 2013)

Image #45
(Berkes, 2004)

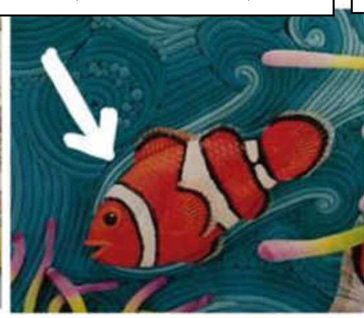


Image #46
(Berkes, 2004)

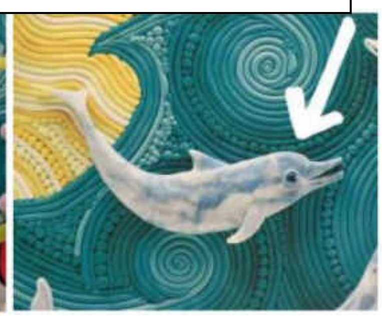


Image #47
(Berkes, 2004)

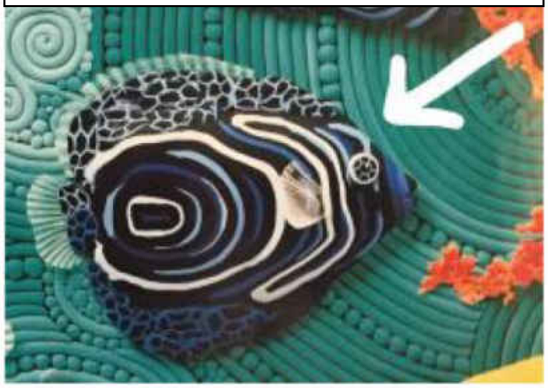


Image #48
(Berkes, 2004)

Image #49
(Berkes, 2004)

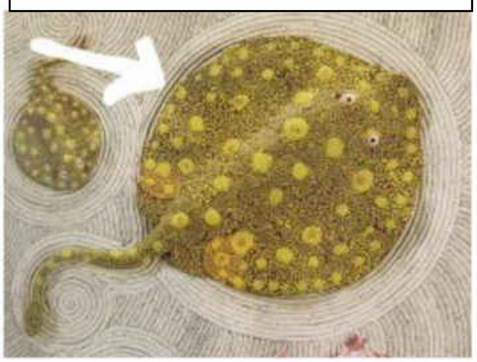
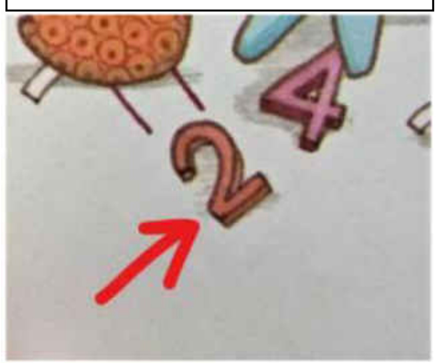


Image #50
(Beaty, 2016)



APPENDIX F:
PARENT CONSENT

Discovering latent gender bias in children's STEM literature images

Parent Informed Consent

Co-Principal Investigator(s): *Christine Proebsting Herlihy M.Ed., M.E.S.S.*
Laurie O. Campbell E.D.

Investigational Site(s):

- Orlando Science School
- Seminole Science School
- Osceola Science School
- Bridge to Independence
- Cranium Academy
- KinderCare
- La Petite Academy
- LadyBird Academy
- Bright Horizons
- Boys & Girls Clubs
- YMCA
- The Willow School

Greetings & Introduction: Researchers at the University of Central Florida (UCF) study many topics. To do this we need the help of people who agree to take part in a research study. You are being asked to allow your child to take part in a research study which will include ***kindergarten aged children and images from current children's books***. You and your child are being invited to take part in this research study. The survey study should take 5-10 minutes during class for each survey, for a TOTAL of 20 minutes. They will be shown 20-30 images during each survey period, with TWO separate surveys to be given. Survey participation time periods will be determined by your child's school. Dr. Campbell & Christine Herlihy of the University of Central Florida, Department of Educational and Human Sciences in the College of Education and Human Performances are conducting this study. Children read books every day at home, school, and other settings. It is our goal to gain a better understanding of how readers view the images in the books that they look at every day. Through your child's participation in our study, we hope to gain this understanding.

How to Return this Consent Form: For your child to participate in this survey research, you must ***complete the attached form, sign, and return it*** back to your child's teacher or the researcher on site.

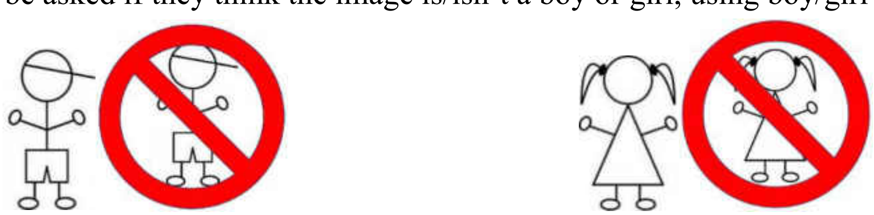
What you should know about a research study:

- Someone will explain this research study to you.
- A research study is something you volunteer for.
- Whether you take part is up to you.
- You should allow your child to take part in this study only because you want to.
- You can choose not to take part in the research study.
- You can agree to take part now and later change your mind.
- Whatever you decide it will not be held against you or your child.
- Feel free to ask all the questions you want before you decide.

