A Critical Content Analysis of the Representation and Portrayals of Females in YALSA Award-Winning Science Comics, 2002-2017: A Feminist Perspective

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Dedication

This dissertation is dedicated to my past, present, and future female students. You inspire me every day to be a better science educator, as well as a better person. For that, I am truly grateful. May you always believe in yourself, eliminate doubt, overcome obstacles, celebrate successes, share your achievements, and support each other. Know that I will always be cheering you on!

> *"We look at science as something very elite, which only a few people can learn. That's just not true. You just have to start early and give kids a foundation. Kids live up, or down, to expectations."* -Mae Jemison, physicist and astronaut

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Abstract

According to the results from the 2015 NAEP science exam, female students in 12th grade scored an average of 5 points lower than males, indicating continual stagnation since 2009. Research indicates one of the ways schools can positively impact the self-confidence and interest in science for female learners is through equitable representation and healthy portrayals of women doing science (Kimmel, 1999). In addition, studies have indicated the positive role comics and graphic novels play in student learning, academic performance, and identity development in the academic sciences (Özdemir, 2010; Hosler & Boomer, 2011). With the increasing popularity of graphic literature in the classroom, this study critically examined the representation and portrayals of females in award-winning science comics and graphic novels. Framed in critical feminism and relational learning theory, the text and illustrations of YALSA award-winning comics/graphic novels were analyzed using a coding scheme created using the deductive and inductive approaches to qualitative content analysis. The findings of this qualitative content analysis revealed females were underrepresented in YALSA award-winning science comics in the total number of frames. However, healthy depictions of female characters were revealed in half of the sample with the presence of counter stereotypes, positive self-identity, personal development, and the relational approach to learning. Overall, this study indicated there remains a need for increased representation of females in science comics.

Preface

This dissertation is the original, unpublished, independent work by the author, C. Bowen.

Table of Contents

CHAPTER I: INTRODUCTION AND GENERAL INFORMATION 1
Statement of the Problem 2
Purpose of the Study 6
Significance of the Study 6
Definitions 7
Summary 8
CHAPTER II: LITERATURE REVIEW 9
Theoretical Framework 9
Science and Gender 12
Relational Science 15
Feminist Pedagogy 17
Gender Representation in Classroom Literature 21
Comics 24
Science Comics 27
Summary 31
CHAPTER III: METHODOLOGY 32
Research Design 32
Qualitative Content Analysis 34
Researcher Reflexivity 35
Sample 36
Data Collection and Analysis 39
Coding Scheme 39
Pilot Coding 41
Double Coding 45
Trustworthiness and Transparency 46
Summary 48
CHAPTER IV: FINDINGS AND DISCUSSION 49
Representation of Females 49
Portrayal of Females 55
Counter Stereotypes of Females 55
Self-Identity 61
Positive Growth 64
Relational Approach 65
Discussion 67
Representation 69
Portrayals 71
Summary 73
CHAPTER V: CONCLUSIONS AND RECOMMENDATIONS 75
Conclusions 75
Implications for Practitioners 77
Implications for Future Studies 80
Final Thoughts 81
LITERATURE CITED 83

LIST OF REFERENCES 86
APPENDIX 108
Appendix A 109
Appendix B 127
Appendix C 129
VITA 131

List of Tables

Table 1. Sample of Science Comics 38
Table 2. Final Coding Scheme.....43
Table 3. Example of Theme Description 46
Table 4. Representation of Female Main Characters in Sample.....51
Table 5. Representation of Female Characters by Frame Count 56

List of Figures

Figure 1. Dvorah, Nyuki, and an unnamed drone from *Clan Apis* 53
Figure 2. Robot Randy and ONE from *Legends of Zita the Spacegirl* 54
Figure 3. The narrator as a skeleton and a human girl from *Human Body Theater: A Non-Fiction Revue* 54
Figure 4. Katya making dinner from *Laika*, Mom from *The Secret Science Alliance* 59
Figure 5. Greta from *The Secret Science Alliance*, Zita from *Legends of Zita the Spacegirl*, and Cleo and Akila from *Cleopatra in Space* 59
Figure 6. Lucy using her scientific knowledge; one of Lucy's inventions from *Last of the Sandwalkers* 62
Figure 7. Lucy using her scientific knowledge from *Last of the Sandwalkers* 62
Figure 8. Sample pages from Lucy's research journal from *Last of the Sandwalkers* 63
Figure 9. Nyuki and Sisyphus from *Clan Apis* 66
Figure 10. Naming observed primates by Goodall, Fossey, and Galdikas from *Primates* 68
Figure 11. Lucy confronting the status quo from *Last of the Sandwalkers* 68
Figure 12. Examples of the authentic interactions with other organisms from *Last of the Sandwalkers* 69

CHAPTER I: INTRODUCTION AND GENERAL INFORMATION

"Girls read comics when there are comics for girls to read" (Robbins, 1999, p. 4).

On the first full school day of every academic year, I begin my 8th grade science instruction by asking my students to close their eyes and imagine they are going on a mental field trip. On this field trip, they meet scientists at their workspace and introduce themselves, observing everything around them. The total duration of the mental field trip is approximately 30 seconds. Next, I tell my students to open their eyes, take their science journals and colored pencils or markers, find an isolated spot in the room, and use the next 2-3 minutes to sketch what they observed on their mental field trip. At the conclusion of the drawing time, I instruct students to put away their art supplies. Through the use of small group discussions, students are encouraged to describe their drawings to their group peers. As I swiftly monitor the discussions, I record the descriptions of their drawings, which most typically exemplify stereotypes of scientists - male, crazy hair, glasses, lab coat, working indoors/laboratory, mixing chemicals, and smoking test tubes or explosions.

After a few minutes of small group discussion, I begin facilitating a class discussion on the students' drawings. As students share a characteristic about their drawing, I document it on the board and begin tallying the occurrences of the descriptive trait. Since I started using this activity in my classroom over ten years ago, there have only been a few student illustrations that have strayed from the common stereotypes of scientists. However, it was the dialogue from one male student four years ago that clarified my career goals as an educator. When I asked this student what he illustrated, he replied, "I drew a marine biologist who studies sharks to save them. She's wearing a wetsuit, and she's in the ocean, surrounded by sharks and fish and other

marine biologists in the ocean." When I commented on how appreciative I was that he drew a female marine biologist, he commented, "Well, you taught my sister, and she said she learned from you that anyone can be a scientist…girls, boys, black, white, or anything else." It seemed my former students shared these stories with their family members and friends. At that moment, I realized my conscious instructional decision to share the stories of female, African American, Latino, Native American, and differently-abled scientists, inventors, and mathematicians from differing economic classes – the stories left out of science textbooks and lessons – with my middle school students was invaluable. This emphasized to me the importance of consciously selecting specific curricular materials, such as books, movie clips, guest speakers, and classroom posters, which not only supplement scientific concepts, but also contain healthy portrayals of underrepresented populations with whom all of my students can relate.

Statement of the Problem

Under the most recent reauthorization of the Elementary and Secondary Education Act (US Department of Education, 2015), public schools are directed with providing educational programs for all students, including, "female students, minority students, English learners, children with disabilities, and low-income students" (p. 219), that increase their access to, as well as improve their engagement and achievement in science technology, mathematics, and engineering. The solitary promotion of federal and state educational programs for all students has not eliminated the gender gap in science achievement or self-efficacy, as is evident from national and international assessments (National Center for Education Statistics [NCES], 2016; Organisation for Economic Co-operation and Development's [OECD], 2016).

Results from the 2015 National Assessment of Educational Progress (NAEP) science exam publically released on October 22, 2016 revealed that female students in 4th and 8th grade

were performing on par with their male peers (NCES, 2016). However, female students in 12th grade scored an average of 5 points lower than males, indicating stagnation since 2009 (NCES, 2016). According to the Organisation for Economic Co-operation and Development's (OECD, 2016) Programme for International Student Assessment (PISA), a higher percentage of American 15-year-old male students enjoy learning science more than their female peers. In addition, the average number of female students enrolling in physical or biological science college courses is lower than that of males, and those enrolled have lower self-efficacy than their male peers (Glynn, Brickman, Armstrong, & Taasoobshirazi, 2011; National Coalition for Women & Girls in Education, 2012). In addition to science achievement, contemporary science education reforms have concentrated their efforts on reducing the gender gap in conferred science degrees and science careers (Hill, Corbett, & St. Rose, 2010; Legewie & DiPrete, 2014; National Research Council [NRC], 2010). Although the gender gap has dramatically decreased in the biological sciences over the past 40 years, women remain underrepresented in degree attainment and career placement in the physical sciences, mathematics, and engineering (National Science Foundation [NSF], 2017; Smyth & Nosek, 2015).

As the STEM industry continues to grow exponentially, numerous high-salary STEM jobs have been created. Yet only 25% of STEM employees are female even though women account for half of the entire workforce (Simon, Wagner, & Killion, 2017). Several factors have been attributed to the underrepresentation of females in STEM careers. Negative self-efficacy as a result of cultural and gender-based stereotypes contributes to the gender gap in academic performance in science, student attitudes toward science, and persistence in continuing science education and careers (Lauer et al., 2013; OECD, 2016). Some have argued that a masculine culture saturates science education and scientific research due to its withdrawal from embracing

subjectivity, emotions, and personal experiences (Harding, 1991; Keller, 1985; Thayer-Bacon, 2003). Stereotypes concerning the masculinity of STEM, in addition to perceptions of the sexist climate of STEM careers, create a deterrent for girls to pursue careers in these fields (Beede et al., 2011; Kane & Mertz, 2012; Papastergiou, 2008). Research on implicit gender stereotypes in 34 countries by Kane and Mertz (2012) revealed a strong correlation between gender stereotypes and eighth grade science and mathematics test performance. The results of their study provide compelling evidence of the sociocultural influence on gender performance in science and mathematics.

The middle school years are often a difficult time as students are transforming physiologically, psychologically, and socially (Stattin & Magnusson, 1990). According to Sadker and Sadker (1995):

> Adolescence closes around these [pre-adolescent] precocious, authoritative girls. They begin to restrict their interests, confine their talents, pull back on their dreams. As they work on blending in with other girls, they move toward the end of their colorful phase. (p. 77)

Puberty, as well as the time when it occurs, can significantly impact the self-image, social relationships, and academics of female students (Cavanagh, Riegle-Crumb, & Crosnoe, 2007; Sadker & Sadker, 1995). With the pubescent growth of fatty tissue in noticeable areas, girls become more self-conscious about their body image, an emulated image created by others, and less concerned with their academics (Apter, 2006; Brown & Gilligan, 1992). Consequently, female students are more likely to develop negative attitudes towards science during these life-changing middle school years, which ultimately results in insecurity in their scientific skills, lowered enrollment in collegiate science courses, and underrepresentation of females in the

science career workforce (Moss-Racusin, Dovidio, Brescoll, Graham, & Handelsman, 2012). According to the National Student Clearinghouse Research Center (2015), the number of women earning bachelor's degrees in STEM decreased between 2004 and 2014. Compounding the problem even further is intersectionality, or overlapping social identities such as gender, ethnicity, and race. In 2014, only 0.3% of all STEM bachelor's degrees conferred in the United States were awarded to American Indian women compared to 5.1% of African American women, 6.5% of Latinas, and 30% of Caucasian women (NSF, 2017).

Unequal gender representation in science both professionally and academically has perpetuated concerns over women's decreased scientific literacy, economic equity, and lack of interest in the science career workforce (Rosser & Taylor, 2009). In 2015-2016, the overall gender wage gap in median annual income for female STEM professionals was 18% (Institute for Women's Policy Research, 2017; Michelmore & Sassler, 2016). In addition, the Institute for Women's Policy Research (2016), which tracks gender wage gap trends biannually, conducted a regression analysis of federal data and determined equitable salaries and wages would reduce the poverty rate of working women and their families while adding $482 billion to the U.S. economy. Finally, women with STEM careers face the challenge of balancing work and home responsibilities, often sacrificing their career due to managerial pressures – a dilemma seldom faced by their male colleagues (Fox, 2010; Rifle et al., 2013). Research documenting the benefits of improving girls' interest in science, as well as the recruitment of females to science professions has focused on the importance of positive representations and portrayals of women (Kimmel, 1999). Yet, the stereotypical misrepresentations of women in science curricular materials still exist in American classrooms.

Purpose of the Study

Science comics are one of the latest media used by educators to improve the appeal of science to female students. The purpose of this study is to examine the representation and portrayals of females in Young Adult Library Services Association (YALSA) award-winning science comics through a qualitative content analysis of text and illustrations. The following research questions guided this study's data analysis:

1. How are females represented in YALSA award-winning science comics?

2. In what ways are females portrayed in YASLA award-winning science comics?

The results from this study have the potential to expand the current collection of research focused on improving science education for female learners and other underrepresented groups. Also, this study aims to influence policymakers, educators, and other stakeholders in their selections of curricular materials with healthy, non-stereotypical portrayals of females.

Significance of the Study

A review of the literature reveals the significance of improving science education for females. Researchers have investigated the portrayal of marginalized groups in specific types of literature published for school-age children, such as children's books and textbooks (Bazler & Simonis, 1991; Gooden & Gooden, 2001; Potter & Rosser, 1992; Previs, 2016; Weitzman et al., 1972). Weitzman et al. (1972) quantified the sexist gender stereotypes and underrepresentation of females in children's picture books and maintained that this teaches children of both sexes that girls are less significant than boys. Gooden & Gooden's (2001) study showed an increase in females as main characters in picture books; however, gender stereotypes continued to be prevalent. Textbooks also propagate this marginalization through the implicit reinforcement of sexist gender norms including female passivity (Potter & Rosser, 1992), the lowered status of

women (Bazler & Simonis, 1991), and females requiring assistance from males (Samuels, 1999). Additionally, the scientific contributions of women are minimally addressed, if present at all, in science textbooks (Potter & Rosser, 1992). Although there has been some research on the presence of gender bias in science curricular resources, it is deficient in analyzing female representation and portrayals in science comics. This study serves to update the existing body of research on the representation of females in printed text used by educators, more specifically science comics.

Definitions

There are several terms with multiple definitions used by scholars, and they are defined in the manner that is applicable to my study.

Gender stereotype: assumptions made about a gender's characteristics, including, but not limited to appearance, abilities, interests, occupations, and attitudes

Graphic novel: a book written using sequential art

Panel: an individual drawing representing a stationary moment within a sequence of multiple panels in a comic

Portrayal: the manner in which a female character is illustrated or described

Representation: the presence or absence of female characters from a comic

Science comic: For inclusion in this study, a science comic must be (a) a comic book or graphic novel (b) printed in English, (c) contain a central theme related to science or engineering, and (d) commonly available for use in middle school classrooms or libraries

Stereotype: "a widely held but fixed and oversimplified image or idea of a particular type of person or thing" (English Oxford Living Dictionaries, 2017)

Summary

This chapter described the problem that guided this study. The remaining chapters are organized in the following manner. Chapter II will present a review of the literature, and it focuses on feminist critical theory, feminist pedagogy, gender in science education, and the representations of females in illustrated literature for students. The chosen research methodology is detailed in Chapter III, which includes my research design, data selection, data analysis, and the constructs of validity and reliability. Chapter IV reports the data found, as well as how the data responds to the research questions. In the concluding Chapter V, my conclusions, implications for practitioners, and implications for future studies are addressed.

CHAPTER II: LITERATURE REVIEW

The purpose of this study is to analyze the representations of women in graphic science literature used in middle school settings. Although there is an assortment of published literature describing the portrayal of women in children's literature and media, there is a void in research focused on female portrayals in science comics read by middle school students.

Theoretical Framework

Theory frames the way one sees her/his self, others, and the world, and it provides the foundational tools to analyze, question, and challenge experiences (Davis, Sumara, & Luce-Kapler, 2000). Through the analysis of personal experiences and sociocultural actions, theorists create persuasive arguments for societal change. Feminist scholars have extensively studied the sociocultural effects on women's bodies and personalities (de Beauvior, 1949, Butler, 1999). Feminist theory criticizes patriarchal hegemony and seeks to expose the gendered power relations to reach equal power for women. It implies male ideologies are rooted in unequal power structures politically, economically, and socially whose purpose is to preserve the domineering beliefs and traditions, as well as the subordination of women (Butler, 1999; Hesse-Biber & Leavy, 2007).

Feminist critical theory examines the ways cultural media oppresses women socially, psychologically, politically, and economically while challenging relationships of power (hooks, 1984). Through our patriarchal society, the White upper-class male experience is used as the universal standard by which the experiences of women are evaluated. This blind ignorance to the female point of view has damaging effects on both women and men. For example, literature, music, and works of art created by women have not been considered representative of the experiences of all people because they were not created from a male point of view, resulting in

the marginalization of females (McVicker, 2011; Nochlin, 1988; Tyson, 2006). Culture and its societal norms are embedded into artifacts such as texts, pictures, music, and video. Critical theory attests that no cultural artifact is neutral or free of ideology, and it builds cultural understanding and social identity (Freire & Macedo, 1987). Thus it is imperative to conduct investigations of these artifacts to expose and challenge dominant ideologies and stereotyped representations.

The control of knowledge is central to the critical examination of public education; for whoever controls the delivery of knowledge (education) has the power. Education is analogous to a tool that can be used to keep society oppressed instead of preparing them to challenge their oppressor (Freire, 2000). The oppressors, or those with the power, determine what knowledge should be taught to the oppressed, ultimately resulting in the accepted truths. According to Giroux (1999), the critical analysis of education ensures school decisions can be "informed by a public philosophy that addresses how to construct ideological and institutional conditions in which the lived experiences of empowerment for the vast majority of students becomes the defining feature of schooling" (p. 1). Therefore, critical feminists aim to identify, challenge, and ultimately change the inequities of education with the purpose of ensuring the interests, backgrounds, and goals of all students are included in all aspects of teaching and learning.

Education should present learning opportunities for all students to understand the perspectives of marginalized societal groups, including women. Nevertheless, the White, Euro-western male perspective is taught in classrooms using pedagogical methods and materials designed for and benefitting White male learners (Owens, 2013). Sadker et al. (2009) reported at-length about how classroom communication, specifically the various treatments and responses provided by teachers, has supported male learners and deprived female learners. Classroom

biases and sexism encourages sociocultural norms, which follow students into the workforce where ultimately men receive more authority and higher salaries. Evidence from research has shown that women are less competitive than men; therefore, the endorsement of competitiveness among students, including grade point averages, high stakes assessments, and the selective placements of Honors and Advanced Placement courses, should be eliminated from schools (Gneezy, Niederle, & Rustichini, 2003; Niederle & Vesterlund, 2007).

In an education system deeply rooted in sexist norms, girls often experience isolation, misrepresentation, confusion, and even invisibility (Sadker et al., 2009). To combat this, educators can integrate feminist pedagogies and resources into their classrooms. For example, in a participatory learning setting, students and teachers are encouraged to share their diverse perspectives and experiences, which helps form relationships and promotes mutual respect and understanding (Hoffmann & Stake, 1998; Noddings, 1992; Weiler, 1995). Although the inclusion of feminist pedagogies is necessary, modifying classroom instruction is not adequate for creating an emancipatory education for all students – the curriculum, content, and resources must also be analyzed for marginalization. Classroom resources such as textbooks, trade books, and movies often omit or misrepresent women's voices from diverse backgrounds and reinforce the view that only middle and upper-class males are capable of "doing" science (Barton, 1997; Previs, 2016). Because texts are instrumental in establishing sociocultural norms (Peterson & Lach, 1990; Weitzman et al., 1972), it is crucial that educators deconstruct the cultural understandings of gender, race, and class in curricular resources, as well as their methods of instruction, to reveal any implicit or explicit representation of privilege or marginalization.

Science and Gender

Early feminist research in science education was dedicated to providing females with equal access to the same educational opportunities to excel in science as their male peers (Brickhouse, 1998; Brotman & Moore, 2008). In addition, feminists urged science educators to support girls in science through the implementation of classroom interventions and after-school programs (Drury, Siy, & Cheryan, 2011; Duran et al., 2014; Fadigan & Hammrich, 2004). Where most research has analyzed the role of teachers, some researchers have investigated what students can do to promote gender equitable classrooms. Guzzetti and Williams (1996) investigated high school physics students' awareness of gender inequities within the classroom and suggested the involvement of students in altering gender bias in the classroom. Samuels (1999) maintained the focus should be on eliminating the stereotypes depicting scientists as only males in textbooks and other mass media. Feminists challenged the scientific workplace where women are discriminated against or excluded from the scientific community altogether because of their familial responsibilities (Baker, 1998; Dasgupta, & Stout, 2014; Hill, Corbett, & St. Rose, 2010). Focusing on equity issues in the scientific workforce helped to reestablish the vision of establishing gender equitable science education. Yet, this redirection failed to address the dominance of traditional androcentric epistemologies, including Enlightenment epistemology, on what is considered scientific knowledge (Brickhouse, 1998, 2001).

In addition to the content being primarily authored by men, feminists have challenged the role of authority in education through the development of instructional practices that disrupt the traditional hierarchy between students and teachers. These pedagogies reduced the role of the teacher from the all-knowing evaluator and knowledge dispenser to that of student facilitator and co-learner (Belenky, Clinchy, Goldberger, & Tarule, 1986; Noddings, 1992). Noddings' (1988)

ethic of caring established the significance on the relationship between student and teacher and the ways each responds to the other's intellectual and emotional needs. Feminists did not believe it was enough to level the playing field regarding equitable science education, which fueled the challenge of the unjust societal structures by changing science curriculum and pedagogy (Brotman & Moore, 2008).

Harding (1991) and Harraway (1998) sharply critiqued the objectivity of science due to sociocultural influences and the context in which scientific knowledge was created. Societal values, which include gender, have dictated what should be studied, tested, and observed by scientists in the natural world, and therefore, makes it impossible to separate scientific knowledge from these values (Brickhouse, 2001). Because science is not separate from gender influences, it has historically created dualisms, such as masculine/feminine, objective/subjective, reason/emotion, and mind/body (Hekman, 1990; Thayer-Bacon, 2003). Through these dualisms, our culture has aligned the values of science, objectivity, reason, and mind with masculinity while establishing opposition to femininity. Finally, feminists have criticized science curriculum because White Western males have primarily written the scientific concepts on which it is based, ultimately creating problems for science educators in their pursuit of gender equitable science education (Brickhouse, 2001; Harding, 1991; Pagano, 1988).

Middle school (grades 6-8) is a crucial time for students' academic performance in both science and mathematics, which determines their enrollment in high school courses, as well as attitudes and future career interests in science (Singh, Granville, & Dika, 2002). Between the ages of nine and fourteen, interest in science among female students significantly decreases (Archer et al., 2010). By the eighth grade, the persistent stereotypical belief of the male as scientist reduces girls' interest in science (National Science Foundation, 2007). Before entering

high school, most students have already determined whether to take advanced science and mathematics courses (e.g., Advanced Placement, Honors, International Baccalaureate), usually based on their middle school experiences that predominantly neglect female ways of knowing and experiential learning. Students are not born rational thinkers; instead, they begin in a relational state with their mothers and caregivers and attain knowledge through their interactions with others (Thayer-Bacon, 2013). Nevertheless, educators choose instructional strategies and resources that appeal to boys while neglecting the learning styles and educational needs of girls.

Since Isaac Newton's mechanistic view of science, the wave of empirical sciences and view of science has flourished. This circumstance has resulted in science being a male-dominated or male-favored area, and therefore, has typically excluded women in pedagogical decisions and depictions in instructional resources. Contrasting with current educational pedagogy, feminist scholars have maintained the way knowledge is constructed is equally as important as the actual content (Harding, 2008; Smith, 1992). Scientific concepts are primarily taught without any explanation of the experiences, struggles, and challenges faced by scientists (Kuhn, 2012; Lin-Siegler, Ahn, Chen, Fang, & Luna-Lucero, 2016). Research has shown that students strongly identify with the gender portrayals in classroom textbooks (Blumberg, 2008; Foley & Boulware, 1996). Some textbook publishers have included achievements made by relatively few female scientists, such as Marie Curie and Rachel Carlson, in their texts. However, these fragmented references usually appear in a sidebar at the end of a chapter, while the contributions of male scientists are part of the main narrative. Absent from science textbooks are the scientific contributions of pivotal figures like McClintock, Jackson, Daly, Johnson, Franklin, Hodgkin, Goodall, Wu, Lovelace, Fossey, or Blackburn (to name a few). These omissions beg

the question of how girls are expected to relate to a subject when the accomplishments of female scientists are excluded (or not credited) from the textbook.

In addition to relational problems, the exclusion of female contributions to science, technology, engineering, and mathematics in science education has perpetuated the belief that women are unable to succeed in science or careers in science (Watts, 2014). Because of this stereotype, females are often discouraged from studying the physical sciences, resulting in inadequate exposure to these scientific disciplines and ultimately poor assessment performance in these areas (Lauer et al., 2013; OECD, 2016; Watts, 2014). Assessment scores have been used to perpetuate the stereotype that female students lack the ability to be successful in the physical sciences, hindering female students from enrolling in physical science and mathematics courses in high school and college (Hong, Lin-Siegler, & Graesser, 2012). Feminist scholars criticize the historically androcentric views of science as rational and objective and suggest scientific practices that reflect science and knowledge as being relational and socially constructed (Keller, 1992; Smith, 1992).