Purpose of the research study: The purpose of this study is to evaluate how children perceive images from popular STEM (Science, Technology, Engineering & Mathematics) children's books.

What your child will be asked to do in the study: Students will be asked to take part in two separate surveys during their school day. Dates and time periods for participation will be determined by your child's school administration and classroom teacher. Students will take two separate surveys on an IPAD (or on paper if your site does not have Wi-Fi access), while being shown 20-30 pictures/images from popular children's books. The student will be shown an image from children's books (a list of books to be used can be provided to you upon request). They will answer questions relating to how much they like the image they are shown, using happy/sad faces.

They will also be asked if they think the image is/isn't a boy or girl, using boy/girl symbols.



The students will interact with one University researcher during the class. Each survey will take between 5-10 minutes, for a TOTAL of 20 minutes. Your child does not have to answer every question. Your child doesn't have to complete both surveys. You or your child will not lose any benefits if your child skips questions, drops out before completion of the survey, or chooses not to participate in the study at all. Your child may withdraw their participation at any time during the survey periods.

What you are being asked to do in the study: As a parent or guardian, you are being asked to:

1. Give your permission for the participation of the minor child before the child will be allowed to participate in the study.
2. Complete a 17-question survey, taking less than 5 minutes to complete. A form can be sent home to you for completion or you can go online and complete the survey. http://ucf.qualtrics.com/jfe/form/SV_1zEfKaAaDnN0VvL

Your child will not be penalized from participating in the study if you do not complete the parent guardian survey, as long as you give signed permission for them to participate.

Location: The student's classroom site.

Time required: We expect that your child will take 5-10 minutes during class to complete each survey, for a TOTAL of 20 minutes.

Funding for this study: This research study does not have outside funding.

Financial disclosure statement: The researchers do not have a financial interest in the study.

Risks: There are no expected risks for taking part in this study. There are no reasonably foreseeable risks or discomforts involved in taking part in this study. There are no anticipated risks for you as the parent or guardian related to completing the survey.

Benefits:

We cannot promise any benefits to you, your child, or others from your child taking part in this research. However, possible benefits include identifying unintentional bias in children's literature, as well as possibly identifying solutions to improve image content of children's literature, and perhaps learning more about the research process are expected.

Compensation or payment:

There is no compensation, payment, or extra credit for your child's part in this study.

Confidentiality: We will limit your personal data collected in this study. Efforts will be made to limit you and your child's personal information to people who have a need to review this information. We cannot promise complete secrecy. Organizations that may inspect and copy your information include the IRB and other representatives of UCF.

Study contact for questions about the study or to report a problem: If you have questions, concerns, or complaints, or think the research has hurt your child, talk to Dr. Campbell at the University of Central Florida, locampbell@ucf.edu or 407-823-3382.

IRB contact about you and your child's rights in the study or to report a complaint: Research at the University of Central Florida involving human participants is carried out under the oversight of the Institutional Review Board (UCF IRB). This research has been reviewed and approved by the IRB. For information about the rights of people who take part in research, please contact: Institutional Review Board, University of Central Florida, Office of Research & Commercialization, 12201 Research Parkway, Suite 501, Orlando, FL 32826-3246 or by telephone at (407) 823-2901. You may also talk to them for any of the following:

- Your questions, concerns, or complaints are not being answered by the research team.
- You cannot reach the research team.
- You want to talk to someone besides the research team.
- You want to get information or provide input about this research.

Withdrawing from the study:

You may decide not to have your child continue in the research study at any time without it being held against you or your child. If you decide to have your child leave the study, contact the investigator so that the investigator can remove your child's information from the study.

Your signature below indicates your permission for the child named below to take part in this research