Relational Science

Relational scientists choose to view the world as evolving, unified, and interactive with its inhabitants. James Lovelock (1979/1987) dissolved the traditional boundaries among biology, chemistry, physics, and geology with his Gaia theory. The Gaia theory posits that Earth's organic and inorganic components jointly evolved forming one single self-maintaining and self-transforming living system, the biosphere, which affects oceanic chemistry, atmospheric makeup, and global temperature (Lovelock & Epton, 1975). Facing harsh criticisms and rejections from the scientific community, Lovelock continued to develop his relational theory of the interconnectedness of Earth's biotic and abiotic components. He has become increasingly

vocal about our transactional relationship with Earth due to serious ecological imbalances caused by humans, such as extensive deforestation in the Amazon, widespread loss of biodiversity, and the accumulation of greenhouse gases.

Lynn Margulis' symbiotic theory of evolution also faced opposition from the scientific community. Contrasting with the evolutionary principles of Darwinism, Margulis' (1998) theory suggested that all organisms containing a nucleus (eukaryotes) originated from an endosymbiotic relationship with organisms without a nucleus (prokaryotes). The prokaryotic organisms living inside specific organelles of the larger eukaryotic cell provide and receive life-sustaining benefits. In addition to embracing the collaborative partnerships of macro- and microorganism, Margulis' theory emphasized the understanding that the world continually evolves through cooperative alliances among living organisms rather than individual competition (Margulis & Sagan, 1986).

The Nobel prize-winning geneticist Barbara McClintock practiced science in a compassionate way, eliminating the boundary between the observer and the observed (Thayer-Bacon, 2003). McClintock viewed the maize plants she studied as "friend[s] she was trying to understand" (Thayer-Bacon, 2003, p. 240). In direct contrast to her cytogeneticist peers who used fruit flies or bacteria in their research, McClintock chose to work with maize plants, which have a longer development time. She modeled compassionate consciousness through her direct interactions with her friends, the maize plants, and professed, "As you look at these things they become a part of you" (Skolimowski, 1994, p. 166). This relational view of nature revolutionized science with its opposition to the masculine mechanical framework established in the late 17th century with Isaac Newton. Like McClintock, Margulis, and Lovelock, educators can challenge

the masculine framework inherent in science education through the promotion of connected, or feminist pedagogy.

Feminist Pedagogy

The interests, experiences, and cognitive needs of female students, as well as male students, students of color, and students from low socioeconomic households, should be included in science instruction. Students need to feel genuinely connected to the instructional content in order to remain engaged to develop their conceptual understanding and science identity (Carlone & Johnson, 2007; Jordan, Fern, Morris, Cross, & Mathur, 2014). In order to advance gender equity in science education, some researchers have suggested providing positive science experiences to girls, including exposure to female scientist role models and involvement with scientific phenomena outside of school (Drury, Siy, & Cheryan, 2011; Duran et al., 2013; Hermann et al., 2016; Hong, Lin, & Lawrenz, 2008; Zeldin & Pajares, 2000). Others posit the media that girls are exposed to within the classroom setting, such as textbooks, videos, and trade books, influences the self-identities, high school and college course selections, and possible career choices of female students (Brotman & Moore, 2008; Halpern et al., 2007). In addition to challenging the educational system and its methods for educating female learners, critical feminists also propose solutions such as Noddings' (1988) ethic of caring that removes individualism and replaces it with interpersonal connections among students and teachers. Educational policymakers, administrators, and teachers must attentively select instructional materials (print and multimedia) that reflect diverse perspectives, and throughout the selection process, the materials should be carefully examined for healthy portrayals of females and female scientists of all races, ethnicities, and backgrounds.

Feminists have also criticized science education for its lack of acknowledging the differences between female and male learners (Belenky et al., 1986; Harding, 1991). In their explorative study on the ways women approach learning and knowledge, Belenky, Clinchy, Goldberger, and Tarule (1986) acknowledged five different ways of knowing for women: silence, received knowledge, subjectivism, procedural knowledge, and constructed knowledge. Silence, received knowledge and subjectivism are considered passive approaches to knowing because of the absence of new ideas or the inability to assess the legitimacy of others' ideas (Belenky et al., 1986; Zohar, 2006). Active, creative, and critical thinking are expressed in procedural knowledge and constructed knowledge (Belenky et al., 1986; Clinchy, 2002). Procedural knowledge, divided into either separate or connected knowing, uses context-specific methods to evaluate sources of knowledge and to communicate what they know to others (Belenky et al., 1986). Whereas a separate knower evaluates from an unbiased, impersonal perspective, a connected knower strives to understand others using their contextual experiences (Belenky et al., 1986; Clinchy, 1989). It is the connected knower's belief that knowledge is personally constructed from experiences, intuition, reason, emotions, and imagination (Belenky et al., 1986; Ruddick, 1996; Thayer-Bacon, 2003). Thus, integrating women's ways of knowing into science education would signify to all learners that girls' experiences and interests are equally as important as their male peers (Belenky et al., 1986; Howes, 2002).

The instruction in science classrooms should be carefully planned to assist female students in developing their identities and understandings of science (Brickhouse, 2001; Legewie & DiPrete, 2014). However, conventional science instruction emphasizes an androcentric learning culture of individuality and competition, which significantly decreases female participation (Koul, Roy, & Lerdpornkulrat, 2012). Previous research has indicated that both

male and female science teachers make instructional decisions that primarily benefit male students (American Association of University Women [AAUW], 2002). Female students are less likely to be called on to complete tasks, answer higher-order thinking questions, and receive less praise and substantive feedback than their male peers (Moss-Racusin et al., 2012; Sadker, Sadker, & Zittleman, 2009; Shumow & Schmidt, 2013). In addition, gender differences in self-confidence in science and mathematics manifest as students undergo puberty during the middle school years (6-8) and increase in high school (Cavanaugh, Riegle-Crumb, & Crosnoe, 2007; Hill, Corbett, & Rose, 2010; Pajares, 2005).

Feminist pedagogy addresses the gender inequality in the classroom by challenging the content that is taught and the instructional methods used. It has been described as interactive, experiential, collaborative, relational, connected, and rational (Gunter, 2000; Kimmel, 1999; Maher & Tetreault, 2001). Some feminist scholars have advocated for educators and students to defy the status quo by creating collaborative learning environments that inspire and reassure all learners (hooks, 1984). In a classroom culture influenced by feminist pedagogy, the teacher and the students validate the experiences and voices of all students, and they encourage each other to make connections between their learning and their own lives (Kimmel, 1999). Examples of feminist pedagogy in the science classroom include interdisciplinary learning units, collaborative learning experiences, performance-based assessments, and long-term scientific investigations that are applicable to students' lives (Capobianco, 2007; Rosser, 1997). The Next Generation Science Standards, the most recent national science education reform, align with feminist pedagogy in their push for educators to "have a more thorough understanding of content, culture, and discourse" (Raven, 2014, p. 244).

Girls benefit from a relational curriculum that incorporates female experiences and interests (Häussler & Hoffman, 2002; Howes, 1998, 2002; Zohar, 2006). Instead of the traditional science classroom, which is separate and disconnected from the female learner and how she approaches the world, a relational approach to learning uses authentic learning experiences to connect the learner and her experiences with the content that is being studied. Häussler and Hoffman (2002) studied specific curricular interventions aimed at improving high school girls' interest in physics. Their study indicated that a relational approach to teaching science topics related to the lives and culture of female students positively impacted students' self-confidence and proficiency in physics (Häussler & Hoffman, 2002). Brotman and Moore (2008) posited that a gender-inclusive curriculum is built on the experiences of both female and male students, prioritizes active learning instead of passive learning, integrates real-life scenarios and contexts, and promotes communication and collaboration among learners. For example, the use of inquiry-based or hands-on instruction has been shown to improve attitudes toward science and the learning of scientific concepts for both girls and boys (Brotman & Moore, 2008).

A relational approach to education challenges the traditional positivist assumptions of science and sexist approaches to science education. All genders, races, ethnicities, backgrounds, sexual orientations, and abilities are accurately represented and portrayed in relational science education to address the intersectionality of social identities (Scantlebury, 2012). This inclusive approach to science education is intentional in its integration of diverse social and cultural perspectives into the curriculum. Relational learning allows students to co-construct their knowledge through their interactions and relationships using reason, emotions, intuition, and imagination (Ruddick, 1996; Thayer-Bacon, 2003). To truly embrace the relational approach to learning and, science educators should modify instruction to promote discourse, rearrange the

classroom layout to encourage student interactions and co-construction of knowledge, and select curricular materials that avoid marginalization, stereotyping, and gender exclusivity (Raven, 2014).

Gender Representation in Classroom Literature

Literature that students are exposed to acts as a sociocultural influence affecting their beliefs and knowledge about gender and other cultural norms. The Child Study Association of America (1969) advised authors to carefully craft their narratives and illustrations because of their significant influence on the psychological development of children. This report triggered the examination of children's literature for multiple socio-cultural issues, including depictions of race, ethnicity, class, and gender.

Weitzman, Eifler, Hokada, and Ross's (1972) pioneering study investigated the representation of women in eighteen Caldecott Award-winning children's books, as well as their portrayal of gender roles and stereotypes. Their results exposed vast underrepresentation of women in the book titles, main characters, and illustrations, in addition to the reinforcement of gender stereotypes such as the predominance of submissive, dependent, and domestic females and authoritative, independent, and active males (Weitzman et al., 1972). According to Weitzman et al. (1972), children's literature serves as "a vehicle for the presentation of societal values to the young child…In addition, books provide children with role models – images of what they can and should be like when they grow up" (p. 1126). Results concerning gender representations from LaDow's (1976) and St. Peter's (1979) content analyses of children's books were similar to those of Weitzman et al. (1972). From a critical feminist perspective, this would indicate a correlation between the results of these studies and the accepted socio-cultural norms of that period.

In addition to the representation of female characters, it is also important to identify and challenge gender bias portrayed in classroom literature. One of the ways children are taught societal expectations and values, such as gender roles, is through books. Prior research examining gender stereotypes in children's books has focused on quantifying the frequency of females in submissive or confined roles (Hamilton, Anderson, Broaddue, & Young, 2006; McCabe, Fairchild, Grauerholz, Pescocolido, & Tope, 2011; Weitzman et al., 1972). Kortenhaus and Demarest (1993) discovered that despite an increase in female characters depicted in Caldecott and non-award winning children's books, characters were predominantly portrayed in sexist and biased roles. For instance, pages with animals being cared for or used by a human character primarily showed a male having control (Kortenhaus & Demarest, 1993). Even though children can feel confused and isolated from their peers when they do not see themselves represented in books and media (Sadker et al., 2009), the marginalization and stereotypical portrayals of gender persist in contemporary children's literature (Crabb & Marciano, 2011; McCabe et al., 2011). In their analysis of Caldecott books from 1990-2009, Crabb and Marciano (2011) concluded that female characters were more likely than males to be illustrated using tools of domesticity (i.e., cooking, cleaning, ironing), and they were less likely than males to be illustrated using tools of production (i.e., construction, manufacturing, farming). In their study of children's science trade books, Rawson and McCool (2014) found a majority of the images portrayed the scientist as a White male. This result is alarming because teachers often use science trade books as supplements to the traditional textbooks, and these books are reinforcing young readers to gender stereotypes about science careers (Rawson & McCool, 2014).

Although there have been studies that exclusively targeted the representations of physically active females in television and adult print media, little research has been conducted

using children's picture books. This void in the research led Roper and Clifton (2013) to their analysis of ten children's picture books for representations of physically active female characters. The study's findings indicated nine of the sampled texts portrayed female characters wearing appropriate clothing or athletic apparel. All ten books depicted physically active female characters; however, all ten female characters were illustrated with slender bodies, an unrealistic portrayal of the bodies of young girls. In addition, stereotypical gender roles of parents were evident in this study with the fathers actively involved in the female characters' physical activity, while the mothers primarily functioned as an encouraging support. Only three books contained discouragement by peers, yet the female characters ignored their peers' criticisms and persevered. Finally, comparing physical abilities of females to males, three books affirmed that girls were better than boys. Although these affirmations were most likely intended to reduce female inferiority, they only succeeded in perpetuating gender inequality. From this study, it is evident that more authors and publishers of children's books need to create stories about physically active females and gender equity.

Textbooks have a significant influence on a teacher's pedagogical decisions, and they are often the primary instructional resource used when designing activities and lessons (Chiappetta, Ganesh, Lee, & Phillips, 2006). With the focus on standardized testing tied to teacher accountability, middle school and high school educators have become dependent on textbooks for teaching science (Ceglie & Olivares, 2012). However, textbooks provide limited support in students' exposure to gender neutral, including the range of occupations and roles of females (Blumberg, 2008; Ceglie & Olivares, 2012). According to Pienta and Smith (2012), "When textbooks do not portray representations of women engaging in scientific pursuits to improve the world, then female students have few role models to guide them to become stewards of social

transformation in the working world" (p. 34). Curricular resources, including textbooks, lack positive female role models desperately needed to influence early career aspirations (Provenzo, Shaver, & Bello, 2011). In Delgato's (2009) study of science textbooks from major publishers, most of the illustrations were of White adult males. In addition, adult females were depicted in submissive or background roles instead of actively engaged in "doing science" (Delgato, 2009). Consequently, textbooks contribute to the overall tone of marginalization and misrepresentation of females resulting in many female students developing a negative self-identity about science and avoiding active participation in science courses (Ceci, Williams, & Barnett, 2009). Because textbooks often drive classroom delivery of instruction, the absence of content is as crucial as what is present. The result has been some educators adopting different text and media formats, such as comics, graphic novels, and mass media into their classrooms (Botzakis, 2011; Versaci, 2001).

Comics

Comics have served as supplementary curricular materials in classrooms due to their positive effects on reading skills (Crawford, 2004; Gustafson, 2007), engagement (MacDonald, 2004; Nylund, 2007), and the development of multiple literacies (Schwarz, 2002). Even with these positive effects on learning, educators should carefully select graphic texts that do not marginalize or misrepresent people. Through a feminist lens, Jorgensen and Lechan (2013) reviewed the history of comics and graphic novel publishing from the early 1930's to the present decade and discovered numerous examples of gender bias. It was from this review that they established criteria to assist librarians (and other readers) in selecting comics and graphic novels with healthy female role models. Using the Amelia Bloomer Project, a booklist of the best feminist books for young readers, Jorgensen and Lechan (2013) based their criteria on "feminist

books [that] show women solving problems, gaining personal power, and empowering others. They celebrate girls and women as a vibrant, vital force in the world" (p. 276).

According to Jorgensen and Lechan (2013), the story should contain strong female protagonists who play an active role in the story's development, assume non-traditional roles or make informed decisions to remain or leave traditional roles, and are not reliant on males for their emotional or physical well-being. Female characters should be unique, realistic representations of various races, ethnicities, classes, and sexual orientations that are identified by their own traits and depict positive growth. To address the varied interests of different girls, authors should create storylines from multiple genres including, but not limited to, historical fiction, nonfiction, fantasy, action, romance, and mystery. Also, the stories should reflect the diverse interests of its readership, spanning a cross-section of daily struggles, lifestyles, and relationships. Depictions of violence against women should never be used to propel the plot, need to be addressed thoughtfully, and include the consequences for the offenders and victims. Lastly, Jorgensen and Lechan (2013) suggest artwork should include different styles, enhance the story's plot, and never hypersexualize females. To aid in combatting gender stereotypes, it is critical for educators to carefully review and select resources that portray women in a positive, gender-conscious manner. These criteria could assist educators in selecting comics and graphic novels that foster positive, healthy female protagonists.

Most people associate comics with the illustrated stories of superheroes and villains. These mainstream superhero comics are known for their resilient, heroic male characters actively defending the world against evil and crime. Unfortunately, they also have a reputation for portrayals of passive, hypersexualized females and the reinforcement of gender stereotypes. Historically, women in comics had the tendency to flaunt their bodies in their pursuit of the male

protagonist (Collins, 2003). Comic book writer and illustrator, Trina Robbins (1996), suggested the flagrant depiction of heroines as sexual objects likely narrowed the readership of superhero comics. Female characters are typically drawn with unrealistic body types similar to the idealized supermodel or adult film star (Thompson, 2012). Even though both males and females are often portrayed in comics wearing tight-fitting costumes, only the females are illustrated in "clothes [that] are constantly falling off, strategically ripped, or hardly there in the first place" (Jorgensen & Lechan, 2013, p. 274). Cocca (2014) conducted a mixed methods study to determine the frequency of "broke back" art, when "a female character's back is drawn unnaturally twisted…displaying all of her curves in front and back simultaneously" (p. 411), which serves only to objectify them. The sample of 144 issues included both female-headed (Wonder Woman, Supergirl, Batgirl, etc.) and ensemble (e.g., Avengers, Justice League) mainstream superhero comics published by the largest superhero comic publishing companies, Marvel and DC, from the past twenty years.

Using quantitative content analysis, Cocca (2014) compared the covers and panels of earlier published issues with more recent issues of the same title, as well as female-headed titles with ensemble titles. Her search included the numbers of (1) speaking female characters / total number of characters, (2) panels depicting women and women's bodies / total number of panels, (3) broke back poses, (4) arched back poses, and (5) bare breasts, barely covered breasts, or breasts larger than the character's head. This quantifiable data from all samples was then compared across comic book titles and publishers, as well as over time.

Cocca (2014) reported lower female representation in the ensemble titles (25% of characters, 25% of panels) than the female-headed titles (~50% of characters, 66% of panels). Out of 144 issues analyzed, the portrayal of female characters in a sexually objectifying manner

was evident in 136 issues. The covers of ensemble titles contained more images (66%) of broke back, other sexualized poses, and large or revealed breasts than the female-headed titles (50%), while the panels of both the ensemble and female-headed titles had fewer occurrences (33% and 25%, respectively). In comparing both ensemble and female-headed title issues by decade, the objectification of women was approximately 50% less during the 2010s than the 1990s. However, objectified female characters were more prevalent in the current ensemble titles (30%) than the female-headed titles (15%).

Although the number of occurrences has decreased, Cocca's (2014) study confirmed female characters are still hypersexualized in modern superhero comics. With their reduced number of appearances in both overall issues and panels, it is crucial to represent female characters in a positive, healthy way. This representation can only be accomplished if the authors, illustrators, and publishing companies take ownership in their perpetuation of gender stereotypes and then make conscious, concrete efforts to eliminate it from their pages.

Science Comics

Educational reform efforts have focused on increasing student engagement and performance in science. Some science educators have turned to a popular medium that students choose to read on their own – comics – as a possible means to increase the academic performance and engagement of students.

A study conducted by Hughes-Hassell and Rodge (2007) found 78% of females surveyed read for pleasure, compared to 64% of male students, confirming results from previous studies conducted on leisure reading (Moffitt & Wartella, 1992; Simpson, 1996). Also, 44% of surveyed students preferred reading comics, while only 30% favored books (Hughes-Hassell & Rodge, 2007). The combination of student interest in comics and science education reform has prompted

several publishing companies to create educational science comics (Tatalovic, 2009). To increase interest and learning in the academic sciences, teachers and librarians are making room on their bookshelves and e-readers for science comics. Contemporary examples include Capstone Publishing's *Max Axiom Super Scientist* series (Capstone Publishing, n.d.), First Second's *Science Comics* series (First Second, n.d.), the University of Nebraska's *World of Viruses* series (Diamond et al., 2012), and Jay Hosler's *Optical Allusions* (Hosler, 2000). The expanding popularity of the use of science comics in classrooms is a relatively recent phenomenon, and there have been few studies conducted on them as yet.

Students are bombarded with multiple forms of communication, including, but not limited to lectures, textbooks, Internet sites, worksheets, signs, as well as non-verbal forms such as facial expressions and body language. To provide students with the critical skills necessary to engage in making meaning from diverse communicative forms, educators are embracing the view of literacy occurring in multiple modes through the use of graphic literature (Jacobs, 2007; Versaci, 2001). The separated panels within comics provide multiple opportunities for students to make cognitive connections and negotiate meanings through inductive and deductive reasoning. Literacy researchers have identified the need to expand literacy education beyond the traditional word-based approach to one that integrates multiple modes of meaning-making and relates the textual to visual, audial, spatial, and behavioral (Cope & Kalantzis, 2000). Educators have used multimodal texts, such as comics and graphic novels, to improve literacy and increase engagement through the combined use of illustrations and verbal content (Hoover, 2012; Jacobs, 2007; Mills, 2010; Yildirim, 2013).

Science classrooms have seen similar benefits to student learning through the use of comics (Hosler & Boomer, 2011; Özdemir, 2010; Rota & Izquierdo, 2003). Hosler and Boomer

(2011) studied the effectiveness of science comics on the learning and engagement of undergraduate students. The four participant groups included (1) non-science majors enrolled in an introductory biology course, Sensory Biology, (2) sophomore science majors enrolled in Biology II, (3) junior and senior science majors enrolled in Organic Evolution, and (4) junior and senior science majors enrolled in Neurobiology. The science comic, *Optical Allusions* (Hosler, 2000), was used to supplement the instruction of Sensory Biology, Organic Evolution, and Neurobiology; the comic was not used in Biology II, which served as the control for the study. Results indicated the science comic was as effective at communicating scientific concepts as the traditional textbook (Hosler & Boomer, 2011). Furthermore, Hosler & Boomer's (2011) noted the use of comics significantly increased the engagement and attitudes toward biology of the non-majors, yet produced no significant change in the upper-class biology majors.

Researching the effects of instructional science comics on sixth-grade students, Özdemir (2010) discovered that students exposed to science comics during classroom instruction achieved significantly higher scores on the post-test than the control group. Results from this study also indicated there was an increase in the participation of disinterested students when science comics were used (Özdemir, 2010). In another study, Rota and Izquierdo (2003) created and used a science comic to analyze its effect on teaching agricultural biotechnology to Brazilian students (ages 12-14). Qualitative results from this study indicated an increase in questions asked, curiosity on the topic, and motivation to search for additional information related to the concept (Rota & Izquierdo, 2003). On the use of comics in science as a pedagogical tool, Rota and Izquierdo (2003) remarked, "if information is diluted in the adventure, in the humor, it is received with excitement and the learning process doesn't have barriers or restrictions" (p. 87).

This occurs simultaneously with active thinking, which occurs when the reader is forced to make inferences between sequential comic panels from different settings.

Citing evidence from educational and psychological research, Jee and Anggoro (2012) published a list of potential cognitive impacts of science comics on student learning to inform educators, future researchers, and creators of science comics. First, science comics serve as visual models making abstract phenomena more concrete, from the microscopic processes of the human body to the macroscopic interactions of astronomy (Jee and Anggoro, 2012). Next, unlike traditional textbooks, the combination of text embedded in an image (i.e., spatially contiguous) in a comic book leads to better understanding compared with text separated from an image (Jee and Anggoro, 2012). Also, the use of narrative storytelling in comics, versus the informative and analytical nature of textbooks, forms mental placeholders for new information that assist the reader with creating inferences. Finally, relational or personified story characters can increase engagement, as well as improve memorization (Jee and Anggoro, 2012). However, Jee and Anggoro (2012) warned against unrelatable characters and their potential for reinforcing negative stereotypes and advocated for the inclusion of diverse characters to appeal to all readers. Ultimately, focusing on the cognitive science can maximize the impact of science comics on learning.

Science comics can be used to engage learners and teach scientific concepts, as well as improving their visual literacy, or ability to interpret and use visual information. As with any classroom medium, educators must consider not only the scientific content of the comics but also how that content is conveyed and its appeal to all learners. Despite the increasing presence of science comics in classrooms and libraries, research has not yet been published regarding their representation of females.

Summary

This literature review explored several foundational topics related to the representation and portrayal of females in science comics, beginning with the foundational lens for this study: feminist critical theory. This was followed by a review of feminist research in science education, which focuses on opposing the traditionally masculine views of science as well as the methods for teaching science. The literature also described research-based feminist pedagogies for teaching science to all learners. Next, research on representation and portrayals of females in graphic literature used in the classroom, including children's books and comics, was reviewed. Finally, this chapter concluded with studies detailing the cognitive benefits of using comics in a science classroom.

CHAPTER III: METHODOLOGY

As specified in Chapters 1 and 2, the purpose of this study is to examine the representation and portrayals of females in science comics through a critical feminist lens. This study was guided by the following research questions: 1. How are females represented in science comics? 2. In what ways are females portrayed in science comics? In this chapter, I describe the data source, data analysis methods, and the rationale behind my selections. The first section describes the design of my research study. Next, I provide an explanation of the sample of comics, followed by an explanation of the methods used to collect and analyze data. Finally, I describe the ways trustworthiness is maintained throughout this study.

Research Design

Having roots in the study of mass communications in the 1950s, early forms of content analysis emphasized the systematic examination of identifiable aspects of texts (Krippendorff, 2004). More contemporary approaches have been adapted outside the field of mass communications to offer researchers flexibility in their descriptions, analyses, and interpretations of societal artifacts (White & Marsh, 2006). This flexibility assists the researcher in making "predictions about the variables of interest or about the relationships among the variables" (Hsieh & Shannon, 2005, p. 1281).

According to Beach et al. (2009), content analysis is "a conceptual approach to understanding what a text is about, considering content from a particular theoretical perspective, such as sociohistorical, gender, cultural, or thematic studies" (p. 130). During content analysis, evidentiary materials (e.g. documents, interview transcripts, video recordings, pictures, music, etc.) are systematically reduced to manageable categories, which are then analyzed allowing the researcher to make inferences about the materials, eventually leading to new insights and

understandings of a particular phenomenon (Becker & Lissman, 1973; Krippendorff, 1969; Neuendorf, 2017). Unlike other research methodologies, the data collected using a content analysis is not created by the researcher and is non-interactive; therefore, there is an inherent level of authenticity (Hesse-Biber & Leavy, 2006).