---

DO NOT SIGN THIS FORM AFTER THE IRB EXPIRATION DATE

Signature of parent or guardian

Date

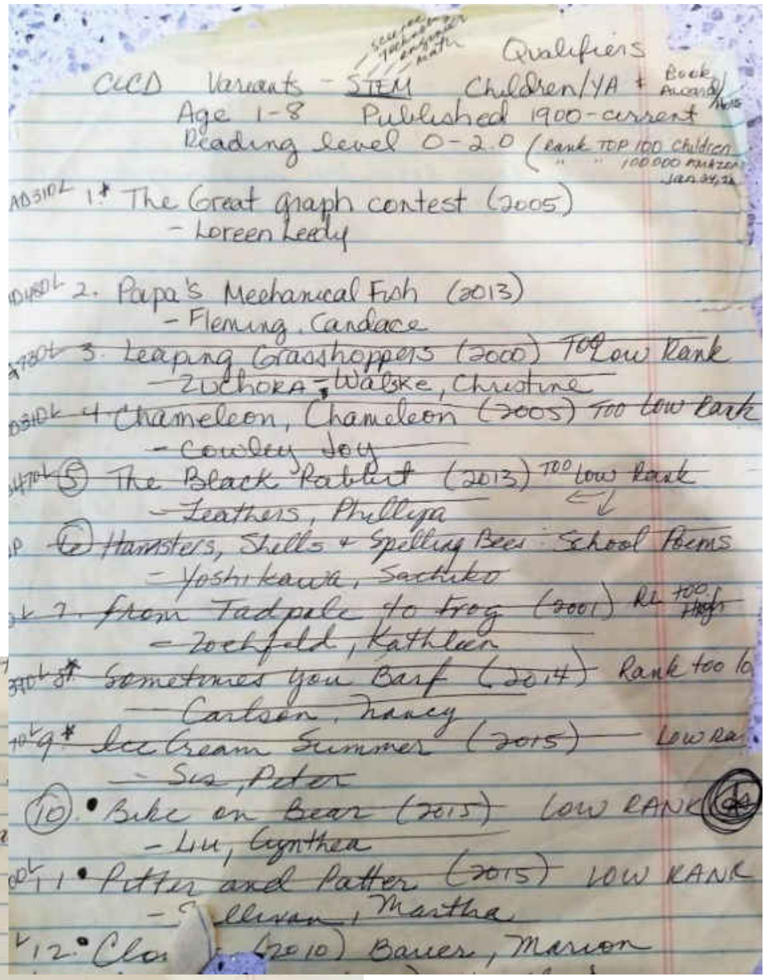
- ❑ Parent
- ❑ Guardian

Printed name of parent or guardian

Name of child participant

APPENDIX G:
CLCD SEARCH

(sample)



science / technology / engineering / math
Qualifiers
CLCD Variants - STEM Children/YA + Book Awards
Age 1-8 Published 1900-current
Reading level 0-2.0 (Rank TOP 100 Children / 100 000 Amazon / Jan 24, 22)

AD310L 1.* The Great graph contest (2005)
- Loreen Leedy

AD480L 2. Papa's Mechanical Fish (2013)
- Fleming, Candace

3. Leaping Grasshoppers (2000) Too Low Rank
- Zuchora-Walske, Christine

4 Chameleon, Chameleon (2005) Too Low Rank
- Cowley, Joy

5 The Black Rabbit (2013) Too Low Rank
- Leathers, Phillipa

6 Hamsters, Shells + Spelling Bees School Poems
- Yoshikawa, Sachiko

7. From Tadpole to Frog (2001) RL Too High
- Zoehfeld, Kathleen

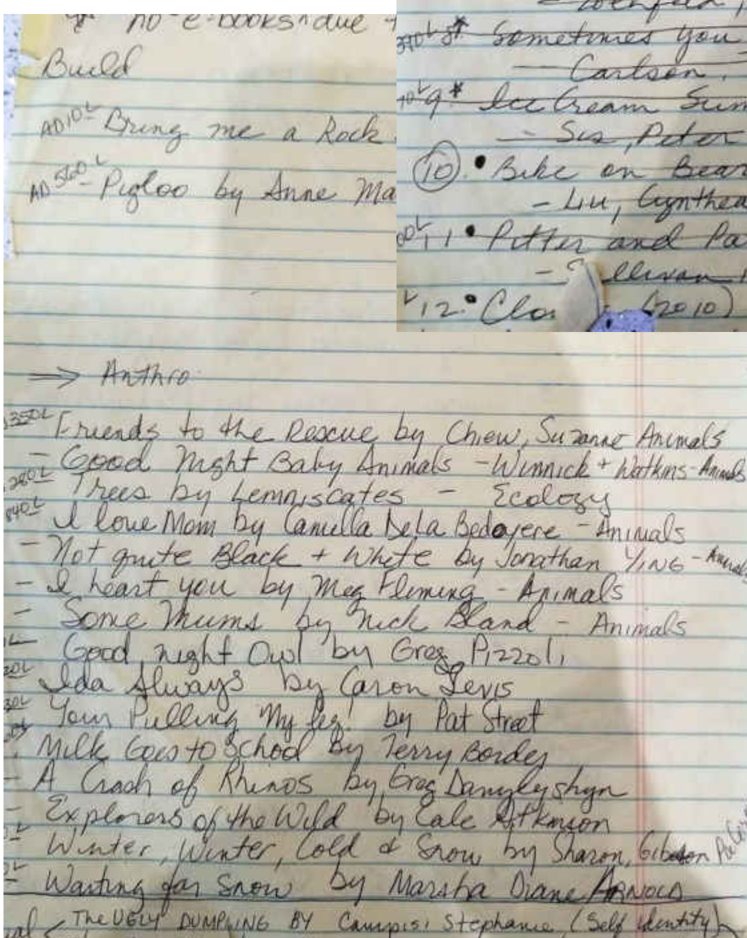
8* Sometimes you Barf (2014) Rank too low
- Carlson, Nancy