Feminists use content analysis to critically analyze cultural materials to challenge the patriarchal dominance over society that marginalizes and oppresses women and other minorities (Hesse-Biber & Leavy, 2007). During the progression of the modern women's movement in the 1950s and early 1960s, feminist scholars began "to document the assertion that images of women in Western culture have generally been created from the male perspective" through the critical analysis of content (Stern, 1999, p. 2). Early content analysis studies examining the depictions of gender roles in comic strips went beyond quantifying the numbers of females and males depicted and instead focused on hidden features, such as the emotions, goals, relationships, and intelligence of characters (Saenger, 1955; Spiegelman, Terwilliger, & Fearing, 1953). In their study of gendered portrayals in comic strips, Spiegelman, Terwilliger, and Fearing (1953) found the male characters were predominantly involved in gaining power through violence or other actions, while female characters were interested in obtaining a loving relationship through their groomed appearance. This blatant sexism persists in contemporary superhero comics, along with the overemphasis of female sexualization over their achievements (Brown, 2011). From a critical feminist perspective, content analysis examines the correlation between the representations of gender and reality, challenges the sociocultural views of women and men, and forms the foundation for additional research on the effects of the content on its recipients (Leavy, 2007; Rudy, Popova, & Linz, 2010).

Qualitative Content Analysis

Content analysis can be used in either quantitative or qualitative research studies, or in studies merging these two paradigms (Bauer, 2000; Mayring, 2000). Within a sociocultural context, some meanings are more standardized, or automatic, and require little interpretation from the researcher, resulting in the selection of quantitative content analysis as the preferred method (Schreier, 2012). However, if the content lacks distinct, universal meanings and must be interpreted by the researcher, such as the presence of stereotyped gender roles, then qualitative content analysis (QCA) is utilized (Schreier, 2012; Zhang & Wildemuth, 2009).

QCA examines the existence, meanings, and connections of words and concepts embedded in cultural artifacts (Krippendorff, 2004). The processes of QCA, including the conceptualization of the study, data collection, data analysis, and interpretation of the results, do not always follow a predetermined structure to discover implicit themes in content (Bryman, 2012; White & Marsh, 2006). Research questions and broad categories are created at the initial stage of research; however, they can be modified, expanded, or rejected throughout the research process. QCA requires the reading and rereading of evidentiary materials "to pin down key themes and, thereby, to draw a picture of the presuppositions and meanings that constitute the cultural world of which the textural material is a specimen" (Denzin & Lincoln, 2005; p. 870). In contrast to quantitative content analysis, the researcher may alter the entire direction of QCA with the discovery of new significant patterns or concepts (Krippendorff, 2004; Schreier, 2012).

The researcher selects one of three different strategies for constructing the coding frame in QCA. First, the deductive approach uses predetermined coding categories based on prior research or existing theories (Hsieh & Shannon, 2005). Frequently this is used to compare results across different data types, time periods, or cultures (Schreier, 2012). Next, an inductive

approach to QCA engages the researcher in open coding and continual interpretations of emergent data categories (Flick, 2014; Hesse-Biber & Leavy, 2007). During this coding process, the researcher questions data, identifies common themes, and reveals new meanings as relationships among concepts and data are uncovered (Coffey & Atkinson, 1996; Mayring, 2000). Finally, qualitative studies are designed to be inherently flexible; therefore, QCA can employ a combination of both deductive and inductive strategies.

This study involves the revealing of implicit themes within the content, requires active interpretation by the researcher, and employs a flexible coding scheme based on both previous research and developing patterns. Therefore, I selected the combined inductive/deductive approach to QCA as the most appropriate method for examining the representation and portrayals of females in science comics.

Researcher Reflexivity

According to Goodall (2000), reflexivity is "the process of personally and academically reflecting on lived experiences in ways that reveal deep connections between the writer and his or her subject" (p. 137). As this was a qualitative research study, I performed an integral role throughout the research process. In fact, during the analysis, I served as the research instrument. Therefore, it was necessary to convey my background, experiences, and beliefs that could potentially affect my approach to this study and my interpretations of data (Creswell, 2013).

I identify as a White feminist male reared by two parents together with my two male siblings in suburban middle class neighborhoods in Sandston and Sterling, Virginia, and Johnson City, TN. I have thirteen years of experience teaching science in a Title I public middle school and eight years of experience teaching at the university level, both located in the city where I reside. Biology was my undergraduate course of study, while my postgraduate education focused

on education. Personally, I enjoy reading graphic novels, and I have served on informative discussion panels regarding female representation in educational materials.

I have observed the stereotypical portrayals of females in media such as television programming, movies, and advertisements. Being an uncle to a niece and godparent to two females has motivated me to examine the curricular materials used by science educators. As an alternative to the traditional textbook, my students use science comics in the classroom throughout the academic year, indicating a correlation of my research interests to my professional interests. It is possible this study's finding could impact the instructional decisions I make, such as selecting curricular materials and making recommendations to administrators, colleagues, and loved ones. In addition to my research focus, I am cognizant that my life experiences as a White middle-class male and as a feminist researcher could influence my data analysis. Throughout the research process, I have recorded and critically analyzed my thoughts in my research journal, which has forced me to continually reflect on potential biases and ways to minimize them.

Sample

Selecting a sample that appropriately responds to my research questions is of great importance. Therefore, I purposefully compiled a sample of science comics awarded the Great Graphic Novels for Teens by the Young Adult Library Services Association (YALSA) using their Teen Book Finder Database. A Microsoft (MS) Excel spreadsheet was created to store and organize information about the sample including title, author, publication date, publisher, publisher's description, YALSA award, and cover art (Appendix A).

YALSA award-winning science comics were selected because of their potential for the highest accessibility due to their purchase availability, prominent placement in bookstores and on

websites, and additional advertising that is afforded to award-winning books. The Great Graphic Novels for Teens is an annual list of recommended graphic novels and illustrated works of non-fiction for 12-18-year-old readers (ALA, 2012). I intentionally included comics without apparent female protagonists or secondary main character (in the publishers' descriptions or on their covers) in the sample to address the first research question – *How are females represented in award-winning or nominated science comics?* All titles were reviewed and judged for inclusion in this study based on the following selection criteria:

- Science comic book or graphic novel
- Printed in English
- Target audience of ages 11-14
- Recipient of a YALSA award
- Can be used to teach a scientific concept
- Available for purchase (i.e., not out of print)

When multiple award-winning titles from a series existed, such as *Cleopatra in Space* and *Legends of Zita the Spacegirl*, only the first YALSA award-winning volume was included in the sample. After eliminating comics that did not satisfy all required criteria, the final sample was reduced to eighteen titles (Table 1).

In tandem with selecting the sample, I selected the coding unit, or unit of text that is classified during coding (e.g. words, phrases, sentences, images), through an examination of the research questions, as well as the identification of possible concepts I hoped to find during my analysis (Neuendorf, 2017; Rose, Spinks, & Canhoto, 2015). For this study, I selected the individual panel as the coding unit. An individual panel is a single drawing that represents a stationary moment within a sequence of multiple panels in a comic.

Table 1.

Sample of Science Comics

Title	**Date Published**	**Award**
Age of Reptiles Omnibus, Vol. 1	2011	2012 YALSA Great Graphic Novels for Teens
Clan Apis	2000	2002 YALSA Great Graphic Novels for Teens
Cleopatra in Space – Book 1: Target Practice	2014	2014 YALSA Great Graphic Novels for Teens
Evolution: The Story of Life on Earth	2011	2012 YALSA Great Graphic Novels for Teens
Feynman	2011	2012 YALSA Great Graphic Novels for Teens
How to Fake a Moon Landing: Exposing the Myths of Science Denial	2013	2014 YALSA Great Graphic Novels for Teens
Human Body Theater: A Non-Fiction Revue	2015	2016 YALSA Great Graphic Novels for Teens
The Imitation Game: Alan Turing Decoded	2016	2017 YALSA Great Graphic Novels for Teens
Laika	2008	2008 YALSA Great Graphic Novels for Teens
Last of the Sandwalkers	2015	2016 YALSA Great Graphic Novels for Teens
Legends of Zita the Spacegirl	2012	2013 YALSA Great Graphic Novels for Teens
Love: The Fox	2016	2017 YALSA Great Graphic Novels for Teens
Mighty Jack	2016	2017 YALSA Great Graphic Novels for Teens
Primates: The Fearless Science of Jane Goodall, Dian Fossey, and Biruté Galdikas	2013	2014 YALSA Great Graphic Novels for Teens
The Secret Science Alliance and the Copycat Crook	2009	2010 YALSA Great Graphic Novels for Teens
T-Minus: The Race to the Moon	2009	2010 YALSA Great Graphic Novels for Teens
Trashed	2015	2016 YALSA Great Graphic Novels for Teens
Trinity: A Graphic History of the First Atomic Bomb	2013	2013 YALSA Great Graphic Novels for Teens

Data Collection and Analysis

The primary research instrument in QCA is the researcher who develops a coding scheme and applies it to cultural artifacts to answer h/is research questions (Neuendorf, 2017). One of the first steps when creating a coding scheme is forming anchor codes directly from the research questions. The research questions for my study are:

1. How are females represented in YALSA award-winning science comics?

2. In what ways are females portrayed in YASLA award-winning science comics?

From these research questions I established the anchor codes *representation* and *portrayal*. *Representation* refers to the presence of absence of characters from a sociocultural group (in this particular study, gender), while *portrayal* relates to the depictions of a character.

Coding Scheme

This study's coding scheme was created using a combination of two strategies: (1) the deductive, or concept-driven way, based on prior research; and (2) the inductive, or data-driven way, based on the revealed data through open coding (Schreier, 2012). In the deductive approach to QCA, the researcher builds the coding scheme by modifying the categories from a previous research study. With the purpose of responding to the research questions for this study, I received permission from Jorgensen and Lechan (2013) to adapt their *Criteria for selecting graphic novels with healthy female role models* (Appendix B) for my initial coding scheme. From a critical perspective, Jorgensen and Lechan (2013) "establish[ed] criteria to develop graphic novel collections that provide healthy role models and lessen the bias against female protagonists" (p. 276).

In addition to the categories and subcategories established from Jorgensen and Lechan's (2013) research, new coding categories were created using the inductive approach to QCA.

During this process textual content is reduced and similar passages are summarized into single statements (Mayring, 2010). This unique data-driven approach to establishing coding categories is representative of the inherent flexibility of QCA. Due to the framed structure of comics, readers often infer meaning from the text and drawings simultaneously. However, I examined the text and images separately, as well as simultaneously, to conduct a more thorough analysis of each science comic.

According to Schreier (2012), "in QCA it is usually best to build your coding frame using the same material that you want to analyse" (p. 91). With this in mind, I selected the comic, *Clan Apis*, from the sample to read in a trial coding session. Before any memo-writing or coding occurred, I read the book twice to immerse myself in the narrative. Next, I coded text that conveyed gender into an MS Excel spreadsheet. Then I read the entire comic again, but this time I analyzed each panel and coded the illustrated depictions of females in the spreadsheet. As I analyzed the data, I began using different colors to highlight codes that appeared to fit together. Content that did not align was not deleted so that I could determine if new categories or subcategories should be added to the coding scheme.

Using my knowledge of relational theory, I began analyzing the unaligned content comparing it to the notes in my research journal. Influenced by the feminist research of Gilligan (1982), Ruddick (1989), and Belenky, Clinchy, Goldberger, & Tarule (1992), relational theory focuses on the experiences of women and how they help develop their psychological and intellectual growth through interdependent connections with others (Fletcher, 1998). From this inductive approach to QCA, codes were discovered that represented several aspects of a relational approach to learning. These included the following: (1) interacts with others; (2) personally constructs knowledge from experiences, intuition, reason, emotions, and imagination;

(3) forms relationships and/or cooperative alliances; and (4) views the world as an evolving, unified planet that interacts with its inhabitants. These codes were grouped under the new category, *Relational approach to knowledge*, which was placed under the anchor code, *Portrayal*.

Pilot Coding

To further enhance the trustworthiness of the coding scheme, I recruited two coders to join me in testing the initial coding scheme in a pilot coding session. The coders included two female colleagues, both of whom were educators and had earned postgraduate degrees. I intentionally selected both coders because of their identified gender (female), profession, and level of degrees earned (postgraduate). In addition, I believed their diverse life experiences would add a different perspective to the coding scheme.

Due to last minute scheduling conflicts, only one female coder, Coder A, attended a Skype meeting to familiarize herself with my research questions and the coding scheme. Therefore, to ensure the other female coder, Coder B, received identical training, I recorded the training using QuickTime, which she later viewed. During the training, I reviewed the initial coding scheme, modeled how to use it with a sample page from *Lowriders in Space*, and demonstrated how to record their coding and memo-writing in the MS Excel spreadsheet. I modeled how textual clues were to be used to corroborate the coding of images (e.g. gender-specific pronouns and names were used to code the perceived gender of each character). Finally, we mutually agreed upon a date to complete the coding and meet to discuss our results and possible revisions to the coding scheme.

During pilot coding, the comic, *Lowriders in Space,* was read four separate times and blind coded by each member of the coding team. Pilot coding was used to identify any problems

with the initial coding scheme before it was used to code the entire sample (Neuendorf, 2017). The purpose of the first reading was to understand the complete narrative. During the second reading, the coders read and analyzed lines of text for implied meanings, and marked lines referring to a character's gender along with the corresponding page numbers. Using data reduction and summarization, the coders compared these marked lines of text to the main coding categories to reveal patterns in the data. When the content aligned with the coding scheme, the coder entered it into an MS Excel spreadsheet under the appropriate code with a memo for justification. Additionally, the coders used memos to record relevant lines of text or illustrations that did not align with any coding categories. The actions of the third reading (i.e., reading, recording, comparing, and deciding) were similar to those of the second reading, although the coder's focus was on the illustrations. Finally, the fourth reading afforded the coder an additional opportunity to corroborate data from previous readings.

After the entire coding team finished blind coding *Lowriders in Space*, I scheduled a meeting to discuss our coding sessions with the goal of providing crucial feedback about the initial coding scheme, which would be used to revise the coding scheme. Memos documenting our coding decisions, specifically personal interpretations of the codes and their related data, were referenced throughout our discussions. Only minor differences in our coding occurred, and they were the result of personal misinterpretations of a category or unit of coding. For concepts that did not fit into any of the categories, a mutual decision was made to either place the concepts into a new category or omit them entirely. When no new categories or patterns were uncovered, and the coding team had reached a final agreement (percentage of agreement > 90%), the coding scheme was considered finalized (Table 2). Because only a few minor revisions to the initial coding scheme were made, a second trial coding was not warranted (Schreier, 2012).

Table 2.

Final Coding scheme

Anchor code	**Category**	**Subcategory**	**Criteria**
Representation	Characterization	Character's name	Name of the character
		Gender	Female, male, or non-gendered
		Character status	Main, secondary character who is necessary to the storytelling, or tertiary character
Portrayal	Diversity	Human	Is the character a human?
		Anthropomorphic	If not a human, what is the character?
		Age	Specific age or indicate whether an adult or child
		Race or origin	Refers to the race, ethnicity, or both
		Class	(1) lower class, (2) middle class, (3) upper class
		Sexual orientation	(1) heterosexual, (2) homosexual, (3) bisexual, (4) other:_____
	Appearance	Face	Makeup or natural
		Hair color	(1) black, (2) brown, (3) red, (4) blonde, (5) other _____, (6) no hair
		Hair length	(1) short, (2) long, (3) no hair
		Hair style	(1) straight, (2) curly, (3) other ___
		Clothing	Description of the character's attire
		Posture	Drawn from the neck and/or shoulders up or whole body
		Hypersexualized	Accentuation of breasts, hips, or buttocks
	Relational approach to knowledge	Interactions	(1) with other characters, (2) with no one [alone]
		Relationships	(1) cooperative [alliance] with___, (2) In conflict with ___
		Learning	from (1) experiences [a. personal (including mistakes), b. others], (2) intuition, (3) reason, (4) emotions, (5) imagination
		Worldview	Views the world as an evolving, unified planet that interacts with its inhabitants?
	Behavior	Decision-making	Independently and carefully plans decisions, makes decisions based on how it will affect her

Table 2. Continued

Anchor code	**Category**	**Subcategory**	**Criteria**
Portrayal	Behavior	Decision-making	Takes responsibility for decisions Faces the consequences of her decisions without being rescued by a male
		Physical location	(1) inside the home (2) grocery store (3) outside of the home performing non-domestic actions
		Career	(1) domestic, (2) assistant or secretarial, (3) _____
		Tools	Shown using (1) domestic, (2) manufacturing, (3) science, (4) weapons, (5) _____
	Independence	Physical	If an adult, depends on (1) self, (2) a female, (3) a male; If a child, (1) is aware or becomes aware of her environment & her effect on it, (2) does not ever become aware of her environment & her effect on it
		Emotional	Relies on (1) self, (2) females, (3) males
		Personal identity	Defined by (1) skills and talents, (2) romantic relationships, or (3) _____
	Power	Position	Is the character in a position of power? How does s/he gain power (personal effort, inherited, etc.)?
		Use	Does s/he use power for good or bad?
		Helplessness	Does s/he (1) overcome or (2) remain in a state of perpetual weakness or distress?
		Violence	Was violence enacted against the character in the past, present, or future? If so, what happened to the victim and the perpetrator?
	Individuality	Back-story	Background or history of the character
		Unique personality	Distinctive qualities
		Personal goals	Ambitions, dreams, aspirations
		Personal flaws	Imperfections or limitations; makes mistakes

Double Coding

Following blind coding, I double coded the sample using the updated coding scheme leaving ten days between coding sessions. After reading each science comic three times, I used the coding scheme to guide my examination of the science comics while documenting the coding in MS Excel. After the double coding was complete for a title, the initial and second coding sessions were compared to expose possible coding discrepancies, which did not exist with the exception of minor wording variations.

After completing the blind coding of the sample, I compared codes searching for similarities. Next, I began to summarize and group codes that appeared to align with common themes. For example, I grouped the codes “curious about her the forbidden land” and “longs to discover what is beyond her home” together because they were concerned with gaining additional knowledge about places forbidden and away from the comforts of home. Theme descriptions were created with explicit definitions, coding rules, and examples to increase trustworthiness and consistency during data analysis (Mayring, 2000). I created the definitions for my theme descriptions using my knowledge of feminist theory and the relational approach to knowledge (Table 3).

I reviewed all codes again by comparing each one to the themes I generated to ensure no codes were omitted or grouped into a less appropriate theme. I also analyzed codes to determine if any of them overlapped, or fit into more than one category. Because this study was grounded in critical theory, I did not omit any codes unaligned with a theme. This decision was made due to the possible effects this could have on my interpretation of results. Therefore, each unaligned code had the potential of being established as a new theme.

Table 3.

Example of Theme Description

Coding Theme	**Rule**	**Definition**	**Example**
Positive Growth	If in a position of power, they use their power to accomplish good Personally overcomes weakness Emotionally, physically, and intellectually independent from others. If a child dependent on her parents/guardians, then she becomes more aware of her effect on others and her environment.	This theme focuses on realizing one's full potential, using power for good, overcoming weakness, and becoming emotionally, physically, and intellectually independent of others/ aware of her personal effect on others/environment.	*Last of the Sandwalkers*: Lucy leads an expedition team to the forbidden desert. With her leadership (power), she educates those back home (p. 2) *Clan Apis*: Nyuki frees herself from the mantis (p. 68) *Legends of Zita the Spacegirl*: Zita desires to return to Earth, yet she leaves to save Pizzicato, whom is "in trouble and it's [Zita's] fault" (p. 200)

Four major themes were identified from codes that were present in at least five of the nine books containing female protagonists and secondary characters. In this study, the themes included *Counter Stereotypes of Women, Self-Identity, Positive Growth,* and *Relational Approach* (Appendix C).

Trustworthiness and Transparency

While planning the design of this study, I internally struggled with the issue of addressing reliability and validity. Although the measures of reliability and validity are often used in qualitative research, they are rooted in positivism, which is rejected by critical feminists (Elo et al., 2014). Initially, I considered these measures irrelevant to this qualitative study because I am the research instrument. I am the feminist who is critically examining and interpreting text and

drawings to enact change. “Voices of power” began attacking my initial thoughts, resulting in self-deprecation and confusion. During this period of uncertainty, I was reminded of the silencing effect “voices of power” had on women of different races, ethnicities, classes, and sexual orientations in Belenky, Clinchy, Goldberger, and Tarule’s (1986) study. This initiated this study’s return to my previous feminist view of trustworthiness and transparency.

Instead of reliability or validity, some feminist researchers evaluate content analysis studies using the criteria of trustworthiness, or the support that findings are “worth paying attention to” (Lincoln & Guba, 1985). As this study was conducted in the critical feminist paradigm, the criteria for determining trustworthiness are different from those in other research paradigms (Morrow, 2005). An important aspect of evaluating trustworthiness is the accurate reporting of the research process (Lincoln & Guba, 1985; Neuendorf, 2017; Schreier, 2012). The design of this study was conducted systematically, responded to the research questions appropriately, and was documented explicitly to afford transparency to readers.

The use of additional trained coders provided valuable insights that strengthened the initial coding scheme. When an individual coder’s results differed from the rest of the coding team, we examined the differences together and discussed possible reasoning using our memos to reach a consensus. I included double coding using a ten-day lapse between sessions to enhance the consistency of data analysis. To improve the transparency of qualitative research, it is essential to acknowledge the potential impact of the researcher’s background, experiences, and views on the study. Through my reflexivity, of which I was constantly aware, I publicly disclosed my understanding of the possible influence these factors could have on this research. Finally, I critiqued myself through personal examination and reflection throughout this study, which was documented in my research journal.

Summary

The combined inductive/deductive approach to QCA was used to examine the representation and portrayals of females in YALSA award-winning science comics. To be included in this study, the criteria were established to provide consistency in the sample selection. Using YALSA's Teen Book Finder Database, the entire sample was selected and reduced to eighteen science comics. All titles in the sample were purchased, read, and analyzed. The coding scheme was created deductively from Jorgensen and Lechan's (2013) research and inductively from a trial coding session of one science comic. The initial coding scheme was then tested using the blind coding of a science comic from a team of three coders. Next, the sample was independently double coded using a ten-day waiting period between coding. Through constant comparison, reduction, and summarization, similar codes were then grouped into broader themes for additional analysis.

CHAPTER IV: FINDINGS AND DISCUSSION

The purpose of this study was to analyze the representation and portrayals of females in YALSA award-winning science comics through a critical feminist lens. The following research questions guided this study's data analysis:

1. How are females represented in YALSA award-winning science comics?

2. In what ways are females portrayed in YASLA award-winning science comics?

As described in the previous chapter, these questions were investigated using a combination of the inductive and deductive approaches to qualitative content analysis. Data from eighteen award-winning science comics were analyzed using both the deductive and inductive approaches to QCA.

Using a coding scheme adapted from Jorgensen and Lechan's (2013) research, the following coding categories were created: *Characterization*, *Diversity*, *Appearance*, *Behavior*, *Independence*, *Power*, and *Individuality*. As the sample was examined repeatedly, *Relational Approach to Knowledge* was established as an emergent category using the inductive approach to QCA. Although *Appearance, Behavior, Independence*, *Power*, and *Relational Approach to Knowledge* were used to examine the portrayals of females in the sample, *Characterization* and *Diversity* were analyzed to determine the representation of females in science comics.

This chapter focuses on the findings of my research study followed by a discussion of the results. To provide organization to this chapter, I have divided it into the two themes from my research questions with a thorough discussion of their related themes.

Representation of Females

For the purpose of this study, *representation* was merely defined as the presence or absence of female characters from a comic included in the sample. My analysis of eighteen

science comics and their book covers confirmed that seven titles featured female protagonists, two titles included female secondary characters, seven titles contained no female protagonists or secondary characters, and two titles contained characters with no definitive gender identified (Table 4). I used Jorgensen and Lechan's (2013) description of strong female characters in my classification of secondary characters:

> They may be secondary characters or a part of the ensemble. They should have an active part in the story, and their characters should be necessary to the storytelling. The female characters should not be nominal or 'token' characters, for example female characters for the sake of having female representatives in the story. They should not be plot devices, with no interaction with other characters, or have no effect on the storyline. (p. 277).

Science comics that prominently featured females as primary characters included *Clan Apis, Cleopatra in Space, Human Body Theater, Laika, Last of the Sandwalkers, Legends of Zita the Spacegirl, Primates: The Fearless Science of Jane Goodall, Dian Fossey, and Biruté Galdikas.* The two titles that contained significant female secondary characters were *Mighty Jack* and *The Secret Alliance and the Copycat Crook*. Four science comics, *Feynman, The Imitation Game: Alan Turing Decoded, T-Minus: The Race to the Moon,* and *Trinity: A Graphic History of the First Atomic Bomb,* did not feature female lead characters in their illustrated retelling of historical events. *Evolution: The Story of Life on Earth, How to Fake a Moon Landing: Exposing the Myths of Science Denial*, and *Trashed* prominently featured male narrators. Lastly, *Age of Reptiles Omnibus, Vol. 1* and *Love: The Fox* were comics without text that featured animal characters with no identifiable gender.

Excluding the two comics without text, the breakdown of the sample by genre was: four historical biographies, three educational/non-fiction, two action/adventure, two action/sci-fi, two

Table 4.

Representation of Female Main Characters in Sample

Title	**Females illustrated on the cover**	**Female protagonists**	**Female secondary characters**
*Age of Reptiles Omnibus, Vol. 1**	0*	0*	0*
Clan Apis	7 (animals)	1	1
Cleopatra in Space – Book 1: Target Practice	1 (human)	1	1
Evolution: The Story of Life on Earth	0	0	0
Feynman	0	0	0
How to Fake a Moon Landing: Exposing the Myths of Science Denial	0	0	0
Human Body Theater: A Non-Fiction Revue	1 (skeleton)	1	0
The Imitation Game: Alan Turing Decoded	0	0	0
Laika	1 (animal)	1	2
Last of the Sandwalkers	1 (animal)	1	1
Legends of Zita the Spacegirl	1 (human)	1	1
*Love: The Fox**	0*	0*	0*
Mighty Jack	2 (human)	0	2
Primates: The Fearless Science of Jane Goodall, Dian Fossey, and Biruté Galdikas	3 (human)	3	0
The Secret Science Alliance and the Copycat Crook	1 (human)	0	1
T-Minus: The Race to the Moon	0	0	0
Trashed	0	0	0
Trinity: A Graphic History of the First Atomic Bomb	0	0	0
Total	18	9	9

**Contained characters whose gender could not be definitively identified*

historical fiction, one educational fantasy, one fantasy, one historical biography, and one satire. Of the six YALSA award-winning science comics based on historical, scientific advancements, only one, *Primates: The Fearless Science of Jane Goodall, Dian Fossey, and Biruté Galdikas,* was about female scientists.

The primary and secondary characters were coded as human, anthropomorphic (i.e., having the characteristics of humans), or animal. The gender of each human character was determined using both the illustration and text. Five of the titles, *Cleopatra in Space – Book 1: Target Practice, Legends of Zita the Spacegirl, Mighty Jack*, *Primates: The Fearless Science of Jane Goodall*, *Dian Fossey*, *and Biruté Galdikas*, and *The Secret Science Alliance and the Copycat Crook*, featured humans as the main female characters. Of the eighteen main and secondary female human characters in the sample, seventeen were White, with Greta Hughes, an African American girl from *The Secret Science Alliance*, representing the only racial diversity in the sample. Maddy, Jack's nonverbal autistic sister in *Mighty Jack*, was the sample's only differently-abled female character. Also, Cleopatra was the only female whose socioeconomic class was evident through the descriptions of her royal family lineage and the illustrations of her palace life. Sexual orientation was only vaguely inferred about the women (e.g., heterosexual marriage) because minimal evidence existed in the text and illustrations.

Anthropomorphism was evident in most of the sample. Insects, animals, robots, and aliens lacking visible gender-identifiable features made it essential to scrutinize the text for confirmation of a character's gender. For example, gender-specific words were used to identify the gender of different honeybee characters in Clan Apis (Figure 1). In Laika, the gender of the female canine, from which the book was titled, was also disclosed in the dialogue of the human

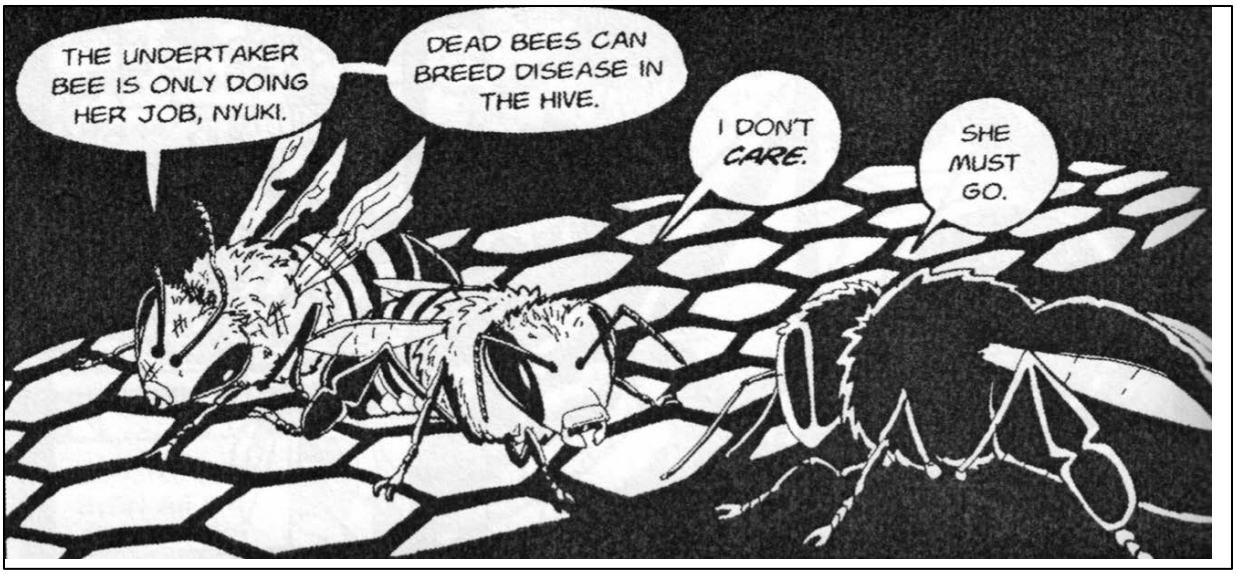


Figure 1. Dvorah, Nyuki, and an unnamed drone from *Clan Apis* (Hosler, 2000, p. 108)

characters ("Once again, Kudryavka proves that she's got incredible endurance for a small dog" [Abadzis, 2009, p. 94].). Gender-specific textual evidence was also required when analyzing the gender of the robots, Randy Robot and ONE, two secondary characters in *Legends of Zita the Spacegirl* (Figure 2). There was only one instance in a comic featuring a female main or secondary character where an anthropomorphic character's gender could not be determined or corroborated using the text. In *Human Body Theater: A Non-Fiction Revue*, word clues did not divulge the gender of the skeleton narrator who obtained different parts of her body throughout the book. Her gender was revealed in the final three pages of the 223-page book by the illustrated suggestion that she has breasts (Figure 3). Some characters were coded as NG, or non-gendered, because their gender could not be confirmed by text or illustrations. In the wordless book, *Love: The Fox*, there was no definitive way to determine the fox's gender. Although the fox eventually makes a perilous journey back to its den where it is reunited with its kits, the adult fox's gender is unknown.

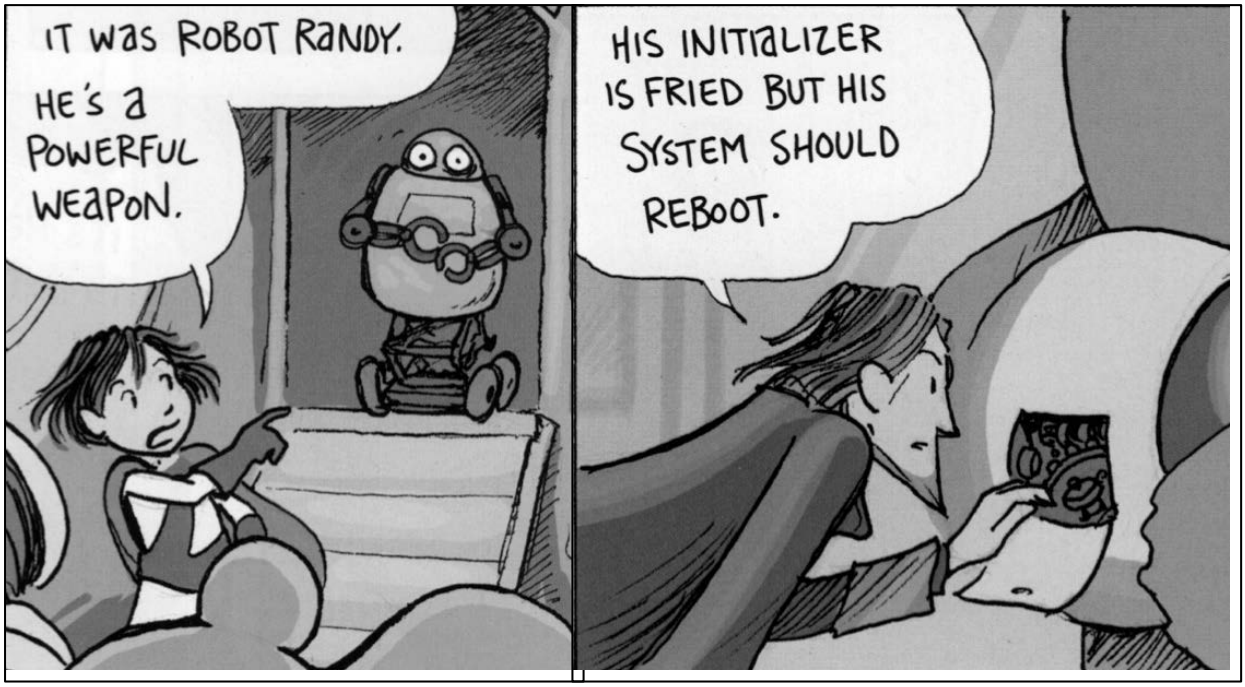


Figure 2. (L to R) Robot Randy and ONE from
Legends of Zita the Spacegirl (Hatke, 2012, p. 14, 130)

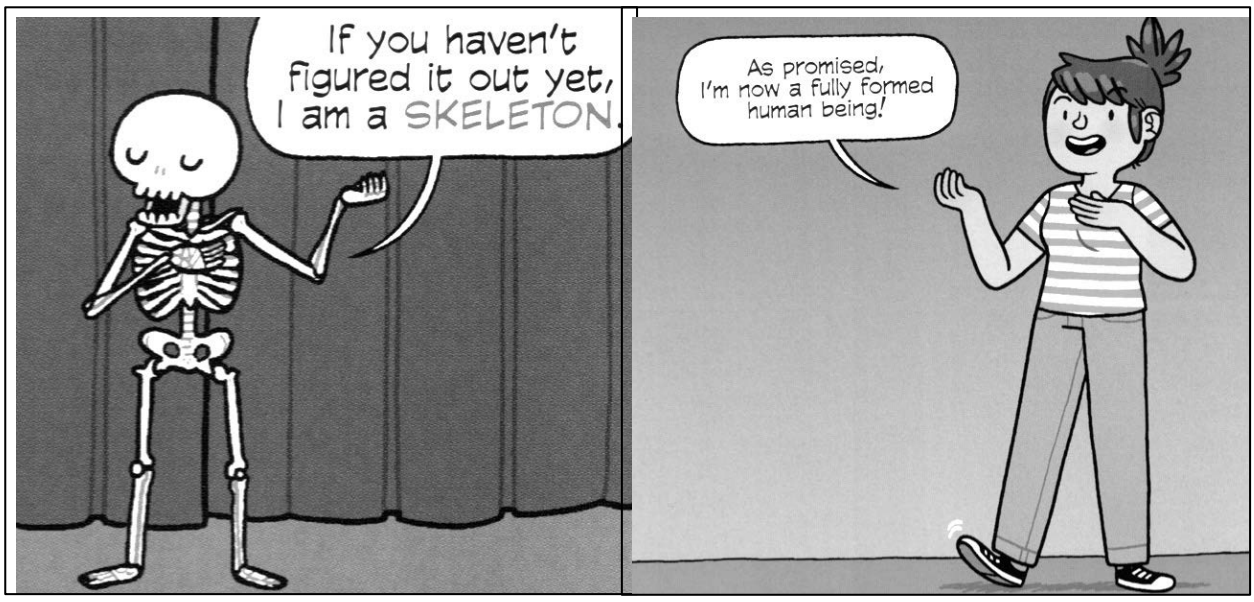


Figure 3. The narrator as a skeleton and a human girl from
Human Body Theater: A Non-Fiction Revue (Wicks, 2015, p. 3, 221)

Because part of my analysis involved the representation of females in science comics, it was critical for me to expose the total amount of frames containing female characters – main, secondary, or minimal for the entire sample. Thus, I recorded the total number of overall frames, frames containing females, and frames containing males for each comic in the sample (Table 5). Upon examining this data in tabular format, it was evident that female characters (31%) were underrepresented compared to male characters (47%) in YALSA award-winning comics[1]. When I calculated the different frame type totals using only the titles that featured female protagonists or secondary characters, female characters (53%) appeared in more frames than male characters (40%).

Portrayal of Females

The definition of *portrayal* as it pertains to this study is the manner in which a character is illustrated or described in a science comic. From my analysis of the frames and text for each of the science comics containing female protagonists or secondary main characters, the themes related to character portrayal revealed in the sample included *Counter Stereotypes of Females*, *Self-Identity*, *Positive Growth*, and *Relational Approach*.

Counter Stereotypes of Females

Upon my examination of the female characters in the sample, I discovered several examples of female counter stereotypes, or ideas that oppose preconceived prejudicial beliefs universally held by a social group. Throughout the content analysis, I observed multiple codes for the following counter stereotypes of females: (a) career-oriented, (b) physical appearance, and (c) risk-taker.

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[1] 22% of the total frames contained no characters

Table 5.

Representation of Female Characters by Frame Count

Title	**Total number of frames**	**Frames containing females**	**Frames containing males**
Age of Reptiles Omnibus, Vol. 1	1157	0	0
Clan Apis	594	557	99
Cleopatra in Space – Book 1: Target Practice	705	412	118
Evolution: The Story of Life on Earth	794	11	89
Feynman	1682	274	1275
How to Fake a Moon Landing: Exposing the Myths of Science Denial	926	57	472
Human Body Theater: A Non-Fiction Revue	1131	13	4
The Imitation Game: Alan Turing Decoded	1165	272	1011
Laika	2106	1221	1007
Last of the Sandwalkers	1311	855	816
Legends of Zita the Spacegirl	1048	487	187
Love: The Fox	372	0	0
Mighty Jack	928	425	597
Primates: The Fearless Science of Jane Goodall, Dian Fossey, and Biruté Galdikas	655	518	261
The Secret Science Alliance and the Copycat Crook	679	363	629
T-Minus: The Race to the Moon	1082	49	686
Trashed	1164	35	891
Trinity: A Graphic History of the First Atomic Bomb	572	38	350
Total	18071	5587 (31%)	8492 (47%)

A majority of the science comics that contained adult female protagonists or secondary characters depicted women as career-oriented instead of homemakers. Of the combined eight adult main and secondary characters, all nine held some degree of power (e.g., manager, supervisor, trainer, etc.) within their agency of professional employment. In *Laika*, Yelena, worked as the dog trainer and caretaker for the Soviet Union's space program (p. 69). Four female principal characters and one secondary character were portrayed as scientists or inventors. Primatologists, Jane Goodall, Dian Fossey, and Biruté Galdikas of *Primates*, studied the behavior of different African primate species in their natural habitat. The beetles, Lucy and Professor Bombardier, in *Last of the Sandwalkers* were scientists on an expedition to discover life outside of their home, Coleopolis:

> Raef: *If you guys are all scientists, why do we only call Bombardier and Own Professor?*
>
> Lucy: *Tradition. They're the senior scientists on the team.* (p. 40)

In *The Secret Science Alliance*, Greta was portrayed as the book's only female member of a secret club of inventors.

There were significantly more female characters depicted outside of the home than inside; none of the primary or secondary female characters remained in the home. However, upon closer examination, three of the minimal female characters left the home to perform other domestic duties such as Tatiana's grocery shopping (*Laika*, pp. 28, 62), Mom chauffeuring Julian to school and an academic lecture (*The Secret Science Alliance*, pp. 2, 19-20), and Tatiana's housekeeping for another family (*Laika*, p. 27). Most of the tools or items used by the female characters also contradicted gender stereotypes. Some consisted of weaponry like the sword, slingshot, and bow and arrow used by Lilly in *Mighty Jack* (pp. 9, 74, 95), or the ray gun that Cleo and Akila used during target practice class in *Cleopatra in Space* (pp. 73-81). Despite the

overwhelming portrayal of career-oriented women in the sample, two minimal characters were portrayed as domestic housewives, Katya chopping vegetables and serving dinner in *Laika* and Mom using a kitchen mixer in *The Secret Science Alliance and the Copycat Crook* (Figure 4).

Adult female characters were predominantly illustrated with counter stereotypical physical appearances. For example, the three primatologists in *Primates* were shown without facial cosmetics and wearing pants or shorts throughout most of the book. Jane Goodall only wore a skirt in the very beginning of the chapter about her life (pp. 4-5, 8) and at the end of the book when she serves as the coordinator of a primatology conference (p. 117, 119-121). The drawings of Dian Fossey in a skirt only occurred in the story during her attendance at academic lectures (p. 44), conferences (pp. 117-121), and meetings with government officials (pp. 128-130). Biruté Galdikas was always outfitted in pants or shorts. Hypersexualiztion, or the accentuation of female breasts, hips, or buttocks, was not observed in any of the titles featuring female protagonists or secondary characters. Despite the counter stereotypes observed, physical stereotypes were present in some of the science comics. In *Laika*, the human female characters were depicted in skirts or dresses, the standard Soviet female attire during the Cold War (pp. 19, 29, 69). Julian's mom wore an apron when she worked in the kitchen in *The Secret Science Alliance* (p. 17). With the exception of Maddy and Lilly in *Mighty Jack* (p. 111), the sample's adolescent female protagonists were all illustrated in skirts or dresses (Figure 5). In addition, both adolescent and adult female characters were portrayed with an unrealistic body shape throughout the sample.

While examining the frames containing female characters, the counter stereotype of risk-taking was also identified during the content analysis. Rather than assuming a passive role, the risk-taking female is goal-oriented, and she exhibits confidence, self-reliance, and decisiveness.



Figure 4. (L to R) Katya making dinner from *Laika* (Abadzis, 2009, p. 33), Mom from *The Secret Science Alliance* (Davis, 2009 p. 17)

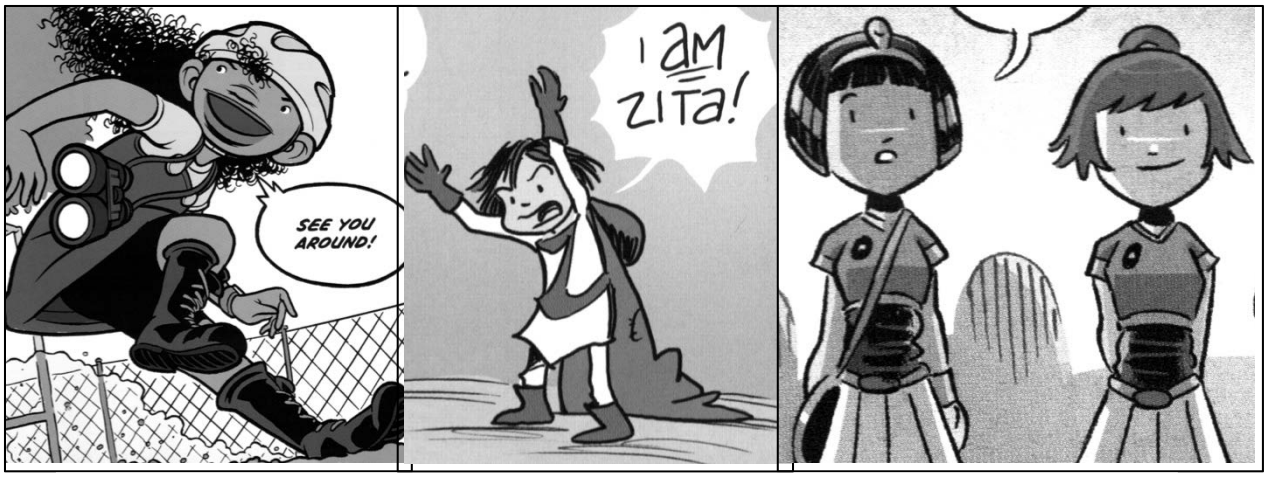


Figure 5. (L to R) Greta from *The Secret Science Alliance* (Davis, 2009, p. 48), Zita from *Legends of Zita the Spacegirl* (Hatke, 2012 p. 43), and Cleo and Akila from *Cleopatra in Space* (Maihack, 2014, p. 113)

Nyuki, the honeybee protagonist in *Clan Apis*, was consumed with finding the new location for the hive despite her lack of knowledge of potential threats to her life (p. 57). Dian Fossey in *Primates* risked her life for gorilla preservation by directly confronting poachers and destroying their camps, which ultimately ended her life (pp. 60, 62, 129-131). To the surprise of her classmates and instructor, Cleo confidently defeated the simulated battalion of alien soldiers with

a single ray gun shot in *Cleopatra in Space* (pp. 81). Zita was left stranded on an alien planet, forcing her to survive by resolving multiple issues in *Legends of Zita the Spacegirl* (pp. 48, 57, 147). Without discussing it with the others, Professor Bombadier in *Last of the Sandwalkers*, directed the expedition group to separate to find a water source (p. 104).

Throughout the sample, it was apparent that the female who takes risks also makes decisions with the potential to positively affect her own life, as well as the lives of others. While the male members of *The Secret Science Alliance* sulked over the theft of their invention notebook, Greta emphatically controlled the situation:

> Julian: *Augh! He's gonna claim all our awesome inventions!*
>
> Greta: *No, he's NOT! Because we're gonna get that notebook back!* (p. 96)

In *Primates*, Jane Goodall made sacrifices to fulfill her dream of studying chimpanzees in their natural habitat. As a young adult, she moved back in with her parents, worked, saved her wages, and once she arrived in Africa, she temporarily assumed the role of Dr. Leakey's secretary (pp. 4, 8, 11). Her personal and professional struggles, along with her patience and willingness to challenge the scientific methods of others, strengthened Goodall both as a scientist and as a person. However, she did not accomplish it at the expense of living organisms. Ultimately, Goodall fulfilled her childhood dream of becoming a primatologist, which always focused on the personal, social, and compassionate side of chimpanzees. Her work also emphasized and advanced the importance of global community conservation and animal rights with the world. At the end of *Primates*, Goodall summarized her life's work and her view of scientists:

> Finished? Heavens no! We've just now studied chimpanzees in the wild for the span of one chimp lifetime. It's as if we'd studied human culture for 80 years and called it quits! And further, what of chimpanzee habitat? What of chimps in captivity? In laboratories?

> The message we've been sending through the years is that you must be a scientist first and a human being second. And I think that's the wrong message. (pp. 131-132)

This quote reflected Goodall's belief that when one practices science, one must approach the research as a human first. This was a direct contradiction to the masculine approach that had dominated science for centuries.

Self-Identity

My content analysis also revealed patterns related to the female character's positive self-identity. Self-identity is defined as "the recognition of one's potential and qualities as an individual, especially in relation to social context" (English Oxford Living Dictionaries, 2017). The female protagonists in the sample appeared to positively identify themselves by their own skills or abilities. In *Last of the Sandwalkers*, Lucy was aware of her achievements as a scientist and inventor, as well as her rank of expedition leader. When forced to make rushed decisions in survival situations, she trusted that her knowledge or innovative solutions would be successful (Figures 6, 7). In addition, Lucy is depicted writing her observations and thoughts into her personal research journal throughout the comic (Figure 8).