9* Ice Cream Summer (2015) Low Rank
- Sis, Peter

10. Bike on Bear (2015) Low RANK
- Liu, Cynthea

11. Pitter and Patter (2015) LOW RANK
- Sullivan, Martha

12. Clo... (2010) Bauer, Marion

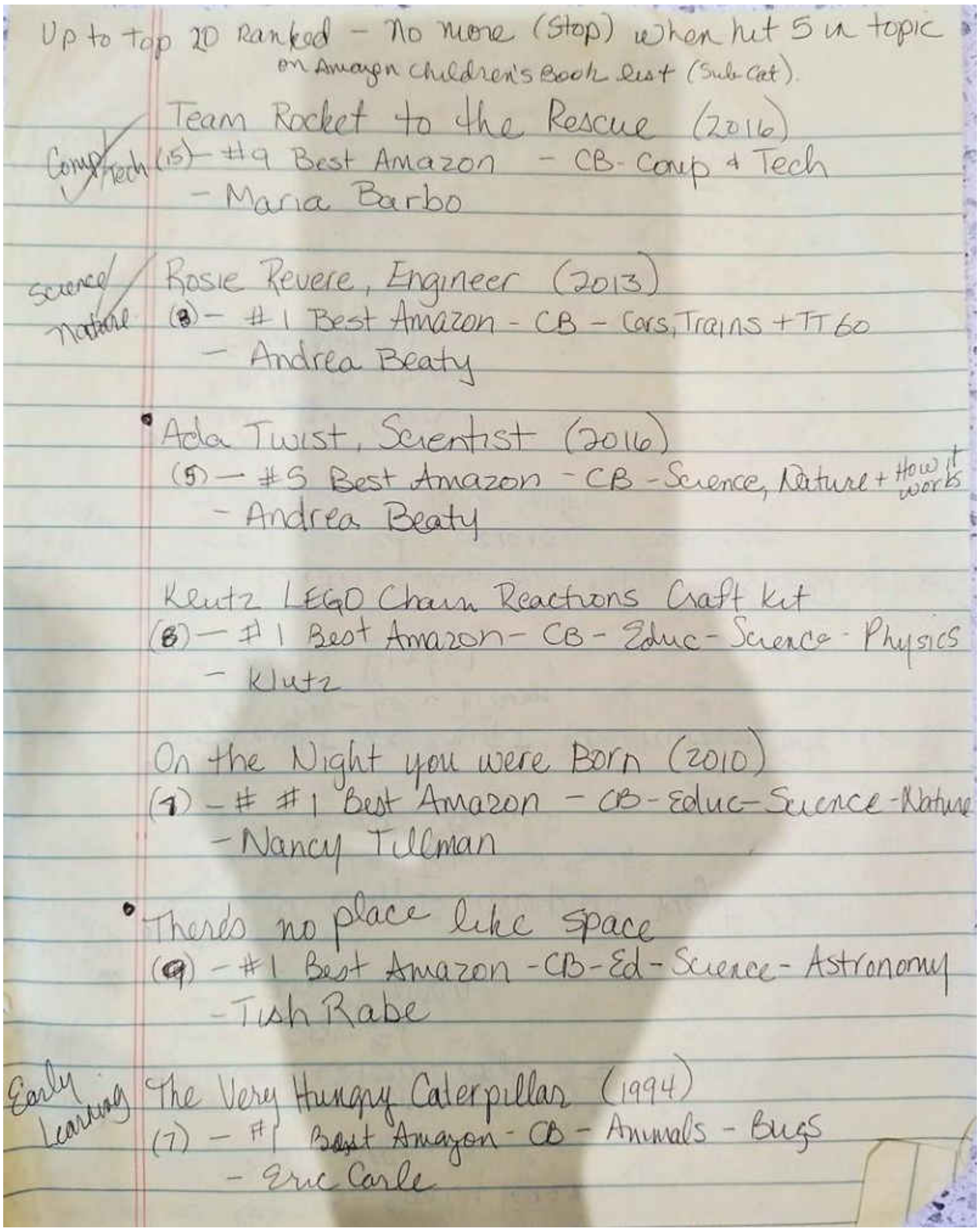


no e-books due
Build
AD10L Bring me a Rock
AD560L Pigloo by Anne Ma...

→ Anthro

Friends to the Rescue by Chew, Suzanne Animals
- Good Night Baby Animals - Winnick + Watkins - Animals
Trees by Lemniscates - Ecology
I love Mom by Camilla De La Bedoyere - Animals
- Not quite Black + White by Jonathan Ying - Animals
- I heart you by Meg Fleming - Animals
- Some Mums by Nick Bland - Animals
Good night Owl by Greg Pizzoli
Ida Always by Caron Levis
Your Pulling My Leg! by Pat Street
Milk Goes to School by Terry Border
- A Crash of Rhinos by Greg Danylyshyn
Explorers of the Wild by Cale Atkinson
Winter, Winter, Cold & Snow by Sharon Gibson
- Waiting for Snow by Marsha Diane Arnold
The UGLY DUMPLING BY Campisi Stephanie (Self Identity)
I'M A GIRL by YASMEEN ISMAIL

APPENDIX H:
AMAZON RANKING SUBCATEGORY SEARCH


Up to Top 20 Ranked – No more (Stop) when hit 5 in topic
on Amazon Children's Book list (Sub Cat).

Comp/Tech
Team Rocket to the Rescue (2016)
(15) – #9 Best Amazon – CB-Comp & Tech
– Maria Barbo

Science/Nature
Rosie Revere, Engineer (2013)
(8) – #1 Best Amazon – CB – Cars, Trains + TT 60
– Andrea Beaty

Ada Twist, Scientist (2016)
(5) – #5 Best Amazon – CB – Science, Nature + How it works
– Andrea Beaty

Klutz LEGO Chain Reactions Craft Kit
(8) – #1 Best Amazon – CB – Educ – Science – Physics
– Klutz

On the Night you were Born (2010)
(7) – # #1 Best Amazon – CB – Educ – Science – Nature
– Nancy Tillman

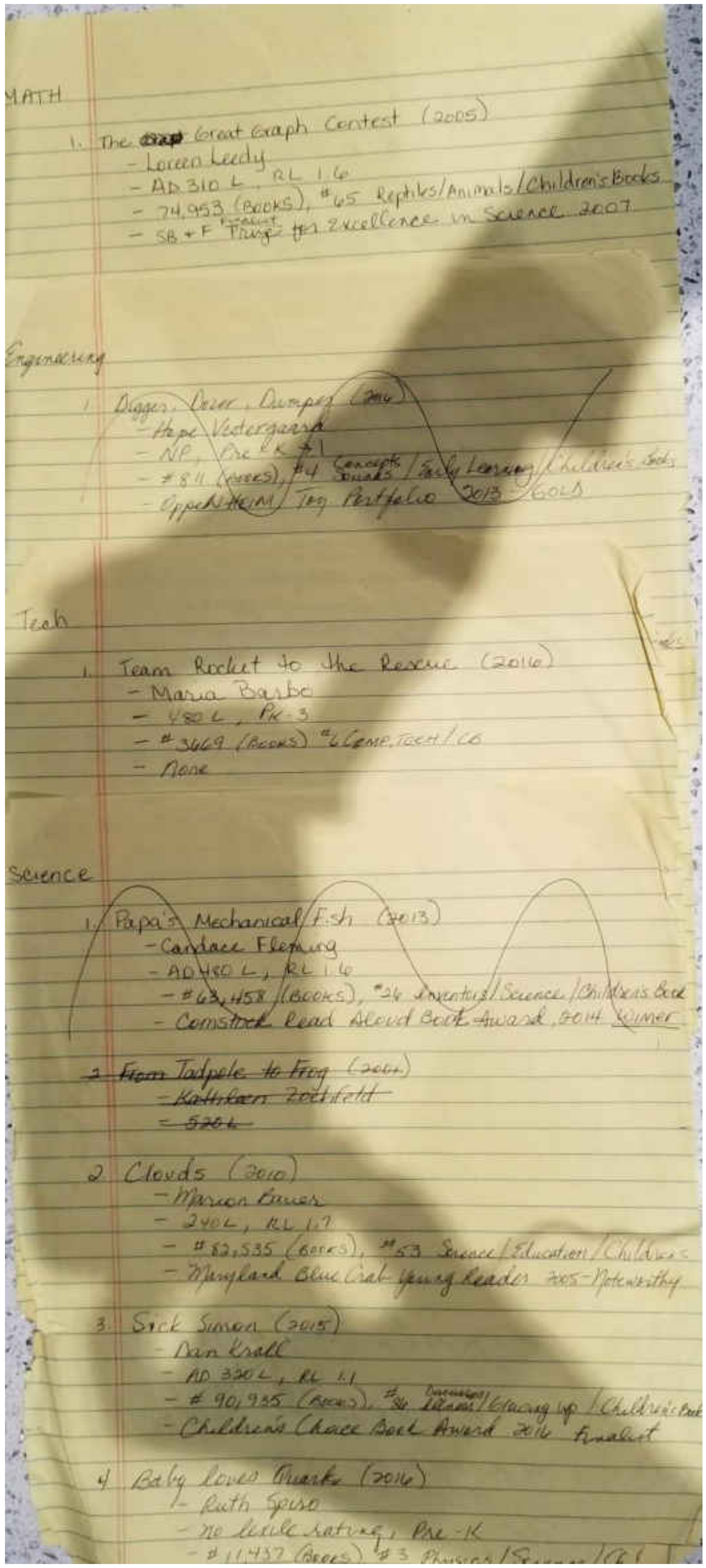
There's no place like space
(9) – #1 Best Amazon – CB – Ed – Science – Astronomy
– Tish Rabe

Early Learning
The Very Hungry Caterpillar (1994)
(7) – #1 Best Amazon – CB – Animals – Bugs
– Eric Carle

(sample)

APPENDIX I:
AWARD-WINNING CLCD BOOKS AND AMAZON SALES IN STEM

(sample)



MATH

1. The Great Graph Contest (2005)
   - Loreen Leedy
   - AD 310 L, RL 1.6
   - 74,953 (BOOKS), #65 Reptiles/Animals/Children's Books
   - SB + F Prize for Excellence in Science 2007

Engineering

1. Digger, Dozer, Dumper (2016)
   - Hope Vestergaard
   - NP, Pre K #1
   - #811 (BOOKS), #4 Concepts Sounds / Early Learning / Children's Books
   - Oppenheim Toy Portfolio 2013 GOLD

Tech

1. Team Rocket to the Rescue (2016)
   - Maria Barbo
   - 480 L, PK-3
   - #3669 (BOOKS) #6 Comp. Tech / CO
   - None

Science

1. Papa's Mechanical Fish (2013)
   - Candace Fleming
   - AD 480 L, RL 1.6
   - #63,458 (BOOKS), #24 Inventors / Science / Children's Book
   - Comstock Read Aloud Book Award, 2014 Winner

~~2 From Tadpole to Frog (2001)~~
~~- Kathleen Zoehfeld~~
~~- 520 L~~

2. Clouds (2010)
   - Marion Bauer
   - 240 L, RL 1.7
   - #82,535 (BOOKS), #53 Science / Education / Children's
   - Maryland Blue Crab Young Reader 2005 - Noteworthy

3. Sick Simon (2015)
   - Dan Krall
   - AD 330 L, RL 1.1
   - #90,935 (BOOKS), #36 Emotions / Growing up / Children's Book
   - Children's Choice Book Award 2016 Finalist

4. Baby Loves Quarks (2016)
   - Ruth Spiro
   - no lexile rating, Pre-K
   - #11,437 (BOOKS) #3 Physics / Science / Ch...