Although Cleo was born into her royal status in *Cleopatra in Space*, she recognized her exceptional talent as a markswoman with multiple weapons. When her male friend missed a target with his slingshot, she responded, "Just watch how a **professional** does it" (p. 30). Her instructors also noticed her unique talent, which resulted in her active participation in a fairly dangerous mid-term exam. Positive self-identity was also apparent among the female secondary characters. For instance, Greta, the only female in *The Secret Science Alliance*, believed her inventions were useful and possibly coveted by others. She showed this when she declared, "All

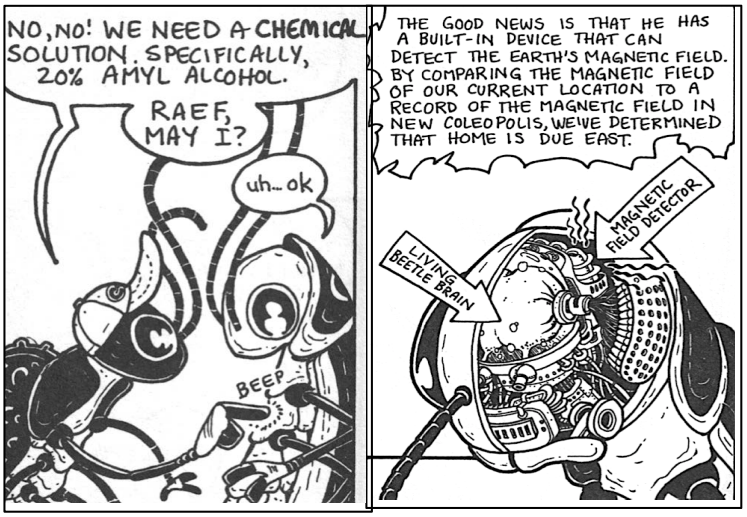


Figure 6. (L to R) Lucy using her scientific knowledge; one of Lucy's inventions from *Last of the Sandwalkers* (Hosler, 2015, pp. 88, 98)

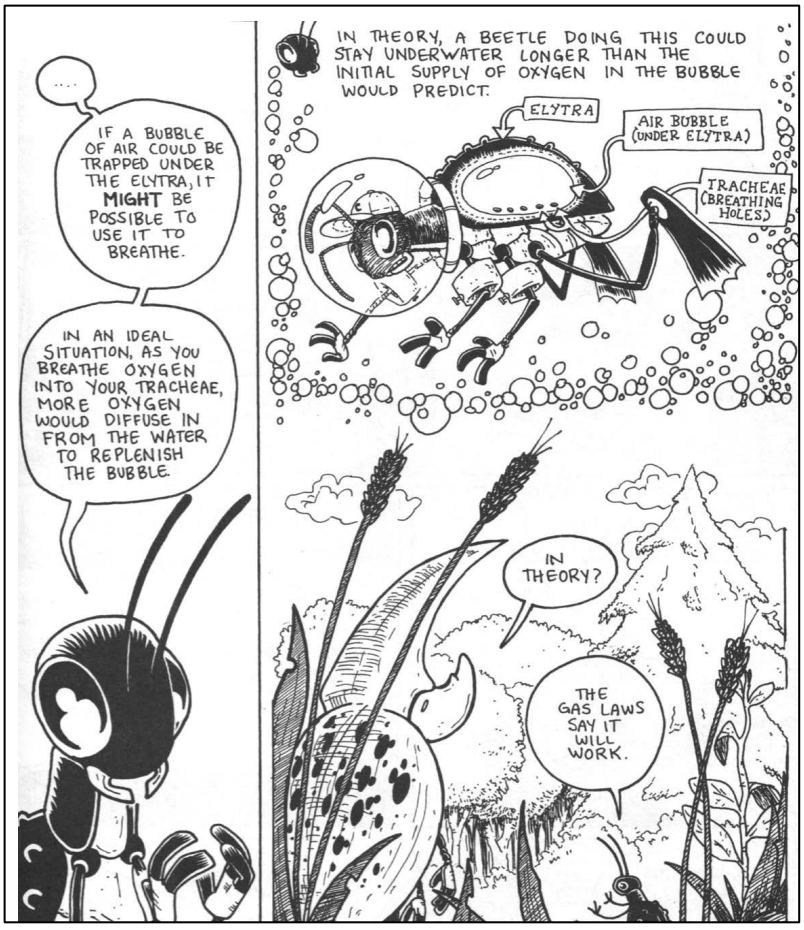


Figure 7. Lucy using her scientific knowledge from *Last of the Sandwalkers* (Hosler, 2015, p. 209)

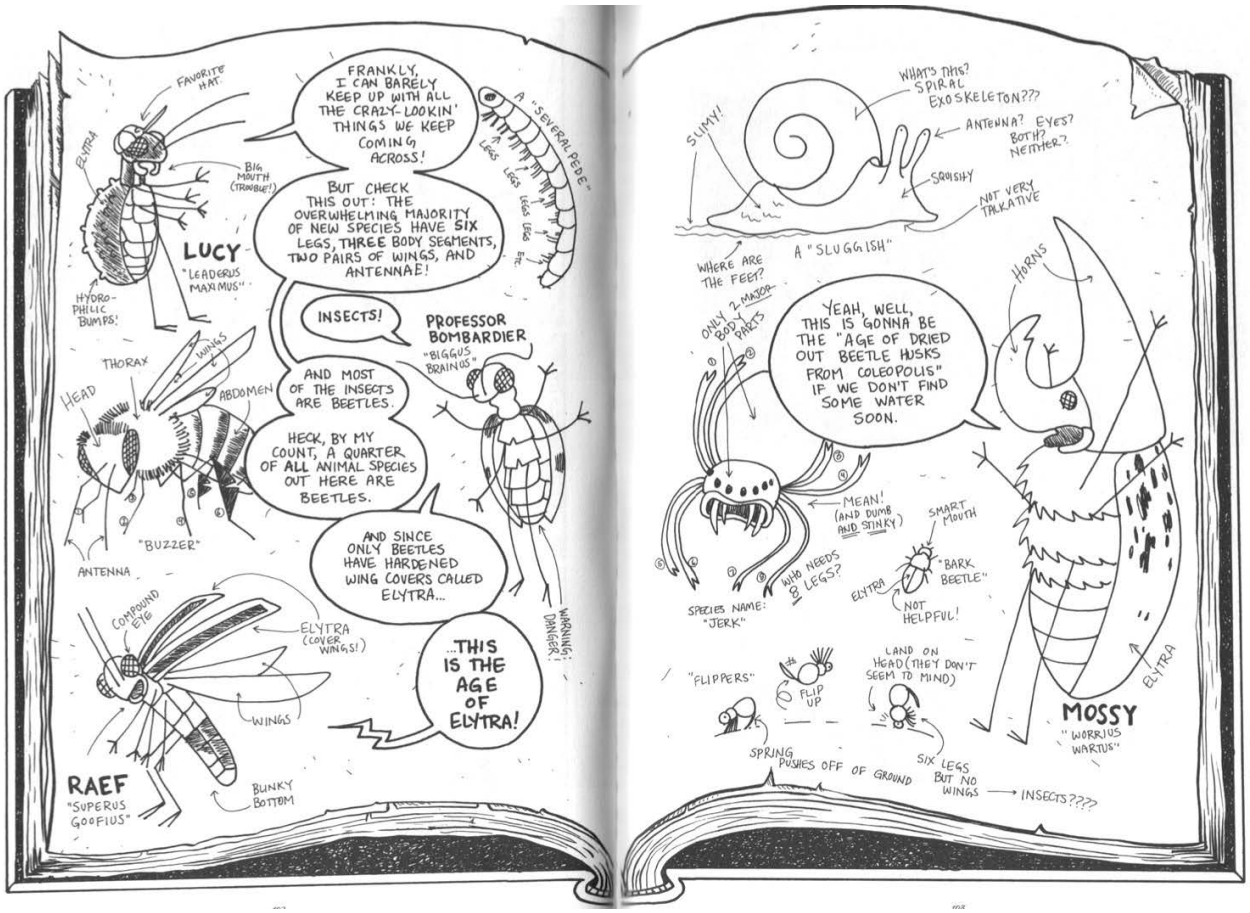


Figure 8. Sample pages from Lucy's research journal
from *Last of the Sandwalkers* (Hosler, 2015, pp. 102-103)

my inventions are deadly serious! They protect us from rival scientists and other adult oppressors" (p. 55).

A majority of the sample's female characters were not depicted as actively pursuing romantic relationships with men. This was mostly due to a focus on achieving personal goals. Of the eighteen female principal and secondary characters in the sample, only two, Jane Goodall and Dian Fossey in *Primates*, were portrayed as married or romantically involved with another person (p. 37, 87). Although these true-life relationships were included in *Primates*, the principal focus of the storyline was the scientists' passion for studying primates.

Positive Growth

The theme *Positive Growth* referred to a female character's personal development throughout the comic. If the female character was an adolescent or a child, it was important to note her awareness of her effect on her environment. However, if she was an adult, the focus was on her behavior during times of distress and how she used her power or influence. From the analysis of the sample, there was evidence of positive growth among the human and anthropomorphic female characters.

The metamorphosis, or development, of a honeybee, Nyuki, was the premise for *Clan Apis*. Her dependence on the bee colony from egg to adult was based on a factual biological phenomenon. However, Nyuki still exhibited positive development as a female character through her cognitive growth and experiences. Like a petulant child, she declared, "Dvorah's not the boss of me. I can't wait to see the look on Dvorah's face when I find the best nest site ever" (p. 57). Nyuki's inexperience with life outside of the hive caused several difficulties for her (e.g., encounters with a praying mantis and a crab spider). During her adventures she confronted her fears and established friendships with a flower and a dung beetle. Ultimately Nyuki accepted her responsibility to assist the entire colony performing different jobs based on the needs of the hive:

> Nyuki: Smells like a good day for nectar. The blooms have been flowing like crazy these last few days. Yeah, but I think a few of us should pick up some propolis.
>
> Melissa: Eww. Those sticky plant resins are so messy.
>
> Nyuki: Maybe, but we need it to insulate the inside of the hive before winter. (p. 117)

The development of another anthropomorphic female character, Lucy in *Last of the Sandwalkers*, represented a different type of personal growth as Nyuki's. Throughout the story, Lucy and her companions, faced challenges for which they were unprepared. As the expedition leader, Lucy

arrogantly proposed solutions to most challenges that required intelligence over strength. For example, with a massive sandstorm approaching, Lucy reacted by directing her companions to bury themselves in the sand and lock arms to prevent them from being separated (p. 26). Yet this often resulted in additional problems for the entire group, as well as verbal abuse toward Lucy from others. The manner in which Lucy responded grew negatively, starting with temporary isolation, moving to sadness and self-pity, and ending with an apology. Although this first appeared negative, upon additional analysis it exemplified positive self-development as it illustrated how Lucy conquered her pride.

Relational Approach

The theme, *Relational Approach*, which was evident in four comics, emphasized the co-construction of knowledge among individuals through their relationships within their contextual settings (Thayer-Bacon, 2003). Through her active engagement with others, the female character demonstrates her interconnectedness to others and the evolving natural environment. In *Clan Apis*, a young Nyuki formed a friendship with Sisyphus, a dung beetle, after being rescued from near death. As the conversation continued, Sisyphus taught Nyuki about honeybees, mutualism, the diverse perspectives of others, and the interconnecting roles different organisms play in the cycle of life (Figure 9). Nyuki revealed how she and Bloomington's "relationship of bartering food for procreation" (p. 123) and being "specialized to meet each other's needs" (p. 124) represents an ancient coevolutionary relationship between a honeybee and flower. When Nyuki was near death, she recited a story her sister once told her:

> Dvorah said the after life, bees are rewarded by the world flower. As compensation for taking care of her children, bees never have to work again. We get to spend eternity sitting on the stem of the world flower and talking with our sisters. And to top it off, the

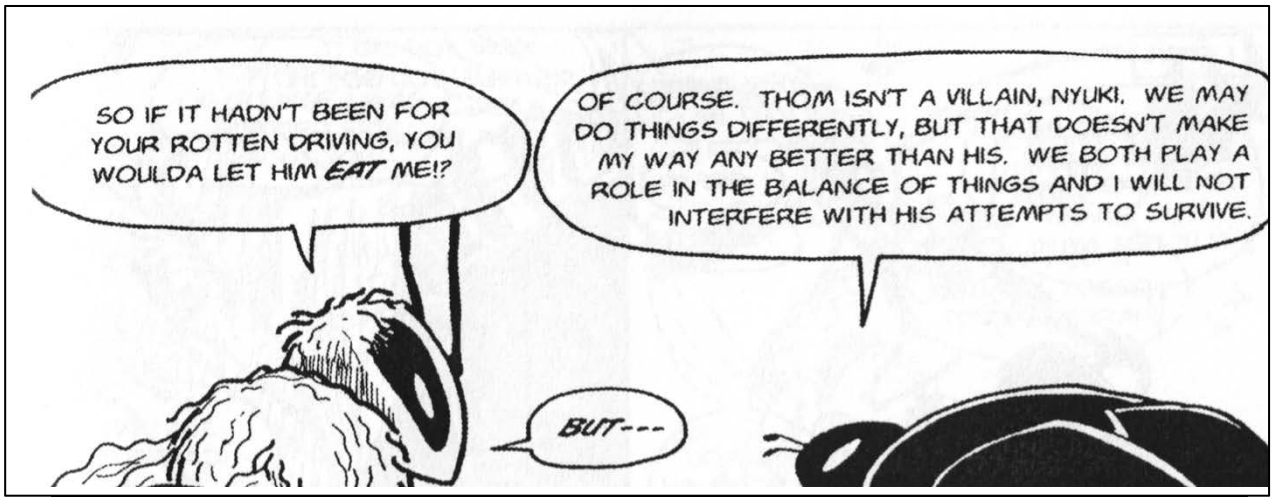


Figure 9. Nyuki and Sisyphus from *Clan Apis* (Hosler, 2000, p. 83)

> world flower actually benefits from our presence. Something about our essence strengthens it and feeds our descendants in this world. (p. 138)

The personal connection between Yelena and the dogs in *Laika* characterized the powerful effect of relationships. At first, Yelena suppressed her feelings toward the dogs when she was with her male colleagues and superiors. For example, when confronted about the death of one of the dogs, Yelena assured her boss, "Of course I feel a little sad. One gets to know these dogs. But I realize the importance of remaining as dispassionate as possible" (p. 102). Yelena's wall that she built between her work as a scientist and her compassion for the dogs began to crumble when she named the dogs, talked to them, and treated them compassionately in a relational manner.

> Dr. Gazenko: She likes you.
>
> Yalena: Yes. Dogs talk to me! Well, gentlemen…If I'm going to care for these dogs, perhaps I'd better find Kudryavka a place to sleep. (p. 72)

Similar to Barbara McClintock's treatment of her maize plants as human subjects, all three female scientists depicted in *Primates* assigned names to each of the primates they were

observing (Figure 10). In addition to personifying the animals she was observing by assigning them names (p. 18, 35), Jane Goodall used her observations of Flo's maternal care to her young chimps, and she applied it to her first-born child (p. 37).

Another example of the *Relational Approach* theme was the characters' authentic learning experiences. In *Last of the Sandwalkers,* Lucy's defiance of the status quo was reminiscent of relational scientists who challenged the positivist view of science (Figure 11). The traditionalist beetles that were in power used folklore, fear, and murder to scare the general beetle population into becoming skeptics of science. Despite these scare tactics, Lucy and her expedition crew continued their quest for discovering living organisms that were not beetles. Through their experiences with nature, this group of beetles participated in (and learned about) authentic interactions among living organisms outside of their home in Coleopolis (Figure 12).

Discussion

My decision to analyze science comics was influenced by the need to expose how females are represented and portrayed in award-winning science comics. With 100% of the pages containing illustrations, it is critical that females be equally represented and positively portrayed so that female learners can relate to the text, in particular the portrayals of women as scientists and inventors. The educator has the ability to advocate for instructional practices and materials that represent women and other marginalized groups and reduce the gender stereotypes common in textbooks (Kimmel, 1999).

After analyzing YALSA award-winning science comics from 2002-2016, a relatively small sampling of comics, I uncovered evidence regarding the presence or absence of female characters (representation) as well as the manner in which female characters were illustrated or described (portrayal).



Figure 10. (L to R): Naming observed primates by Goodall, Fossey, and Galdikas from *Primates* (Ottaviani & Wicks, 2013, pp. 36, 72, 111)



Figure 11. Lucy confronting the status quo from *Last of the Sandwalkers* (Hosler, 2015, p. 86)

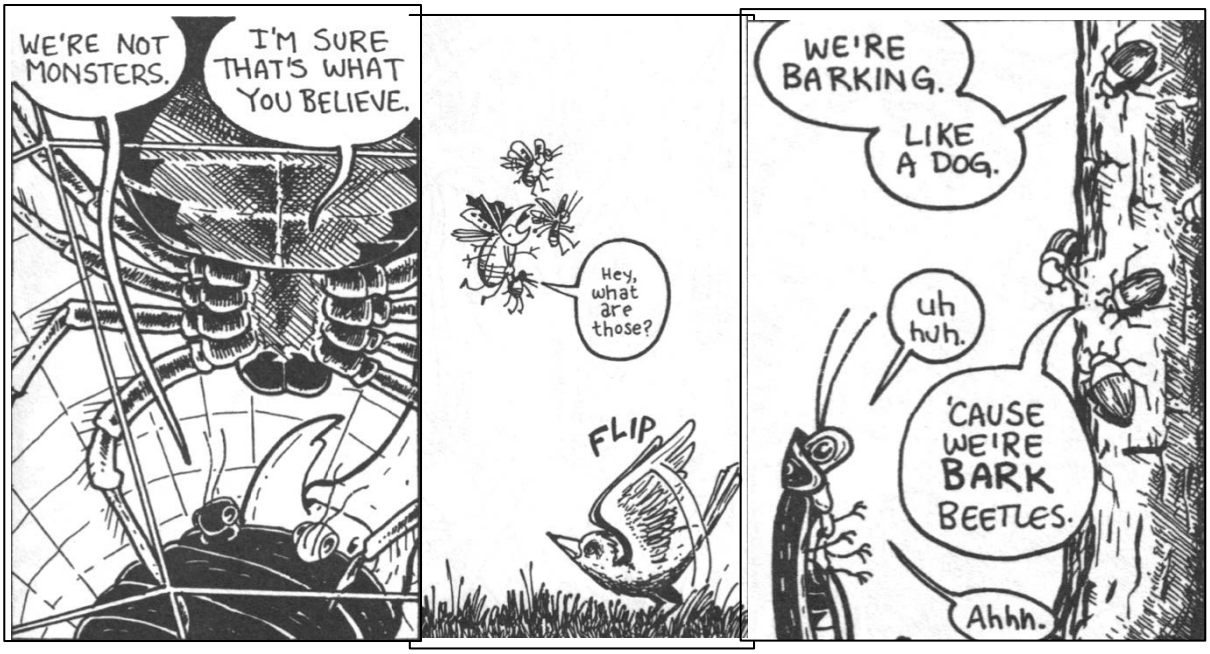


Figure 12. Examples of the authentic interactions with other organisms from *Last of the Sandwalkers* (Hosler, 2015, pp. 57, 72, 87)

Representation

When coding the sample for *Representation*, I specifically looked for the presence (or absence) of female characters, as well as the diverse range of females represented. The findings from the QCA revealed that seven of the eighteen analyzed science comics featured a female protagonist. One of the seven identified comics, *Human Body Theater*, featured a skeleton narrator who revealed her gender three pages from the end of the 223-page book. Six texts in the sample contained secondary female characters that were central to the plot. An analysis of the sample's book covers showed that nine contained females, and of these, four were anthropomorphic animals whose gender could only be determined by reading the story or the book description on the cover insert. In addition, the female characters were present in only 31% of the sample's total frames compared to 47% of male character depictions. These findings

support Blumberg's (2009) study, which showed the continual underrepresentation of females in science texts.

Even though six of the YALSA award-winning comics were based on historical accounts of scientific advancements, only *Primates: The Fearless Science of Jane Goodall, Dian Fossey, and Biruté Galdikas* focused on the work of female scientists. This particular result correlates with Potter and Rosser's (1992) analysis of science textbooks which found the contributions of female scientists were minimally addressed, if present at all, in science textbooks. In addition, the underrepresentation of females in science comics perpetuates the stereotype that women are unable to succeed in science or science careers (Watts, 2014).

Female characters were depicted as humans, animals, and anthropomorphic animals in the sample. Among the eighteen main and secondary female human characters, seventeen were White. This dominant presence of White characters was also observed in Delgato's (2009) analysis of science textbooks adopted for use in Florida schools. In addition to lack of racial and ethnic diversity, there was only one secondary character, Maddy in *Mighty Jack*, which was depicted as differently abled. No lesbian, bisexual, or transgender female characters were included in any of the titles. Finally, the only character explicitly belonging to a particular socioeconomic class was Cleo, the daughter of Pharaoh, in *Cleopatra in Space*. The gender of the animal characters in *Love: The Fox* and *Age of Reptiles Omnibus, Vol. 1* could not be identified by the illustrations, and these comics contained no text. These findings support the need for improved representation of diversity in science texts (Ceglie & Olivares, 2012; Delgato, 2009). Ceglie and Olivares (2012) noted, "A fair depiction of who does science would necessitate that textbooks pay attention to gender, race, culture, disabilities and exceptionalities, and socioeconomic issues, all of which have been concerns to science educators in recent reform

efforts" (p. 53). If science educators continue to use alternative sources of text to supplement their curricula, then the writers of these texts should promote diversity and its influences on science to accurately reflect their readers.

Portrayals

During the coding for *Portrayals*, I examined the science comics for their illustrations and descriptions of female characters. Gender stereotypes were challenged in several of the award-winning comics. First, all nine of the adult female protagonists were professionally employed career women. The presence of career-oriented women in science comics, especially those who were scientists, contradicted the patterns observed in prior research examining children's literature (Gooden & Gooden, 2001; LaDow, 1976; Weitzman et al., 1972). All eighteen female characters were portrayed outside of the home. Tools used by the female characters also contradicted gender stereotypes including swords, slingshots, ray guns, and a bow and arrow. Despite these findings, the stereotype of domesticity was present with the portrayal of two minimal characters as housewives using a kitchen knife and hand mixer. Previous research has revealed similar stereotypical domestic roles and environments for the female characters in children's and young adult literature for decades (Crabb & Marciano, 2011; Kortenhaus & Demarest, 1993; Weitzman et al., 1972). A majority of the adult female characters were illustrated without stereotypical physical appearances. The three protagonists in *Primates*, Goodall, Fossey, and Galdikas, were dressed in gender-neutral clothing (e.g., pants, shorts) and without facial cosmetics. However, in the historical fiction, *Laika*, the female characters were all depicted in dresses, standard attire for women during the time period for the story. Unlike the adult females, all of the illustrations of adolescent female characters were shown wearing the stereotypical attire for women - skirts or dresses.

Unlike Cocca's (2014) research on mainstream comic books, which found overwhelming evidence of hypersexualization, this was not observed in any of the titles from the sample featuring main and secondary female characters. The unrealistic female body type was evident in every science comic analyzed that contained female characters, which reflects the historical and contemporary depictions of females in comics (Cocca, 2014; Thompson, 2012). Finally, female characters exhibited the counter stereotype of bravery, or risk-taking. Instead of assuming a passive role, the female characters in the science comics took an active role in the actions and decisions affecting their lives and the lives of others. This finding upholds the recommendations from Jorgensen and Lechan's (2013) review of published comics and graphic novels portraying females.

In comparison to previous research, this study revealed an improvement in healthy portrayals of females, specifically reducing the stereotype of dependence on males (Samuels, 1999). The female characters recognized in this study identified themselves by their individual talents, knowledge, or scientific skills, and they did not require men to come to their rescue or solve their problems. The primary storylines involving the female protagonists and secondary characters did not involve the infatuation or pursuit of male love interests; this was mainly due to their intense focus on their personal goals. These findings are in direct contrast to research of cultural portrayals of females, which concluded that female characters in popular comics were predominantly viewed by their relationships with or pursuits of male characters (Collins, 2003).

Relational aspects appeared in several comics through the female character's interconnectedness to other characters and the constantly changing environment around her. The co-evolutionary relationship in *Clan Apis* between the honeybee and flower, as well as the mutualism represented by the honeybee colony working together, are examples of the unity of

organisms and their natural environment, or relational science (Thayer-Bacon, 2003). Another relational example was the strong bond between some of the female scientists and the animals that they studied. Through her assigning names to each of the dogs, as well as her talking to them like they were her children, Yelena portrayed compassionate consciousness in *Laika*, which was reminiscent of Barbara McClintock (Skolimowski, 1994). Similarly, all three female primatologists in *Primates*, Jane, Dian, and Biruté, named each of the primates they were observing. Finally, Lucy, the protagonist in *Last of the Sandwalkers*, challenged the traditional ideas accepted by the status quo, much like Lovelock, Margulies, and McClintock, the relational scientists who challenged the positivist and masculine views of science (Thayer-Bacon, 2003).

To remain engaged in learning and to cultivate their science identity, students must feel connected to what they are learning (Carlone & Johnson, 2007). This engagement can be problematic for girls when the instructional materials, such as books and movies, they use do not represent women or their experiences. Therefore, the educator's careful planning of instruction and the resources used is critical to the development of a girl's identity and understanding of science (Brickhouse, 2001).

Summary

The findings presented in this chapter confirmed that although healthy depictions of female characters were present, there was a deficit of female protagonists and secondary characters in award-winning science comics. The data analysis revealed female protagonists and secondary characters were not depicted in the same manner in science comics. For example, some authors used anthropomorphic animals without visible gendered attributes as the main characters, while others portrayed their main characters as humans. In addition, a diverse representation of females was also missing from the sample. With the exception of one African

American secondary character, all female human characters were portrayed as White. Also, the sample only contained one female secondary character that was differently abled. Finally, lesbian, bisexual, or transgender female characters were not included, nor were the explicit representations of different social classes. Several of the award-winning science comics challenged the gender stereotypes of domesticity, physical appearance, and submission. In addition some titles depicted female characters with positive self-identities and personal development. Finally, relational approaches to learning appeared in several comics with evidence of collaborative learning, an interconnectedness with nature, and authentic learning experiences.

CHAPTER V: CONCLUSIONS AND RECOMMENDATIONS

The underrepresentation of women in science academically and professionally has resulted in additional research efforts motivated to identify potential causes and create solutions. For decades feminist scholars have challenged the traditional masculine pedagogies and resources used in public education (Barton, 1997; Rosser & Potter, 1990; Sadker et al., 2009). The marginalization or exclusion of females from science curricular materials, such as textbooks, has perpetuated the stereotype that women are incapable of becoming scientists and discourages them from pursuing additional courses or careers in science (Watts, 2014). This chapter brings closure to my study by describing the conclusions from the findings, reflecting how this study contributes to science practitioners, and discussing the potential for future research.

Conclusions

The purpose of this study was to examine the representation and portrayals of females in YALSA award-winning science comics. The data from this study indicates gender inequalities exist in the analyzed sample of comics. Several conclusions were drawn from the findings reported in the previous chapter.

Even though female protagonists and secondary characters existed in half of the sample, males were still disproportionately represented in the total number of frames in the analyzed science comics. In addition, there was a deficiency of clearly defined females illustrated on the front covers of the sample because the gender of some of the characters could not be determined without textual clues within the stories. The main characters consisted of a mixture of anthropomorphic animals, both with and without visible gendered attributes, and humans. The lack of diversity was evident in the sample from this study with the majority of human female characters depicted as White. In fact, one African American secondary character represented the

only example of racial diversity in the entire sample. There was also a lack of diversity among the female characters with regard to sexual orientation, class, and ability.

Because science textbooks often exclude the lives and contributions of female scientists (Watts, 2014), it is critical that students be exposed to texts in the science classroom that prominently feature female scientists. This study reveals that improvement is still needed in this area. Although there were six comics in the sample that focused on the life or accomplishments of scientists, only one comic's storyline involved the lives and research of female scientists.

Even though inequalities involving gender representation were apparent in this study's sample of adolescent science comics, the presence of healthy gender portrayals in half of the titles reflects a progressive evolution of gender roles. Gender stereotypes, such as the woman as the homemaker, traditional feminine clothing (e.g., dresses, skirts), infatuation with males, and passivity were challenged in the award-winning titles containing female protagonist and secondary characters. In addition, females were not illustrated in a hypersexualized manner. However, it was disappointing to discover that all female characters were drawn having thin or athletic bodies, both stereotypical body types.

The sample's female characters predominantly exhibited healthy self-development and self-identity, which defies traditional gender norms. Self-development was depicted through the female characters' active decision-making as well as their independence from males. Positive self-identity was portrayed through females identifying themselves by their individual talents, knowledge, or scientific skills instead of their relationship to a male character. Examples of the relational approaches to learning, such as the authentic learning experiences, collaborative learning in context, and the interconnectedness to others and their natural environment, appeared in some of the sample's titles. This was apparent in the comics drawn by Jay Hosler, which

explicitly taught biological science concepts. The presence of relational learning in science comics supports feminist pedagogy, which promotes experiential learning, collaboration with peers, and an interconnectedness with one's natural surroundings (Gunter, 2000; Howes, 2002; Kimmel, 1999; Weiler, 1995; Zohar, 2006).

The use of QCA as a method for examining the content in science comics was a principal strength of this study. The deductive and inductive approaches to QCA allowed me to thoroughly examine the illustrations and text for the representations and portrayals of females. This provided opportunities for deeper insight during data analysis. The sample I selected, YALSA award-winning science comics from 2002-2017, has not been used in research investigating the representation and portrayals of females.

Feminist researchers have agreed that gender stereotypes are communicated through textual materials such as magazines, literature, textbooks, and comics. In order for female learners to disassociate from these cultural assumptions, they must be exposed to texts containing healthy portrayals of women with which they can identify. When female learners locate themselves or women engaging in science within the materials they read, they develop a positive self-identity toward science. Science comics, in their many genres, provide a means for both female and male learners to engage in science concepts while challenging their predispositions, revaluating their own experiences, and enhancing their perspectives about their natural world.

Implications for Practitioners

The results from this study serve to add to the existing body of research on the representation and portrayals of females in printed text used by educators, more specifically science comics, to help improve science education for female learners and other underrepresented groups. In addition, this study aims to influence policymakers, educators, and

other stakeholders in their selections of curricular materials containing prominent, healthy, non-stereotypical portrayals of females. Negative self-efficacy resulting from gender stereotypes contributes to the gender gap in attitudes towards science, academic course of study, and career selection (OECD, 2016). Classroom resources should not reinforce gender bias, but rather challenge it on all levels.

Despite the narrow sample used in this study, the issue of gender stereotypes in supplementary curricular resources is improving; however, it has not been eliminated. Exposing and challenging these prejudices through critical research propels a society toward social justice. It is necessary to reveal and challenge the power and gender disparities in instructional resources viewed by both students and educators. Literature perpetuating either implicit or explicit gender stereotypes should be analyzed, and the stereotyped gender representations should be challenged. Feminist scholar Reinharz (1992) claimed,

> By discovering patterns between existing and missing documents, and with power/gender relations in the society of the time, and by bringing this material to the attention of people today, new ties are made that help explain the current relation between gender and power and give some groups a greater sense of their own history. (p. 163)

All students should be afforded opportunities in the classroom to understand the perspectives of marginalized groups. Thus it is important to identify, challenge, and eliminate the biases perpetually addressed in education. According to the National Science Teachers Association (2003),

> In selecting science curriculum, science teachers, administrators, and community members must select only those curriculum materials that promote gender inclusiveness through their text, illustrations, and graphics. [They must] select only those curriculum

> materials that present culturally diverse male and female role models working in all disciplines and at all levels of science. (p. 2)

Science comics can communicate to readers that independent, brave, relational females who are actively involved in science do exist. In fact, several of the comics analyzed in this study would be excellent science classroom resources because they depict healthy female science role models and provide opportunities for boys to confront their own prejudices. When used in the science classroom, comics containing female lead characters doing science could potentially improve female students' appreciation of science and careers in science. Reading science comics about female scientists and their accomplishments could help girls visualize themselves as scientists. The nine comics containing female protagonists and secondary characters in the sample accomplished this by portraying females in counter stereotypical ways. It is critical to include the scientific contributions of women and other marginalized groups in science curricula.

Science educators should create a classroom culture where students identify and confront gender bias, as well as other biases, in science texts. As an example, the science teacher could facilitate a discussion about the presence of gender bias in the textbook that ultimately teaches students the strategies required for critically analyzing materials for gender stereotypes and solutions designed to promote gender equity. This would provide students with the background knowledge and approaches needed to confront gender bias long after they leave the classroom. By revealing the imbalance of power held by males in shaping our society and exposing gender inequality in curricular materials, stakeholders should be empowered to demand that publishers create materials that are inclusive of all students.

Although they are not responsible for the textbooks adopted by their districts, science teachers can be more cognizant of gender representation in the supplementary materials they

choose to use in their classrooms. This should not be limited to print resources such as comics, magazines, books, and articles; it should extend to sources like movie clips, websites, and guest speakers. All students need to see themselves represented in science curricula. With the recent popularity of advertisements empowering female consumers, science teachers could include materials, books, posters, etc., that inspire female students to become scientists, engineers, or mathematicians.

The publication dates for the comics in the sample are contemporary with most occurring between 2012 and 2016. Perhaps the historical settings of some of the stories accounted for the more stereotypical roles of the minimal characters. This could lead to an important discussion among students about gender roles in different cultures throughout history. It is important to note that even though five of the adult female characters were portrayed as scientists, they came from only two books. Pre-service teacher education should address the issue of gender-blindness by embedding gender issues in coursework. This should include the teaching of strategies for identifying gender bias and methods for combatting bias in the classroom (e.g., selection of curricular materials, public displays of gender bias, etc.). Finally, these findings indicate the necessity for gender-neutral science texts in libraries. Both female and male students should have access to literature that fosters healthy portrayals of women practicing science.

Implications for Future Studies

There were additional questions that developed during the research process that could be investigated in future research studies. Part of my research design focused on the analysis of female character portrayals, which intentionally excluded male characters. This oversight was potentially due to a subconscious bias that only females are portrayed stereotypically. Using a different sample could provide a different insight. Because my research design focused on

YALSA award-winning graphic literature, it would be interesting to analyze the representation and portrayals of females in a different sample of science comics. Examples of samples could include science comics recommended by other literary groups, comics that did not receive an award, books authored by the same person, or a specific genre of text. In addition, the sample could extend into other curricular resources such as movies or computer applications.

Another potential study that was recorded in my research journal involved determining the engagement and attitudes towards science of middle school female students after reading science comics. Qualitative studies investigating the use of science comics with positive portrayals of females in science classrooms would provide data not previously analyzed. The sample could be a comic used to teach a specific scientific concept containing a female protagonist like *Clan Apis* or *Last of the Sandwalkers*. Female students should be exposed to curricular materials that represent and portray themselves. With the exclusion of sexual orientation and class, as well as the minimal effort to represent different races, the concept of intersectionality could be examined in science comics. Finally, with aspects of relational learning present in this study's coding scheme, it would be interesting to analyze and interpret the relational occurrences among male characters in the sample or a different sample of science comics.

Final Thoughts

Throughout my teaching career, I have been dedicated to improving my classroom pedagogy. As a reflective practitioner, my instruction evolves in my daily endeavor to meet the cognitive needs of all learners. My passion for developing a compassionate and relational curriculum has not come from the copious amounts of reading, attendance at numerous professional development sessions, or enrollment in curriculum and pedagogy courses. Sadly, in

all of these endeavors, nothing has focused on educating the female learner. That was until I met Dr. Barbara Thayer-Bacon. Her passion for social justice was infused into every course she taught, every discussion she facilitated, and every project she assigned. The publications of Dr. Barb, as she likes to be called, ensured that the voices of women scholars continue to be heard just as loudly and prominently as those of their male colleagues. As a feminist science educator who just so happens to identify as male, I am critical of the patriarchal education system, as well as the marginalization of women in science. I hope this inspires you to join me (and the many others before me) in exposing the hidden sexism abundant in curricular materials and in education, in general.

In conclusion, it is clear that gender bias in curricular materials is an ongoing issue. The sustained efforts of researchers like myself will continue to expose and challenge the marginalization of women and other groups in supplemental science instructional materials. As a feminist scholar, I hope this study exposes the perpetual marginalization of women and other groups from science curricula while challenging those who are responsible for creating these materials (or adopting for use in schools) to advance gender equity.

LITERATURE CITED

*Abadzis, N. (2007). *Laika*. New York, NY: First Second.

Backderf, D. (2015). *Trashed*. New York, NY: Abrams ComicArts.

Brrémaud, F., & Bertolucci, F. (2016). *Love: The fox* (2nd ed.). Chicago, IL: Magnetic Press.

Cunningham, D. (2013). *How to fake a moon landing: Exposing the myths of science denia*l. New York, NY: Abrams ComicArts.

*Davis, E. (2009). *The secret science alliance and the copycat crook*. New York, NY: Bloomsbury.

Delgado, R. (2008). *Age of reptiles omnibus: Volume 1*. Milwaukee, OR: Dark Horse Books.

Fetter-Vorm, J. (2012). *Trinity: A graphic history of the first atomic bomb*. New York, NY: Hill and Wang.

*Hatke, B. (2012). *Legends of Zita the spacegirl*. New York, NY: First Second.

Hatke, B. (2016). *Mighty Jack*. New York, NY: First Second.

*Hosler, J. (2000). *Clan Apis*. Columbus, OH: Active Synapse.

*Hosler, J. (2015). *Last of the Sandwalkers*. New York, NY: First Second.

Hosler, J., Cannon, K., & Cannon, Z. (2011). *Evolution: The story of life on Earth*. New York, NY: Hill and Wang.

*Maihack, M. (2014). *Cleopatra in space – Book 1: Target practice*. New York, NY: Graphix.

Ottaviani, J., Cannon, Z., & Cannon, K. (2009). *T-Minus: The race to the moon*. New York, NY: Aladdin.

Ottaviani, J., & Myrick, L. (2011). *Feynman*. New York, NY: First Second.

Ottaviani, J., & Purvis, L. (2016). *The imitation game: Alan Turing decoded*. New York, NY: Abrams ComicArts.

*Ottaviani, J., & Wicks, M. (2013). *Primates: The fearless science of Jane Goodall, Dian Fossey, and Biruté Galdikas*. New York, NY: Square Fish.

*Wicks, M. (2015). *Human body theater*. New York, NY: First Second.

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LIST OF REFERENCES

American Association of University Women [AAUW]. (2002). How schools shortchange girls. In F. Schultz (Ed.), *Notable selections in education* (pp. 242-249). Guilford, CT: McGraw-Hill/Dushkin

American Library Association [ALA] (2012, March 2). *Great graphic novels*. Retrieved from http://www.ala.org/yalsa/great-graphic-novels

Apter, T. (2006). Resolving the confidence crisis. *Educational Leadership 63*(7), 42-46.

Association of Library Service to Children [ALSC]. (1987). *Welcome to the (Mildred L.) Batchelder Award home page.* Retrieved from http://www.ala.org/alsc/awardsgrants/bookmedia/batchelderaward

Baker, D. R. (1998). Equity issues in science education. In B. J. Fraser & K. G. Tobin, (Eds.), *International handbook of science education* (pp. 869-895). Boston, MA: Kluwer.

Barton, A. (1997). Liberatory science education: Weaving connections between feminist theory and science education. *Curriculum Inquiry, 27*(2), 141-163.

Bauer, M. (2000). Classical content analysis: A review. In M. Bauer & G Gaskell (Eds.). *Qualitative researching with text, image and sound* (pp. 131-151). London, England: Sage Publications.

Bazler, J. R., & Simonis, D. A. (1991). Are high school chemistry textbooks gender fair? *Journal of Research in Science Teaching*, *28(4)*, 353-362.

Beach, R., Enciso, P., Harste, J., Jenkins, C., Raina, S. A., Rogers, R., Short, K. G., Sung, Y. K., Wilson, M., & Yenika-Agbaw, V. (2009). Exploring the "critical" in critical content analysis of children's literature. In R. T. Jiménez, M. K. Hundley, V. J. Risko, & D. W. Rowe (Eds.), *58th yearbook of the national reading conference* (pp. 129-143). Oak Creek, WI: National Reading Conference.

Beede, D., Julian, T., Langdon, D., McKittrick, G., Khan, B., & Doms, M. (2011). *Women in STEM: A gender gap to innovation*. ESA Issue Brief #04-11. US Department of Commerce. Retrieved from http://eric.ed.gov/?id=ED523766

Belenky, M. F., Clincher, B. M., Goldberger, N. R., and Tarule, J. M. (1986). *Women's ways of knowing: The development of self, voice, and mind*. New York, NY: Basic Books.

Blumberg, R.L. (2008). The invisible obstacle to educational equality: Gender bias in textbooks. *Prospects: Quarterly Review of Comparative Education, 38*(3), 345-361.

Botzakis, S. (2011). Using non-print media and texts to support marginalized readers. In L. A. Hall, L. Burns, & E. C. Edwards (Eds.), *Empowering struggling readers: Practices for the middle grades* (pp. 161-177). New York, NY: Guilford Press.

Brickhouse, N. W. (1998). Feminism(s) and science education. In B. J. Fraser & K. G. Tobin, (Eds.), *International handbook of science education* (pp. 1067-1082). Boston, MA: Kluwer.

Brickhouse, N. W. (2001). Embodying science: A feminist perspective on learning. *Journal of Research in Science Teaching, 38*(3), 282-295.

Brickhouse, N. W., Lowery, P., & Schultz, K. (2000). What kind of girl does science? The construction of school science identities. *Journal of Research in Science Teaching, 37*(5), 441-458.

Brotman, J. S., & Moore, F. M. (2008). Girls and science: A review of four themes in science education literature. *Journal of Research in Science Teaching, 45*(9), 971-1002.

Brown, L. & Gilligan, C. (1992). *Meeting at the crossroads*. New York, NY: Ballantine Books.

Brown, J. A. (2011). *Dangerous curves: Action heroines, gender, fetishism, and popular culture*. Jackson, MS: University Press of Mississippi.

Bryman, A. (2012). *Social research methods* (4th ed.). New York, NY: Oxford University Press.

Butler, J. (1999). *Gender trouble: Feminism and the subversion of identity* (10th anniversary ed.). New York, NY: Routledge.

Camper, C., & Gonzalez III, R. (2014). *Lowriders in space*. San Francisco, CA: Chronicle Books.

Capobianco, B. (2007). Science teachers' attempts at integrating feminist pedagogy through collaborative action research. *Journal of Research in Science Teaching, 44*(1), 1-32.

Capstone Publishing (n.d.). Max Axiom super scientist. Retrieved from http://www.capstonepub.com/library/products/graphic-science-19/

Cavanagh, S. E., Riegle-Crumb, C., & Crosnoe, R. (2007). Puberty and the education of girls. *Social Psychology Quarterly, 70*(2), 186-198.

Ceci, S. J., Williams, W. M., & Barnett, S. M. (2009). Women's underrepresentation in science: Sociocultural and biological considerations. *Psychological Bulletin, 135*(2), 218–261.

Ceglie, R., & Olivares, V. (2012). Representation of diversity in science textbooks. In H. Hickman & B. J. Porfilio (Eds.), *The new politics of the textbook* (pp. 49-68). Rotterdam, The Netherlands: Sense Publishers.

Chiappetta, E. L., Ganesh, T. G., Lee, Y. H., & Phillips, M. C. (2006, April). *Examination of science textbook analysis research conducted on textbooks published over the past 100 years in the United States*. Paper presented at the meeting of the National Association for Research in Science Teaching, San Francisco, CA.

Clinchy, B. M. (1989). The development of thoughtfulness in college women: Integrating reason and care. *American Behavioral Scientists, 32*, 647-657.

Clinchy, B. M. (2002). Revisiting women's ways of knowing. In B. K. Hofer & P. R. Pintrich (Eds.), *Personal epistemology: The psychology of beliefs about knowledge and knowing* (pp. 63-87). Mahwah, NJ: Prentice Hall.

Cocca, C. (2014). The broke back test: A quantitative and qualitative analysis of portrayals of women in mainstream superhero comics, 1993–2013. *Journal of Graphic Novels and Comics 5*(4), 411-428.

Coffey, A., & Atkinson, P. (1996). *Making sense of qualitative data*. Thousand Oaks, CA: Sage Publications.

Collins, G. (2003). *America's women: Four hundred years of dolls, drudges, help-mates, and heroines.* New York, NY: William Morrow.

Cope, B., & Kalantzis, M. (Eds.). (2000). *Multiliteracies: Literacy learning and the design of social futures*. New York, NY: Routledge.

Crabb, P.B., & Marciano, D.L. (2011). Representations of material culture and gender in award-winning children's books: A 20-year follow-up. *Journal of Research in Childhood Education, 25*(4), 390-398.

Crawford, P. (2004). A novel approach: Using graphic novels to attract reluctant readers and promote literacy. *Library Media Connection, 22*(5), 26-28.

Creswell, J. W. (2013). *Qualitative inquiry and research design: Choosing among five approaches*. Thousand Oaks, CA: Sage Publications.

Dasgupta, N., & Stout, J. G. (2014). Girls and women in science, technology, engineering, and mathematics: STEMing the tide and broadening participation in STEM careers. *Policy Insights from the Behavioral and Brain Sciences, 1*(1), 21-29.

Davis, B., Sumara, D., & Luce-Kapler, R. (2000). *Engaging minds: Changing teaching in complex times* (2nd ed.). New York, NY: Routledge.

Delgato, M. (2009). *Considerations of multicultural science and curriculum reform: A content analysis of state-adopted biology textbooks in Florida* (Doctoral dissertation). Retrieved from ProQuest Digital Dissertations. (UMI Number: 3394143)

Denzin, N. K., & Lincoln, Y. S. (2005). *The SAGE handbook of qualitative research* (3rd edition). Thousand Oaks, CA: SAGE Publications.

Diamond, J., Floyd, T., Powell, M., Fox, A., Downer-Hazell, A., & Wood, C. (2012). *World of viruses*. Lincoln, NE: University of Nebraska Press.

Drury, B., Siy, J., & Cheryan, S. (2011). When do female role models benefit women? The importance of differentiating recruitment from retention in STEM. *Psychological Inquiry, 22*(4), 265-269.

Duran, M., Höft, M., Lawson, D. B., Medjahed, B., & Orady, E. A. (2014). Urban high school students' IT/STEM learning: Findings from a collaborative inquiry- and design-based afterschool program. *Journal of Science Education and Technology, 23*(1), 116-137.

Elementary and Secondary Education Act of 1965, 20 U.S.C. § 4104 (2015).

Elo, S., Kääriäinen, M., Kanste, O., Pölkki, T., Utriainen, K., & Kyngäs, H. (2014). Qualitative content analysis: A focus on trustworthiness. *SAGE Open*, *4*(1). https://doi.org/10.1177/2158244014522633

Fadigan, K., & Hammrich, P. (2004). A longitudinal study of the educational and career trajectories of female participants of an urban informal science education program. *Journal of Research in Science Teaching, 41*(8), 835-860.

First Second (n.d.). Science comics. Retrieved from https://us.macmillan.com/series/sciencecomics/

Flick, U. (Ed.) (2014). *The SAGE handbook of qualitative data analysis*. Los Angeles, CA: SAGE Publications.

Foley, C. L., & Boulware, B. J. (1996). Gender equity in 1990 middle school basal readers. *Reading Improvement, 33*(4), 220-223.

Fox, M. (2010). Women and men faculty in academic science and engineering: Social–organizational indicators and implications. *American Behavioral Scientist 53*(7), 997–1012.

Freire, P., & Macedo, D. (1987). *Literacy: Reading the word and the world*. London, England: Routledge & Kegan Press.

Freire, P. (2000). *Pedagogy of the oppressed* (30th anniversary ed.). New York, NY: Continuum.

Glynn, S., Brickman, P., Armstrong, N., & Taasoobshirazi, G. (2011). Science motivation questionnaire II: Validation with science majors and nonscience majors. *Journal of Research in Science Teaching, 4*8(10), 1159-1176.

Gneezy, U., Niederle, M., & Rustichini, A. (2003). Performance in competitive environments: Gender differences. *Quarterly Journal of Economics, 118*(3), 1049-1074.

Goodall, H. L. (2000). *Writing the new ethnography*. Lanham, MD: AltaMira.

Gooden, A. M., & Gooden, M. A. (2001). Gender representation in notable children's picture books: 1995-1999. *Sex Roles, 45*(7), 89-101.

Gunter, K. (2000). Authority is not a luxury: "Courageous dialogue" in the feminist classroom. In S. F. Steiner, H. M. Krank, P. McLaren, & R. E. Bahruth (Eds.), *Freireian pedagogy, praxis and possibilities: Projects for the new millennium* (pp. 185-192), New York, NY: Falmer Press.

Gustafson, C. (2007). What librarians can do when kids don't pass the state reading tests. *Library Media Connection, 25*(5), 22-23.

Guzzetti, B. J., & Williams, W. O. (1996). Gender, text, and discussion: Examining intellectual safety in the science classroom. *Journal of Research in Science Teaching, 33*(1), 5-20.

Halpern, D., Aronson, J., Reimer, N., Simpkins, S., Star, J., & Wentzel, K. (2007). *Encouraging girls in math and science* (NCER 2007-2003). Washington, DC: National Center for Education Research, Institute of Education Sciences, U.S. Department of Education. Retrieved from http://ncer.ed.gov

Hamilton, M., Anderson, D., Broaddue, M., & Young, K. (2006). Gender stereotyping and under-representation of female characters in 200 popular children's picture books: A twentieth-century update. *Sex Roles, 55*(11), 757–765.

Haraway, D. (1988). Situated knowledges: The science question in feminism and the privilege of partial perspective. *Feminist Studies, 14*(3), 575-599.

Harding, S. (1991). *Whose science? Whose knowledge? Thinking from women's lives*. Ithaca, NY: Cornell University Press.

Harding, S. (2008). *Sciences from below: Feminisms, postcolonialities, and modernities*. Durham, NC: Duke University Press.

Häussler, P., & Hoffman, L. (2002). An intervention study to enhance girls' interest, self-concept, and achievement in physics classes. *Journal of Research in Science Teaching, 39*(9), 870-888.

Häussler, P., Hoffman, L., Langeheine, R., Rost, J., & Sievers, K. (1998). A typology of students' interest in physics and the distribution of gender and age within each type. *International Journal of Science Education*, *20*(2), 223-238.

Heintz, K. E. (1987). An examination of sex and occupational-role presentations of female characters in children's picture books. *Women's Studies in Communication, 10*(2), 67-78.

Hekman, S. J. (1990). *Gender and knowledge: Elements of a postmodern feminism*. Boston, MA: Northeastern University Press.

Hermann, S. D., Adelman, R. M., Bodford, J. E., Graudejus, O., Okun, M. A., & Kwan, V. S. Y. (2016). The effects of a female role model on academic performance and persistence of women in STEM courses. *Basic and Applied Social Psychology, 38*(5), 258-268.

Hesse-Biber, S. N., & Leavy, P. L. (2006). *The practice of qualitative research*. Thousand Oaks, CA: Sage Publications.

Hesse-Biber, S. N., & Leavy, P. L. (2007). *Feminist research practice: A primer*. Thousand Oaks, CA: Sage Publications.

Hill, C., Corbett, C., & St. Rose, A. (2010). *Why so few?: Women in science, technology, engineering, and mathematics.* Washington, D.C.: American Association of University Women.

Hoffmann, F. L., & Stake, J. E. (1998). Feminist pedagogy in theory and practice: An empirical investigation. *National Women's Studies Association Journal, 10*(1), 79-97.

Hong, H., Lin-Siegler, X., & Graesser, A. C. (2012). How learning about scientists' struggles influences students' interest and learning in physics. *Journal of Educational Psychology, 104*(2), 469-484.

Hong, Z., Lin, H., & Lawrenz, F. (2008). Promoting single-parent family children's attitudes toward science and science performance through extracurricular science intervention in Taiwan. *International Journal of Science Education, 30*(4), 469–493.

hooks, b. (1984). *Feminist theory: From margin to center*. Boston, MA: South End Press.

Hoover, S. (2012). The case for graphic novels. *Communications in Information Literacy, 5*(2), 174-186.

Hosler, J. (2000). *Optical allusions*. Columbus, OH: Active Synapse.

Hosler, J., & Boomer, K. B. (2011). Are comics an effective way to engage nonmajors in learning and appreciating Science? *CBE - Life Sciences Education, 10*(3), 309-317. http://doi.org.proxy.lib.utk.edu:90/10.1187/cbe.10-07-0090

Howes, E. V. (1998). Connecting girls and science: A feminist teacher research study of a high school prenatal testing unit. *Journal of Research in Science Teaching, 35*(8), 877–896.

Howes, E. V. (2002). *Connecting girls and science: Constructivism, feminism, and science education reform*. New York, NY: Teachers College Press.

Hsieh, H., & Shannon, S. (2005). Three approaches to qualitative content analysis. *Qualitative Health Research, 15*(9), 1277–1288.

Hughes-Hassell, S., & Rodge, P. (2007). The leisure reading habits of urban adolescents. *Journal of Adolescent & Adult Literacy, 51*(1), 22-33.