APPENDIX J:
CULLING BOOK LIST

39 Books then Negated the following based on:

→ I'm pulling your leg – more English than anatomy
Very Hungry Caterpillar – too old (1994)
Over in the Grasslands – too high of Amazon rank (+1800)
Being safe with Tech } 1st grade & above
Small Wonders } (need K level!)
Ice Cream Summer – NOT STEM

33 Books:

Over on a Mountain – Repeat author w/ ↑ Amazon + in same STEM area

32 Books:

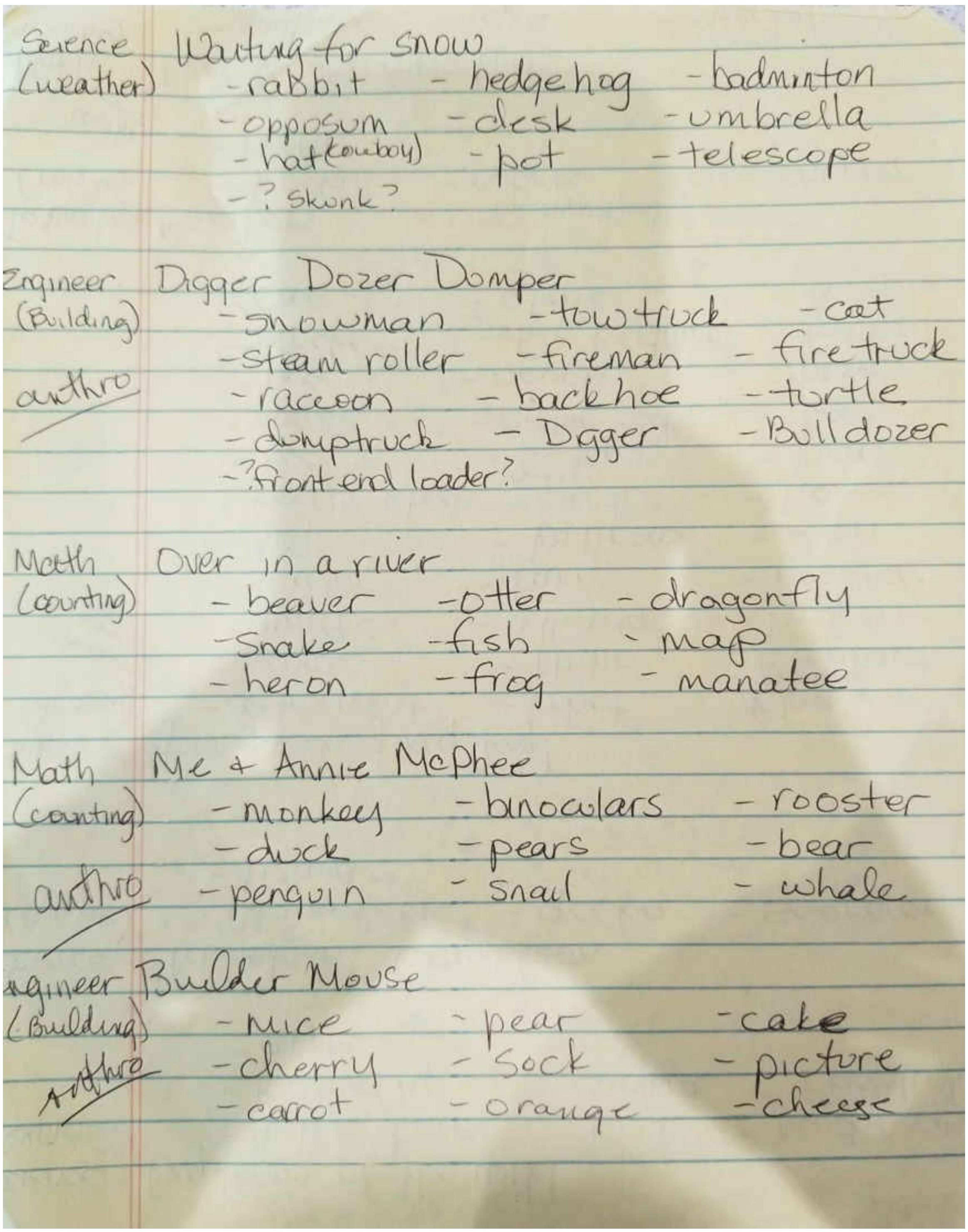
Oh Say Can you see What's the weather today? ← Repeat illustrator in same STEM area

31 Books:

Builder Mouse – } 1477
Nanobots – } 1674 Amazon rank too high.
Drew the Screw – } 1392

APPENDIX K:
ITEMIZING BOOK IMAGES

(sample)



Science (weather) Waiting for snow
- rabbit - hedgehog - badminton
- opposum - desk - umbrella
- hat (cowboy) - pot - telescope
- ? skunk ?

Engineer (Building) Digger Dozer Dumper
anthro
- snowman - tow truck - cat
- steam roller - fireman - fire truck
- raccoon - backhoe - turtle
- dumptruck - Digger - Bulldozer
- ? front end loader ?