Institute for Women's Policy Research. (2016). *The economic impact of equal pay by state* (IWPR Publication No. R468). Retrieved from https://statusofwomendata.org/featured/the-economic-impact-of-equal-pay-by-state/

Institute for Women's Policy Research. (2017). *The gender wage gap 2016: Earnings differences by race and ethnicity* (IWPR Publication No. C454). Retrieved from https://iwpr.org/publications/gender-wage-gap-2016-weekly/

Jacobs, D. (2007). More than words: Comics as a means of teaching multiple literacies. *English Journal, 96*(1), 19-25.

Jee, B. D., & Anggoro, F. K. (2012). Comic cognition: Exploring the potential cognitive impacts of science comics. *Journal of Cognitive Education and Psychology, 11*, 196-208.

Jones, M. G., Brader-Araje, L., Carboni, L. W., Carter, G., Rua, M. J., Banilower, E., & Hatch, H. (2000). Tool time: Gender and students' use of tools, control, and authority. *Journal of Research in Science Teaching, 37*(8), 760–783.

Jordan, A., Fern, B., Morris, C., Cross, R., & Mathur, S. (2014). Critical thinking in the elementary classroom: Exploring student engagement in elementary science classrooms through a case-study approach. *Journal of Emerging Trends in Educational Research and Policy Studies, 5*(6): 673-678.

Jorgensen, A., & Lechan, A. (2013). Not your mom's graphic novels: Giving girls a choice beyond wonder woman. *Technical Services Quarterly, 30*(3), 266-284.

Kane, J. M., & Mertz, J. E. (2012). Debunking myths about gender and mathematics performance. *Notices of the American Mathematical Society, 59*(1): 10-21.

Keller, E. F. (1985). *Reflections on gender and science*. New Haven, CT: Yale University Press.

Keller, E. F. (1992). Feminism and science. In M. Humm (Ed.), *Modern feminisms* (pp. 312-317). New York, NY: Columbia University Press.

Kimmel, E. (1999). Feminist teaching, an emergent practice. In S. Davis, M. Crawford, & J. Sebrechts (Eds.), *Coming into her own: Educational success in girls and women* (pp. 57-76). San Francisco, CA: Jossey-Bass.

Kortenhaus, C. M., & Demarest, J. (1993). Gender role stereotyping in children's literature: An update. *Sex Roles, 28*(3), 219-232.

Koul, R., Roy, L., & Lerdpornkulrat, T. (2012). Motivational goal orientation, perceptions of biology and physics classroom learning environments, and gender. *Learning Environments Research, 15*(2), 217-229.

Krippendorff, K. (1969). Models of messages: Three prototypes. In G. Gerbner, O. R. Holsti, K. Krippendorff, G. J. Paisly & P. J. Stone (Eds.), *The analysis of communication content*. New York, NY: Wiley.

Krippendorff, K. (2004). *Content analysis. An introduction to its methodology* (2nd ed.). Beverly Hills, CA: Sage Publications.

Kuhn, T. (2012). *The structure of scientific revolutions*, 50th anniversary edition. Chicago, IL: University of Chicago Press.

LaDow, S. (1976). A content analysis of selected picture books examining the portrayal of sex-roles and representation of males and females. (ERIC Document Reproduction Service No. ED123165).

Lauer, S., Momsen, J., Offerdahl, E., Kryjevskaia, M., Christensen, W., & Montplaisir, L. (2013). Stereotyped: investigating gender in introductory science courses. *CBE-Life Sciences Education*, *12*(1), 30-38.

Leavy, P. L. (2007). The feminist practice of content analysis. In S. N. Hesse-Biber & P. L. Leavy (Eds.), *Feminist research practice: A primer* (pp. 223-248). Thousand Oaks, CA: Sage Publications.

Legewie, J., & DiPrete, T. A. (2014). The high school environment and the gender gap in science and engineering. *Sociology of Education, 87*(4), 259-280.

Lin-Siegler, X., Ahn, J. N., Chen, J., Fang, F. A., & Luna-Lucero, M. (2016). Even Einstein struggled: Effects of learning about great scientists' struggles on high school students' motivation to learn science. *Journal of Educational Psychology, 108*(3), 314-328.

Lincoln, S., & Guba, Y. (1985). *Naturalistic inquiry*. Thousand Oaks, CA: Sage Publications.

Lovelock, J. E. (1979/1987). *Gaia: A new look at life on Earth.* Oxford, NY: Oxford University Press.

Lovelock, J. E., & Epton, S. (1975). A quest for Gaia. *New Scientist, 65*(935), 304-306.

MacDonald, H. (2004). Drawing a crowd: Graphic novel events are great ways to generate excitement. *School Library Journal, 50*(8), 20-22.

Maher, F. A., & Tetreault, M. K. T. (2001). *The feminist classroom: Dynamics of gender, race, and privilege* (Expanded ed.). Lanham, MD: Rowman & Littlefield.

Margulis, L. (1998). *Symbiotic planet: A new look at evolution*. Amherst, MA: Basic Books.

Margulis, L., & Sagan, D. (1986). *Microcosmos: 4 billion years of evolution from our microbial ancestors* (2nd ed.). Berkeley, CA: University of California Press.

Mayring, P. (2000). Qualitative content analysis. *Forum Qualitative Social Research, 1*(2). Retrieved from http://www.qualitative-research.net/index.php/fqs/article/view/1089

Mayring, P. (2010*). Qualitative content analysis: Basics and techniques* (11th ed.) Weinheim, Denmark: Beltz.

McCabe, J., Fairchild, E., Grauerholz, L., Pescosolido, B., & Tope, D. (2011). Gender in twentieth-century children's picture books: Patterns of disparity in titles and central characters. *Gender and Society, 25*(2), 197–226.

McVicker, M. F. (2011). *Women composers of classical music*. Jefferson, NC: McFarland & Company, Inc.

Michelmore, K., & Sassler, S. (2016). Explaining the gender wage gap in STEM: Does field sex composition matter? *RSF: The Russell Sage Foundation Journal of the Social Sciences, 2*(4), 194-215.

Mills, K. A. (2010). Shrek meets Vygotsky: Rethinking adolescents' multimodal literacy practices in schools. *Journal of Adolescent and Adult Literacy, 54*(1): 35–41.

Moffitt, M. S., & Wartella, E. (1992). Youth and reading: A survey of leisure reading pursuits of female and male adolescents. *Reading Research and Instruction, 31*(2), 1–17.

Moss-Racusin, C., Dovidio, J., Brescoll, V., Graham, M., & Handelsman, J. (2012). Science faculty's subtle gender biases favor male students. *Proceedings of the National Academy of Sciences of the United States of America, 109*(41), 16474-16479.

Morrow, S. L. (2005). Quality and trustworthiness in qualitative research in counseling psychology. *Journal of Counseling Psychology 52*(2), 250-260.

National Center for Education Statistics. (2015). *Bachelor's, master's, and doctor's degrees conferred by postsecondary institutions, by sex of student and discipline division: 2013-14* (Table 318.30). Washington, DC: U.S. Department of Education. Retrieved from https://nces.ed.gov/programs/digest/d15/tables/dt15_318.30.asp

National Center for Education Statistics. (2016). *The nation's report card: 2015 science results.* Washington, DC: U.S. Department of Education. Retrieved from http://nationsreportcard.gov/science_2015/files/overview.pdf

National Coalition for Women and Girls in Education. (2012). *Title IX at 40: Working to ensure gender equity in education.* Washington, D.C.: NCWGE

National Research Council. Committee on Gender Differences in Careers of Science, Engineering, Mathematics Faculty. (2010). *Gender differences at critical transitions in the careers of science, engineering, and mathematics faculty*. Washington, D.C.: National Academies Press.

National Science Foundation. (2007). *Back to school: Five myths about girls and science* (News Release 07-108), Arlington, VA. Retrieved from https://www.nsf.gov/news/news_summ.jsp?cntn_id=109939

National Science Foundation (2017). *Women, minorities, and persons with disabilities in science and engineering: 2017* (Special Report NSF 17-310), Arlington, VA. Retrieved from http://www.nsf.gov/statistics/wmpd/

National Science Teachers Association [NSTA]. (2003). *NSTA position statement: Gender equity in science education*. Retrieved from http://www.nsta.org/about/positions/genderequity.aspx

Neuendorf, K. A. (2017). *The content analysis guidebook* (2nd ed.). Los Angeles, CA: Sage Publications.

Niederle, M., & Vesterlund, L. (2007). "Do women shy away from competition? Do men compete too much?" *Quarterly Journal of Economics, 122*(3): 1067–1101.

Nochlin, L. (1988). *Women, art, and power: And other essays* (1st ed.). New York, NY: Harper & Row.

Noddings, N. (1992). *The challenge to care in schools: An alternative approach to education*. New York, NY: Teachers College Press.

Noddings, N. (1988). An ethic of caring and its implications for instructional arrangements. In B. J. Thayer-Bacon, L. Stone, & K. M. Sprecher (Eds.), *Education feminism: Classic and contemporary readings* (pp. 137-149). Albany, NY: State University of New York Press.

Nylund, C. (2007). Selecting mangas and graphic novels. *Library Media Connection, 25*(5), 30.

Organisation for Economic Co-operation and Development. (2016). *Country note: Key findings from PISA 2015 for the United States*. Paris, France: OECD Publishing.

Owens, S. A. (2013). We teach how we've been taught: Expeditionary learning unshackling sustainability education in U.S. public schools. *Journal of Sustainability Education, 5*. Retrieved from http://www.jsedimensions.org/wordpress/content/we-teach-how-weve-been-taught-expeditionary-learning-unshackling-sustainability-education-in-u-s-public-schools_2013_06/

Özdemir, E. (2010). *The effect of instructional comics on sixth grade students' achievement in heat transfer* (Unpublished doctoral dissertation). Middle East Technical University, Turkey.

Pagano, J. A. (1988). Teaching women. *Educational Theory, 39*, 321-340.

Papastergiou, M. (2008). Are computer science and information technology still masculine fields? High school students' perceptions and career choices. *Computers & Education, 51*(2), 594-608.

Peterson, S. B., & Lach, M. A. (1990). Gender stereotypes in children's books: Their prevalence and influence on cognitive and affective development. *Gender and Education, 2*(2), 185-197.

Pienta, R. S., & Smith, A. M. (2012). Women on the margins: The politics of gender in the language and content of science textbooks. In H. Hickman & B. J. Porfilio (Eds.), *The new politics of the textbook* (pp. 33-47). Rotterdam, Netherlands: Sense.

Potter, E. F., & Rosser, S. V. (1992). Factors in life science textbooks that may deter girls' interest in science. *Journal of Research in Science Teaching, 29*, 669–686.

Previs, K. K. (2016). Gender and race representations of scientists in Highlights for Children: A content analysis. *Science Communication, 38*(3), 303-327.

Provenzo, E., Shaver, A. N, & Bello, M. (2011). *The textbook as discourse: Sociocultural dimensions of American schoolbooks*. New York, NY: Routledge.

Raven, S. (2014). Wanted: The intersection of feminist pedagogy and science education. *International Journal of Gender, Science, and Technology, 6*(2), 242-251.

Rawson, C. H., & McCool, M. A. (2014). Just like all other humans? Analyzing images of scientists in children's trade books. *School Science and Mathematics, 114*(1), 10-18.

Reinharz, S. (1992). *Feminist methods in social research*. New York, NY: Oxford University Press.

Rifle, R., Schneider, T., Hillard, A., Polander, E., Jackson, S., DesAutels, P., & Wheatly, M. (2013). A mixed methods study of gender, STEM department climate, and workplace outcomes. *Journal of Women and Minorities in Science and Engineering, 19*(3), 227-243.

Robbins, T. (1996). *The great women superheroes*. Northampton, MA: Kitchen Sink.

Robbins, T. (1999). *From girls to grrrlz: A history of female comics and teens to 'zines*. San Francisco, CA: Chronicle Books.

Rose, S., Spinks, N., & Canhoto, A. I. (2015). *Management research: Applying the principles*. New York, NY: Routledge.

Rosser, S. V. (1997). *Re-engineering female friendly science*. New York, NY: Teachers College.

Rosser, S. V., & Potter, E. (1990). Sexism in textbooks. In S. V. Rosser (Ed.), *Female-friendly science: Applying women's studies methods and theories to attract students* (pp. 73-91). New York, NY: Pergamon Press.

Rosser, S. V., & Taylor, M. Z. (2009). Why are we still worried about women in science?. *Academe, 95*(3), 7-10.

Rossman, G. B., & Rallis, S. F. (2012). *Learning in the field: An introduction to qualitative research* (3rd ed.). Thousand Oaks, CA: SAGE Publications.

Rota, G., & Izquierdo, J. (2003). "Comics" as a tool for teaching biotechnology in primary schools. *Electronic Journal of Biotechnology, 6*(2), 85-89

Ruddick, S. (1996). Reason's "femininity": A case for connected knowing. In Goldberger, N., Tarule, J., Clinchy, B., & Belenky, M. (Eds.). *Knowledge, difference, and power: Essays inspired by Women's Ways of Knowing* (pp. 248-273). New York, NY: Basic Books.

Rudy, R. M., Popova, L., & Linz, D. G. (2010). The context of current content analysis of gender roles: An introduction to a special issue. *Sex Roles, 62*(11), 705-720.

Sadker, M., & Sadker, D. (1995). *Failing at fairness: How our schools cheat girls*. New York, NY: Touchstone Press.

Sadker, D., Sadker, M., & Zittleman, K. (2009). *Still failing at fairness: How gender bias cheats girls and boys in school and what we can do about it* (Rev. and updated ed.). New York, NY: Scribner.

Saenger, G. (1955). Male and female relations in the American comic strip. *Public Opinion Quarterly, 19,* 195-205.

Samuels, L. S. (1999). *Girls can succeed in science! Antidotes for science phobia in boys and girls*. Thousand Oaks, CA: Corwin Press.

Scantlebury, K. (2012). Still part of the conversation: Gender issues in science education. In B. J. Fraser, K. Tobin, & C. J. McRobbie (Eds.), *Second International Handbook of Science Education* (pp. 499–512). Netherlands: Springer.

Schreier, M. (2012). *Qualitative content analysis in practice*. Thousand Oaks, CA: SAGE Publications.

Schwarz, G. E. (2002). Graphic novels for multiple literacies. *Journal of Adolescent & Adult Literacy, 46*(3), 262-265.

Self-identity. (2017). In English Oxford Living Dictionaries online. Retrieved from https://en.oxforddictionaries.com/definition/us/self-identity

Shumow, L., & Schmidt, J. A. (2013). Academic grades and motivation in high school science classrooms among male and female students: Associations with teachers' characteristics, beliefs, and practices. In R. Haumann & G. Zimmer (Eds.), *Handbook of academic performance predictors, learning strategies, and influence of gender* (pp. 53-72). Hauppauge, NY: Nova Science Publishers.

Simon, R. M., Wagner, A., & Killion, B. (2017). Gender and choosing a STEM major in college: Femininity, masculinity, chilly climate, and occupational values. *Journal of Research in Science Teaching, 54*(3), 299-323.

Simpson, A. (1996). Fictions and facts: An investigation of the reading practices of girls and boys. *English Education*, 28, 268–279.

Singh, K., Granville, M., & Dika, S. (2002). Mathematics and science achievement: Effects of motivation, interest, and academic achievement. *Journal of Educational Research, 95*(6), 323-332.

Skolimowski, H. (1994). *The participatory mind: A new theory of knowledge and of the universe*. London, England: Arkana Penguin Books.

Smith, D. (1992). Women's perspective as a radical critique of sociology. In M. Humm (Ed.), *Modern feminisms* (pp. 306-310). New York, NY: Columbia University Press.

Smyth, F. L., & Nosek, B. A., (2015). On the gender-science stereotypes held by scientists: Explicit accord with gender-ratios, implicit accord with scientific identity. *Frontiers in Psychology, 6*(415). doi:10.3389/fpsyg.2015.00415

Spiegelman, M., Terwilliger, C., & Fearing, F. (1953). The content of comics: Goals and means to goals of comic strip characters. *The Journal of Social Psychology, 37,* 189-203.

St. Peter, S. (1979). Jack went up the hill but where was Jill? *Psychology of Women Quarterly, 4*(2), 256-260.

Stattin, H., & Magnusson, D. (1990). *Pubertal maturation in female development*. Hillsdale, N.J.: Lawrence Erlbaum Associates.

Stereotype. (2017). In English Oxford Living Dictionaries online. Retrieved from https://en.oxforddictionaries.com/definition/stereotype

Stern, B. B. (1999). Gender and multicultural issues in advertising: Stages on the research highway. *Journal of Advertising, 28,* 1-9.

Tatalovic, M. (2009). Science comics as tools for science education and communication: A brief, exploratory study. *Journal of Science Communication, 8*(4), 1-17.

Thayer-Bacon, B. J. (2003). *Relational (e)pistemologies*. New York, NY: Counterpoints, Peter Lang Publishing.

Thayer-Bacon, B. (2013). *Democracies always in the making: Historical and current philosophical issues for education*. Lanham, MD: Rowman & Littlefield.

Thompson, K. (2012, February 21). She has no head: No, it's not equal [Blog post]. Retrieved from: http://goodcomics.comicbookresources.com/2012/02/21/she-has-no-head-no-its-not-equal/

Tyson, L. (2006). *Critical theory today: A user-friendly guide* (2nd ed.). New York, NY: Routledge.

Versaci, R. (2001). How comics can change the way our students see literature: One teacher's perspective. *The English Journal, 91*(2), 61-67.

Watts, R. (2014). Females in science: A contradictory concept? *Educational Research, 56*(2), 126-136.

Weiler, K. (1995). Revisioning feminist pedagogy. *National Women's Studies Association Journal, 7*(2), 100-106.

Weitzman, L., Eifler, D., Hokada, E., & Ross, C. (1972). Sex-role socialization in picture books for preschool children. *American Journal of Sociology, 77(*6), 1125–1150.

White, M. D., & Marsh, E. E. (2006). Content analysis: A flexible methodology approach. *Library Trends, 55*(1), 22-45.

Yildirim, A. H. (2013). Using graphic novels in the classroom. *Journal of Language and Literature Education,* (8), 118–131.

Zeldin, A. L., & Pajares, F. (2000). Against the odds: Self-efficacy beliefs of women in mathematical, scientific, and technological careers. *American Educational Research Journal, 37*(1), 215-46.

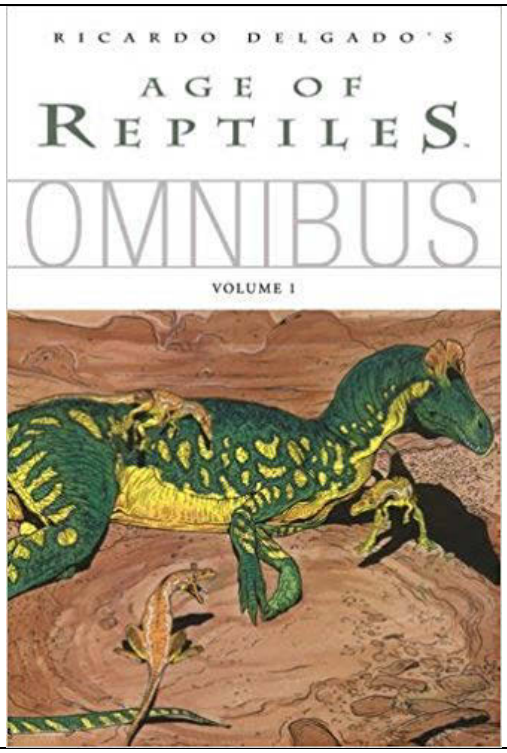
Zhang, Y., & Wildemuth, B. M. (2009). Qualitative analysis of content. In B. Wildemuth (Ed.), *Applications of social research methods to questions in information and library* (pp. 308-319). Westport, CT: Libraries Unlimited.

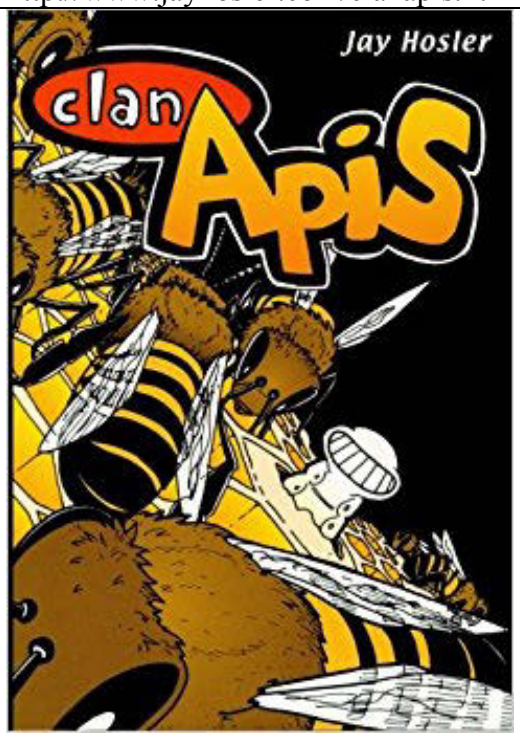
Zohar, A. (2006). Connected knowledge in science and mathematics education. *International Journal of Science Education, 28*(13), 1579-1599.