Math (counting) Over in a river
- beaver - otter - dragonfly
- snake - fish - map
- heron - frog - manatee

Math (counting) Me & Annie McPhee
anthro
- monkey - binoculars - rooster
- duck - pears - bear
- penguin - snail - whale

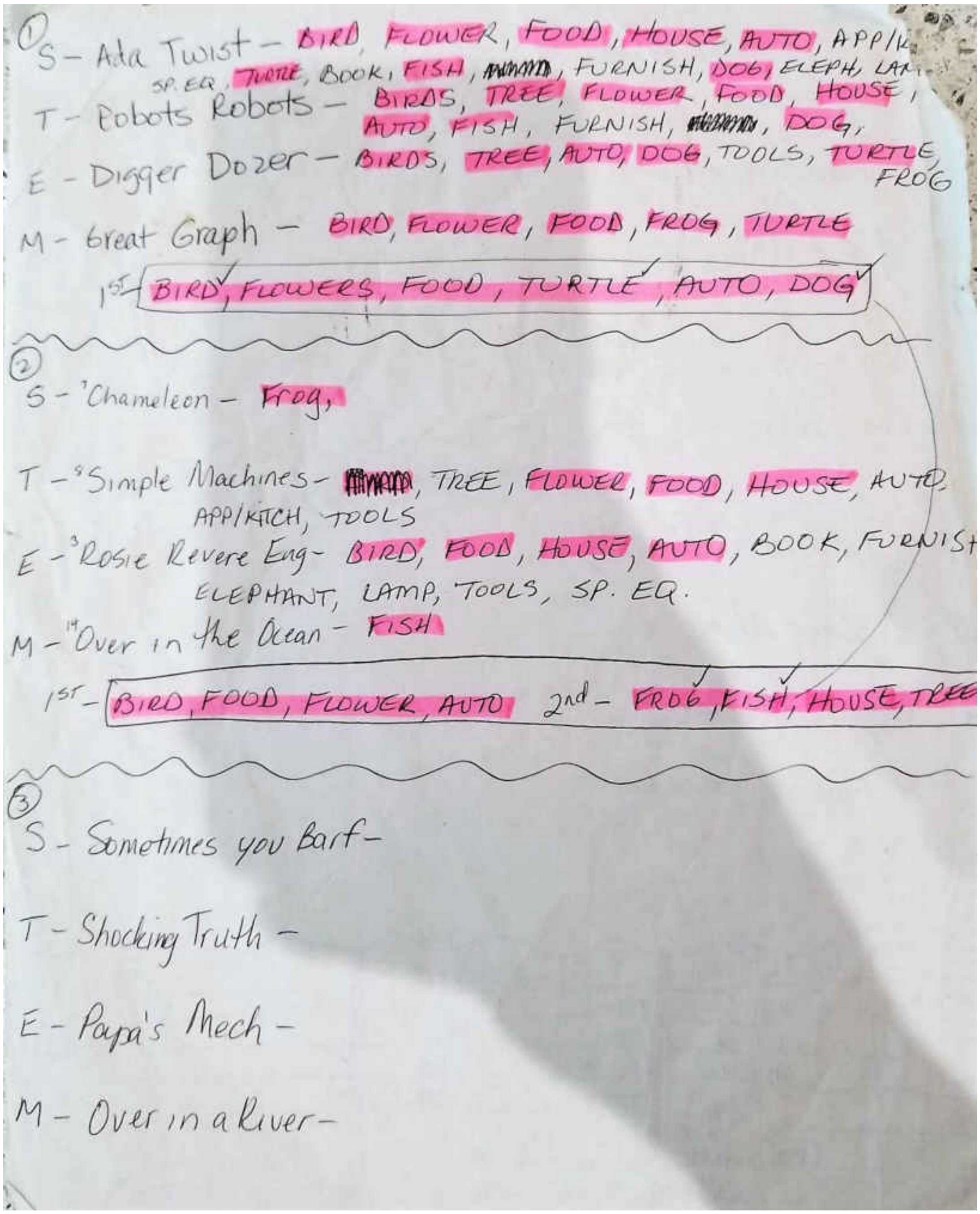
Engineer (Building) Builder Mouse
anthro
- mice - pear - cake
- cherry - sock - picture
- carrot - orange - cheese

APPENDIX L:
DISSERTATION BOOK LIST HANDOUT

Title	Author	Illustrator	Year
Ada Twist Scientist (S)	Beaty, Andrea	Roberts, David	2016
Robots, Robots Everywhere (T/E)	Fleiss, Sue	Staake, Bob	2013
Digger, Dozer, Dumper (E)	Vestergaard, Hope	Slonim, David	2016
The Great Graph Contest (M)	Leedy, Loreen	Leedy, Loreen	2005
Chameleon, Chameleon (S)	Cowley, Joy	Bishop, Nic	2005
Simple Machines: Wheels, Levers, and Pulleys (T/E)	Adler, David	Raff, Anna	2016
Rosie Revere, Engineer (E)	Beaty, Andrea	Roberts, David	2013
Over in the Ocean: In a Coral Reef (M)	Berkes, Marianne	Canyon, Jeanette	2004
Sometimes You Barf (S)	Carlson, Nancy	Carlson, Nancy	2014
The Shocking Truth About Energy (T)	Leedy, Loreen	Leedy, Loreen	2011
Papa's Mechanical Fish (T/E)	Fleming, Candice	Kulikov, Boris	2013
Over in a River: Flowing Out to the Sea (M)	Berkes, Marianne	Dubin, Jill	2013
Waiting for Snow (S)	Arnold, Marsha Diane	Liwska, Renata	2016
Tek: The Modern Cave Boy (T)	McDonnell, Patrick	McDonnell, Patrick	2016
Good Night Owl (E)	Pizzoli, Greg	Pizzoli, Greg	2016
Me & Annie McPhee (M)	Dunrea, Olivier	Hillenbrand, Will	2016
Explorers of the Wild (S)	Atkinson, Cale	Atkinson, Cale	2016
I Love Mom (S)	De la Bedoyere, Camilla	De la Bedoyere, Camilla	2016
Beneath the Sun (S)	Stewart, Melissa	Bergum, Constance	2014
A Number Slumber (M)	Bloom, Suzanne	Bloom, Suzanne	2016

APPENDIX M:
SELECTED BOOKS WITH COMMON IMAGES

(sample)



① S – Ada Twist – BIRD, FLOWER, FOOD, HOUSE, AUTO, APP/K
TURTLE, BOOK, FISH, [illegible], FURNISH, DOG, ELEPH, LAM
SP. EQ.
T – Robots Robots – BIRDS, TREE, FLOWER, FOOD, HOUSE,
AUTO, FISH, FURNISH, [illegible], DOG,
E – Digger Dozer – BIRDS, TREE, AUTO, DOG, TOOLS, TURTLE,
FROG
M – Great Graph – BIRD, FLOWER, FOOD, FROG, TURTLE
1st – BIRD, FLOWERS, FOOD, TURTLE, AUTO, DOG
②
S – Chameleon – Frog,
T – Simple Machines – [illegible], TREE, FLOWER, FOOD, HOUSE, AUTO,
APP/KITCH, TOOLS
E – Rosie Revere Eng – BIRD, FOOD, HOUSE, AUTO, BOOK, FURNISH
ELEPHANT, LAMP, TOOLS, SP. EQ.
M – Over in the Ocean – FISH
1st – BIRD, FOOD, FLOWER, AUTO 2nd – FROG, FISH, HOUSE, TREE
③
S – Sometimes you Barf –
T – Shocking Truth –
E – Papa's Mech –
M – Over in a River –

APPENDIX N:
IRB APPROVAL

University of Central Florida Institutional Review Board
Office of Research & Commercialization
12201 Research Parkway, Suite 501
Orlando, Florida 32826-3246
Telephone: 407-823-2901 or 407-882-2276
www.research.ucf.edu/compliance/irb.html

Approval of Exempt Human Research

From: **UCF Institutional Review Board #1**
FWA00000351, IRB00001138

To: **Christine Proebsting Herlihy** and Co-PIs: **Laurie O'Malley Campbell**

Date: **November 03, 2015**

Dear Researcher:

On 11/03/2015, the IRB approved the following activity as human participant research that is exempt from regulation:

Type of Review:	Exempt Determination
Project Title:	An exploratory investigation discovering potential associations between sexual harassment and emotional intelligence affecting females in traditionally male dominated fields
Investigator:	Christine Proebsting Herlihy
IRB Number:	SBE-15-11693
Funding Agency:	
Grant Title:	
Research ID:	N/A

This determination applies only to the activities described in the IRB submission and does not apply should any changes be made. If changes are made and there are questions about whether these changes affect the exempt status of the human research, please contact the IRB. When you have completed your research, please submit a Study Closure request in iRIS so that IRB records will be accurate.

In the conduct of this research, you are responsible to follow the requirements of the Investigator Manual.

On behalf of Sophia Dziegielewski, Ph.D., L.C.S.W., UCF IRB Chair, this letter is signed by:

Joanne Muratori

Signature applied by Joanne Muratori on 11/03/2015 02:43:59 PM EST

IRB Manager

APPENDIX O:
PAPER-BASED SURVEY DATA COLLECTION CHECKLIST

Name:						Participant's Sex:	Male	Female	???
Question #	Male	Not Male	Female	Not Female	Not Like at all	Not Like	Neutral	Like	Like a lot
1									
2									
3									
4									
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24									
25									

APPENDIX P:
COPYRIGHT PERMISSION

March 27, 2019

Christine Proebsting Herlihy

Christine.herlihy@ucf.edu

Robin LeBlanc

leblancr@wlu.edu

Dear Dr. LeBlanc:

I am requesting permission to reprint the following work:

LeBlanc, R. (2016). "What He Told Me When I Complained About the Boys' Club." In *Gender shrapnel in the academic workplace* (pp. vii-viii). New York, NY: Palgrave MacMillan.

This request is for permission to include the above content in my university doctoral dissertation, here at the University of Central Florida. I believe that you are currently the holder of the copyright, because the original work states that copyright is held in your name and my research indicates that you are the writer of the poem. If you do not currently hold the rights, would you please provide me with any information that can help me contact the proper rights holder. Otherwise, your permission confirms that you hold the right to grant this permission.

This request is for a non-exclusive, irrevocable, and royalty-free permission, and it is not intended to interfere with other uses of the same work by you. I hope that you will support my educational program by granting this permission. I would be pleased to include a full citation to the work and other acknowledgement as you might request.

I would greatly appreciate your permission. If you require any additional information, do not hesitate to contact me at the address, email address or number above.

Sincerely,

Permission is hereby granted:

Signature: ____________________ Name & Title: Robin LeBlanc Professor of Politics

Company/Affiliation: Washington and Lee University Date: 4-16-19

~~INSERT PERMISSION FROM ROBIN LEBLANC~~

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*Citations are from books used for testing in the study.