APPENDIX

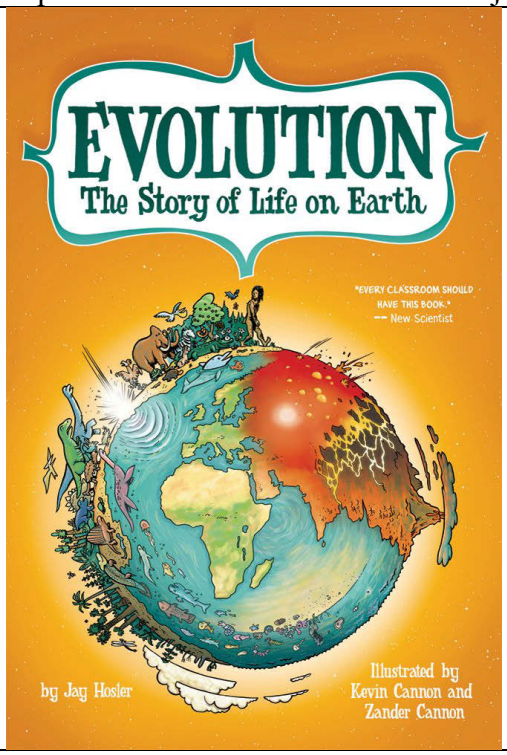
Appendix A

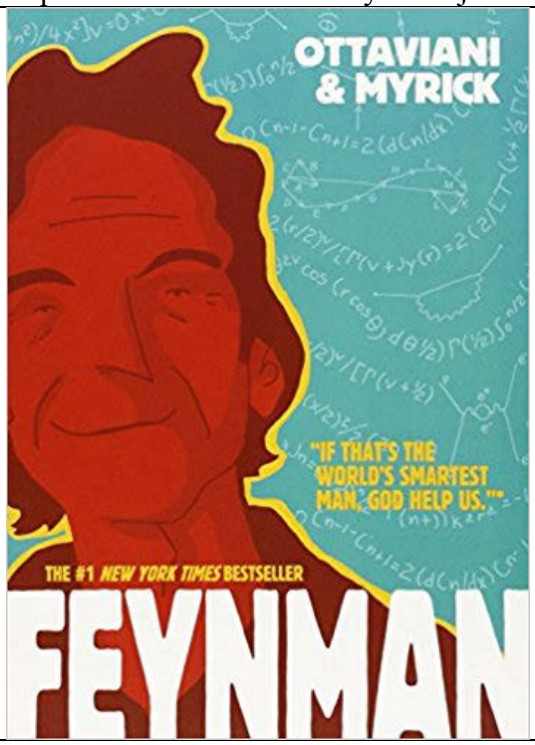
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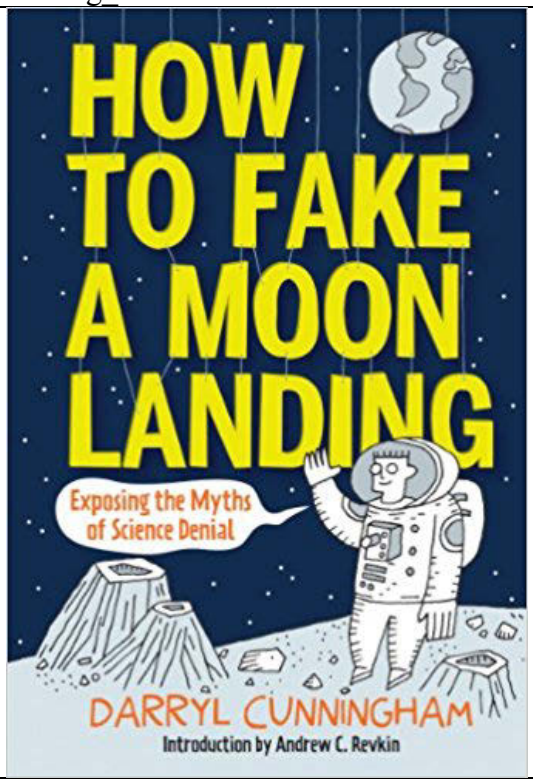
Title	Age of Reptiles Omnibus, Vol. 1
Author	Ricardo Delgado
Illustrator	Ricardo Delgado
Publisher	Dark Horse Books
Publication Date	2011
YALSA Award	2012 YALSA Great Graphic Novels for Teens
Publisher's Description	"When Ricardo Delgado--a prolific development and storyboard artist who has worked on such hit films as Men in Black, The Incredibles, WALL-E, X--Men Origins: Wolverine, and the Matrix series--first set his sights on creating comics, he crafted an epic tale about the most unlikely cast of characters: dinosaurs. Since that first foray into the world of sequential art--which earned him an Eisner win for Talent Deserving of Wider Recognition--he has returned to his critically acclaimed Age of Reptiles again and again, each time crafting a captivating saga about his saurian subjects. This volume collects Age of Reptiles: Tribal Warfare the long--out--of--print Age of Reptiles and Age of Reptiles: The Hunt, and the never--before--collected third series, Age of Reptiles: The Journey." https://www.darkhorse.com/Books/17-809/Age-of-Reptiles-Omnibus-Volume-1
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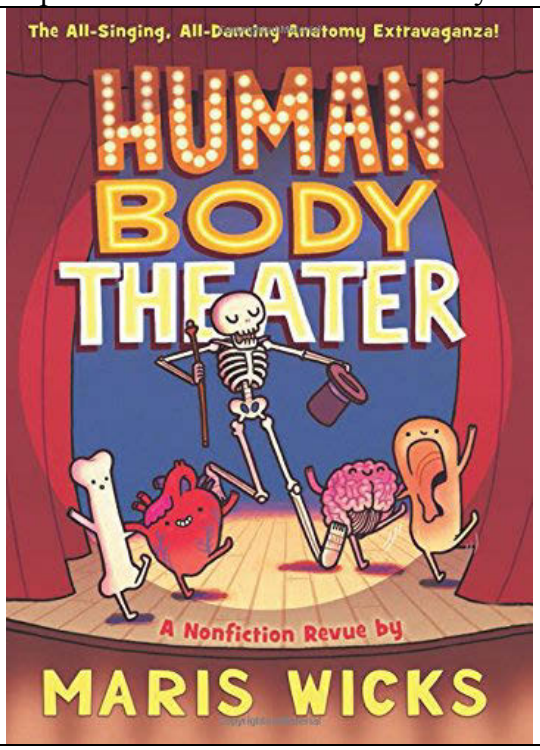
Title	Clan Apis
Author	Jay Hosler
Illustrator	Jay Hosler
Publisher	Active Synapse
Publication Date	2000
YALSA Award	2002 YALSA Great Graphic Novels for Teens
Publisher's Description	"Clan Apis is the biography a honey bee named Nyuki. Written and drawn by biologist Jay Hosler, this story explores an elaborate insect society. Nyuki has a lot to learn about life in the hive and not much time to do it. But, with help of her sister Dvorah, a dung beetle named Sisyphus and a sarcastic flower named Bloomington, she might have a chance to figure it all out." http://www.jayhosler.com/clanapis.html
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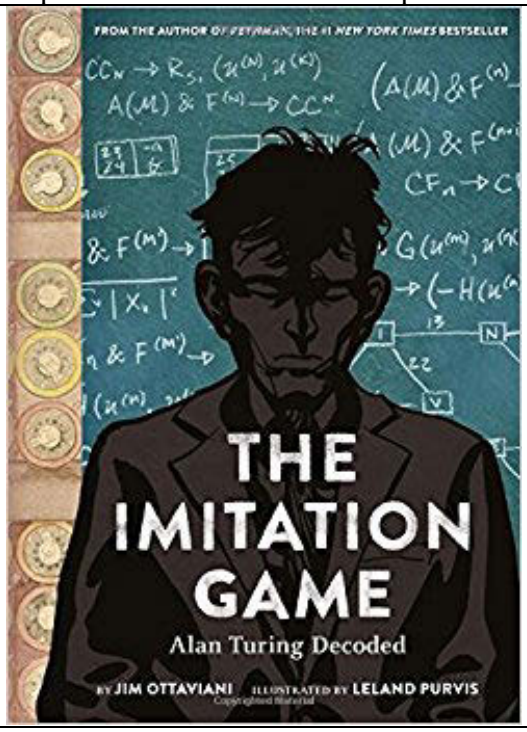
Title	Cleopatra in Space – Book 1: Target Practice
Author	Mike Maihack
Illustrator	Mike Maihack
Publisher	Graphix Scholastic
Publication Date	2014
YALSA Award	2014 YALSA Great Graphic Novels for Teens
Publisher's Description	"When fifteen-year-old Cleopatra (yes, THAT Cleopatra) finds a mysterious tablet that zaps her to the far, REALLY far future, she learns of an ancient prophecy that says she is destined to save the galaxy from the tyrannical rule of the evil Xaius Octavian. She enrolls in Yasiro Academy, a high-tech school with classes like algebra, biology, and alien languages (which Cleo could do without), and combat training (which is more Cleo's style). With help from her teacher Khensu, Cleo learns what it takes to be a great leader, while trying to figure out how she's going to get her homework done, make friends, avoid detention, and do everything else that comes with being the future queen of the universe!" https://shop.scholastic.com/parent-ecommerce/books/cleopatra-in-space-1-target-practice-9780545528429.html
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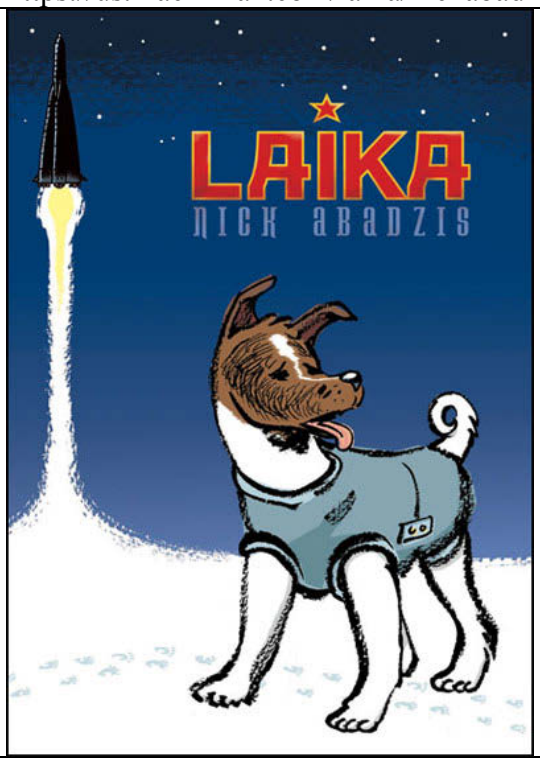
Title	Evolution: The Story of Life on Earth
Author	Jay Hosler
Illustrator	Kevin Cannon and Zander Cannon
Publisher	Hill & Wang
Publication Date	2011
YALSA Award	2012 YALSA Great Graphic Novels for Teens
Publisher's Description	"An accessible graphic introduction to evolution for the most science-phobic reader; Illustrated by the brilliant duo Kevin Cannon and Zander Cannon, this volume is written by the noted comic author and professor of biology Jay Hosler. *Evolution* features the same characters introduced in the highly regarded *The Stuff of Life: A Graphic Guide to Genetics and DNA*, now here to explain the fundamentals of the evolution of life on earth. On the heels of explaining to his planetary leader the intricacies of human genetics in *The Stuff of Life*, the intrepid alien scientist Bloort-183 is charged in this sequel with covering the wider story of evolution. Using the same storytelling conceit that Plenty magazine declared "so charming that you won't even notice you've absorbed an entire scientific field" and that caused Seed to pick *The Stuff of Life* as a best book of 2008, *Evolution* brilliantly answers Wired's demand, "What's the solution to America's crisis in science education? More comic books!" *Evolution*, the most accessible graphic work on this universally studied subject, takes the reader from earth's primordial soup to the vestigial structures, like the coccyx and the male nipple, of modern humans." https://us.macmillan.com/evolution-1/jayhosler/9780809043118/
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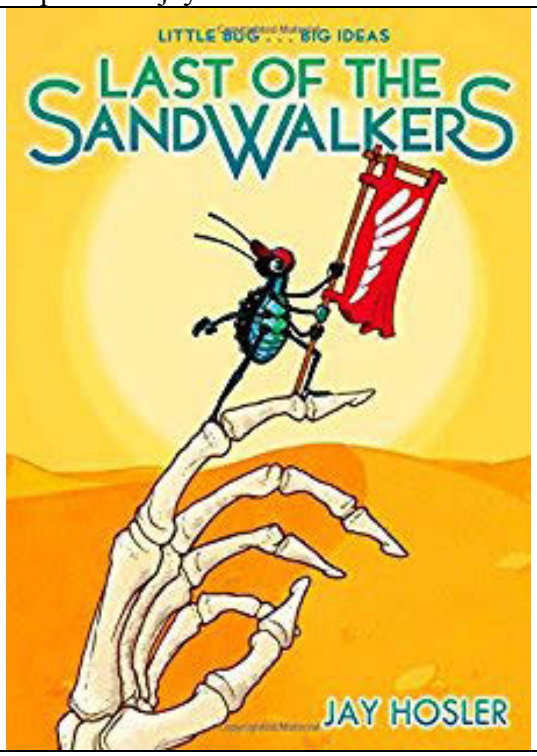
Title	Feynman
Author	Jim Ottaviani
Illustrator	Leland Myrick
Publisher	First Second
Publication Date	2011
YALSA Award	2012 YALSA Great Graphic Novels for Teens
Publisher's Description	"Richard Feynman: physicist . . . Nobel winner . . . bestselling author . . . safe-cracker. In this substantial graphic novel biography, First Second presents the larger-than-life exploits of Nobel-winning quantum physicist, adventurer, musician, world-class raconteur, and one of the greatest minds of the twentieth century: Richard Feynman. Written by nonfiction comics mainstay Jim Ottaviani and brilliantly illustrated by First Second author Leland Myrick, Feynman tells the story of the great man's life from his childhood in Long Island to his work on the Manhattan Project and the Challenger disaster. Ottaviani tackles the bad with the good, leaving the reader delighted by Feynman's exuberant life and staggered at the loss humanity suffered with his death. Anyone who ever wanted to know more about Richard P. Feynman, quantum electrodynamics, the fine art of the bongo drums, the outrageously obscure nation of Tuva, or the development and popularization of the field of physics in the United States need look no further than this rich and joyful work." https://us.macmillan.com/feynman/jimottaviani/9781596438279/
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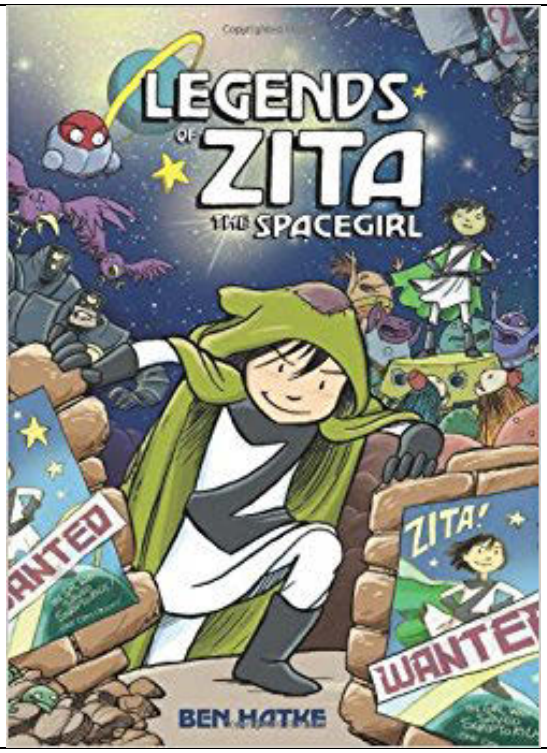
Title	How to Fake a Moon Landing: Exposing the Myths of Science Denial
Author	Darryl Cunningham
Illustrator	Darryl Cunningham
Publisher	Abrams ComicArts
Publication Date	2013
YALSA Award	2014 YALSA Great Graphic Novels for Teens
Publisher's Description	"Is hydro-fracking safe? Is climate change real? Did the moon landing actually happen? How about evolution: fact or fiction? Award-winning author-illustrator Darryl Cunningham looks at these and other hot-button science topics and presents a fact-based, visual assessment of current thinking and research on eight different issues everybody's arguing about. His lively storytelling approach incorporates comics, photographs, and diagrams to create substantive but easily accessible reportage. Cunningham's distinctive illustrative style shows how information is manipulated by all sides; his easy-to-follow narratives allow readers to draw their own fact-based conclusions. A graphic milestone of investigative journalism!" http://www.abramsbooks.com/product/how-to-fake-a-moon-landing_9781419706899/
Cover Art	

Title	Human Body Theater: A Non-Fiction Revue
Author	Maris Wicks
Illustrator	Maris Wicks
Publisher	First Second
Publication Date	2015
YALSA Award	2016 YALSA Great Graphic Novels for Teens
Publisher's Description	"Welcome to the Human Body Theater, where your master of ceremonies is going to lead you through a theatrical revue of each and every biological system of the human body! Starting out as a skeleton, the MC puts on a new layer of her costume (her body) with each 'act.' By turns goofy and intensely informative, the *Human Body Theater* is always accessible and always entertaining. Maris Wicks is a biology nerd, and by the time you've read this book, you will be too! Harnessing her passion for science (and her background as a science educator for elementary and middle-school students), she has created a comics-format introduction to the human body that will make an expert of any reader -- young or old!" https://us.macmillan.com/humanbodytheater/mariswicks/9781596439290
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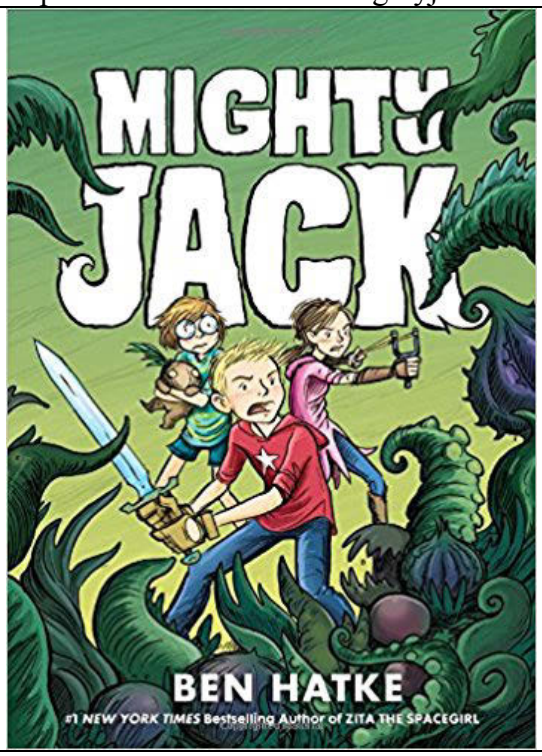
Title	The Imitation Game: Alan Turing Decoded
Author	Jim Ottaviani
Illustrator	Leland Purvis
Publisher	Abrams ComicArts
Publication Date	2016
YALSA Award	2017 YALSA Great Graphic Novels for Teens
Publisher's Description	"English mathematician and scientist Alan Turing (1912–1954) is credited with many of the foundational principles of contemporary computer science. *The Imitation Game* presents a historically accurate graphic novel biography of Turing's life, including his groundbreaking work on the fundamentals of cryptography and artificial intelligence. His code breaking efforts led to the cracking of the German Enigma during World War II, work that saved countless lives and accelerated the Allied defeat of the Nazis. While Turing's achievements remain relevant decades after his death, the story of his life in post-war Europe continues to fascinate audiences today. Award-winning duo Jim Ottaviani (the #1 New York Times bestselling author of Feynman and Primates) and artist Leland Purvis (an Eisner and Ignatz Award nominee and occasional reviewer for the Comics Journal) present a factually detailed account of Turing's life and groundbreaking research—as an unconventional genius who was arrested, tried, convicted, and punished for being openly gay, and whose innovative work still fuels the computing and communication systems that define our modern world. Computer science buffs, comics fans, and history aficionados will be captivated by this riveting and tragic story of one of the 20th century's most unsung heroes." http://www.abramsbooks.com/product/imitation-game_9781419718939/
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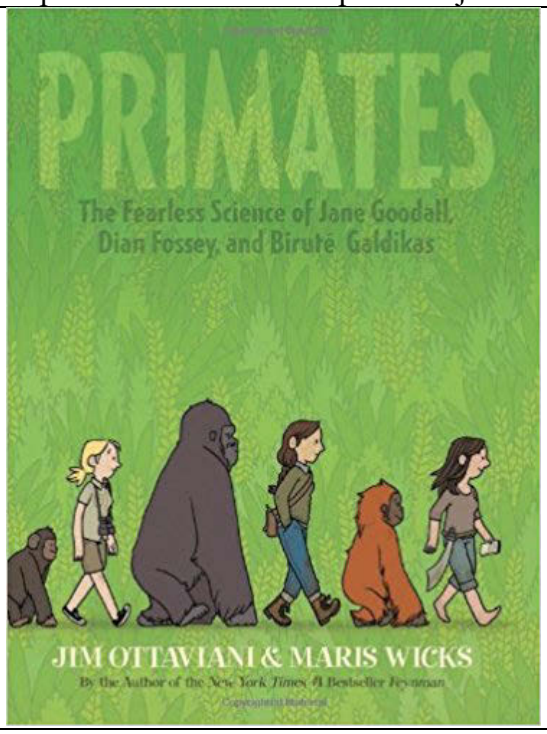
Title	Laika
Author	Nick Abadzis
Illustrator	Nick Abadzis
Publisher	First Second
Publication Date	2008
YALSA Award	2008 YALSA Great Graphic Novels for Teens
Publisher's Description	"Laika was the abandoned puppy destined to become Earth's first space traveler. This is her journey. Nick Abadzis masterfully blends fiction and fact in the intertwined stories of three compelling lives. Along with Laika there is Korolev, once a political prisoner and now a driven engineer at the top of the Soviet space program, and Yelena, the lab technician responsible for Laika's health and life. This intense triangle is rendered with the pitch-perfect emotionality of classics like *Because of Winn Dixie*, *Shiloh*, and *Old Yeller*." https://us.macmillan.com/laika/nickabadzis/9781250050625/
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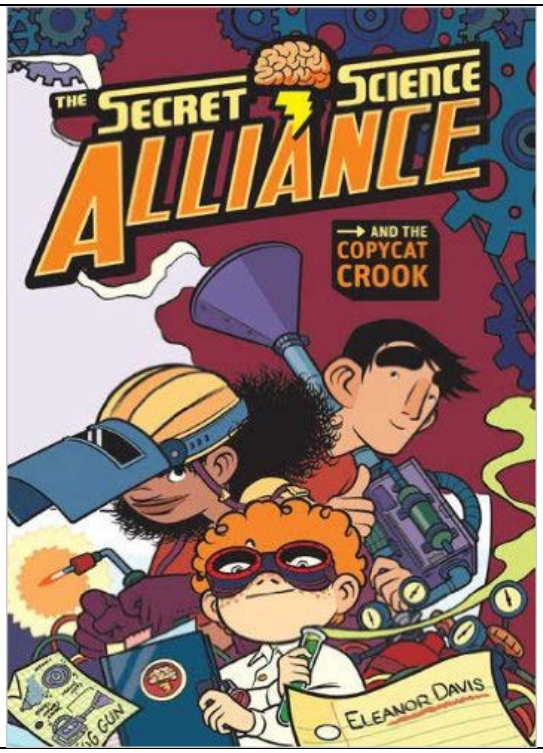
Title	Last of the Sandwalkers
Author	Jay Hosler
Illustrator	Jay Hosler
Publisher	First Second
Publication Date	2015
YALSA Award	2016 YALSA Great Graphic Novels for Teens
Publisher's Description	"Nestled in the grass under the big palm tree by the edge of the desert there is an entire civilization--a civilization of beetles. In this bug's paradise, beetles write books, run restaurants, and even do scientific research. But not too much scientific research is allowed by the powerful elders, who guard a terrible secret about the world outside the shadow of the palm tree. Lucy is not one to quietly cooperate, however. This tiny field scientist defies the law of her safe but authoritarian home and leads a team of researchers out into the desert. Their mission is to discover something about the greater world...but what lies in wait for them is going to change everything Lucy thought she knew." http://www.jayhosler.com/books.html
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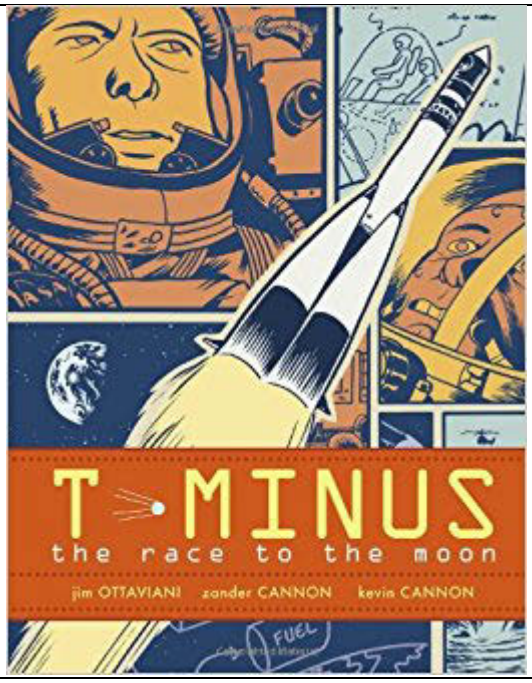
Title	Legends of Zita the Spacegirl
Author	Ben Hatke
Illustrator	Ben Hatke
Publisher	First Second
Publication Date	2012
YALSA Award	2013 YALSA Great Graphic Novels for Teens
Publisher's Description	"Ben Hatke brings back our intrepid space heroine for another delightful sci-fi/fantasy adventure. Zita is determined to find her way home to earth, following the events of the first book. But things are never simple, and certainly never easy, in space. Zita's exploits from her first adventure have made her an intergalactic megastar! But she's about to find out that fame doesn't come without a price. And who can you trust when your true self is being eclipsed by your public persona, and you've got a robot doppelganger wreaking havoc . . . while wearing your face? Still, if anyone can find their way through this intractible mess of mistaken identity and alien invaders, it's the indomitable Zita, in Legends of Zita the Spacegirl." https://us.macmillan.com/legendsofzitathespacegirl/benhatke/9781596434479/
Cover Art	

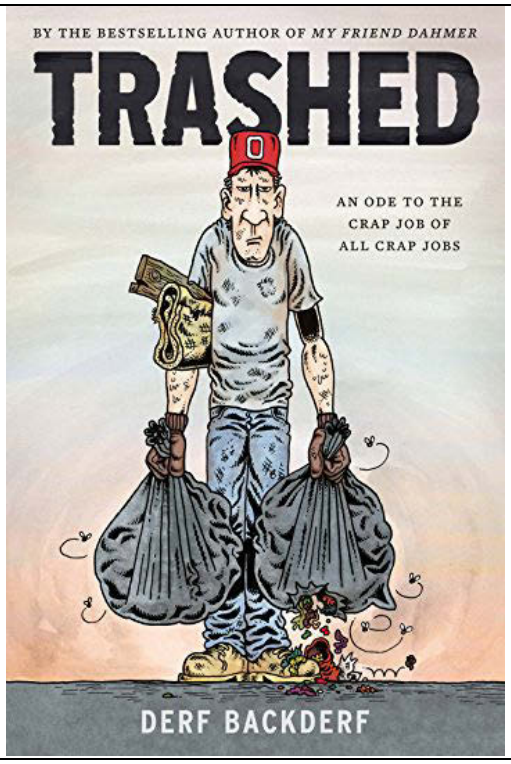
Title	Love: The Fox
Author	Frédéric Brrémaud
Illustrator	Federico Bertolucci
Publisher	Magnetic Press
Publication Date	2016
YALSA Award	2017 YALSA Great Graphic Novels for Teens
Publisher's Description	"It's not easy being one of the smaller predators in the woods, competing with an entire woodland population for scraps along the food chain. But when nature throws cataclysmic weather into the mix, it becomes a race for survival… and Love." http://www.magnetic-press.com/love-the-fox/
Cover Art	

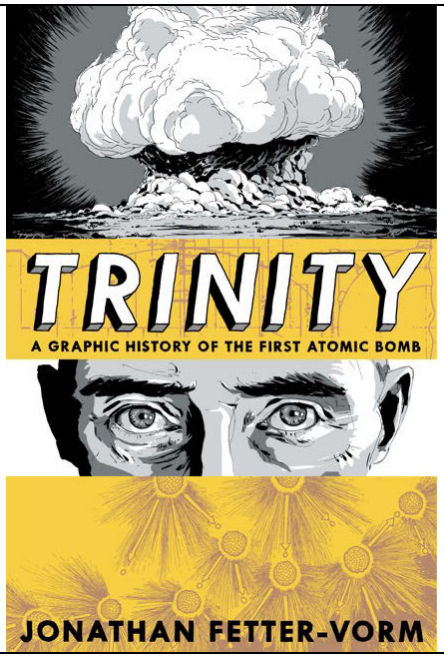
Title	Mighty Jack
Author	Ben Hatke
Illustrator	Ben Hatke
Publisher	First Second
Publication Date	2016
YALSA Award	2017 YALSA Great Graphic Novels for Teens
Publisher's Description	"Jack might be the only kid in the world who's dreading summer. But he's got a good reason: summer is when his single mom takes a second job and leaves him at home to watch his autistic kid sister, Maddy. It's a lot of responsibility, and it's boring, too, because Maddy doesn't talk. Ever. But then, one day at the flea market, Maddy does talk—to tell Jack to trade their mom's car for a box of mysterious seeds. It's the best mistake Jack has ever made. In *Mighty Jack*, what starts as a normal little garden out back behind the house quickly grows up into a wild, magical jungle with tiny onion babies running amok, huge, pink pumpkins that bite, and, on one moonlit night that changes everything…a dragon." https://us.macmillan.com/mightyjack/benhatke/9781626722644/
Cover Art	

Title	Primates: The Fearless Science of Jane Goodall, Dian Fossey, and Biruté Galdikas
Author	Jim Ottaviani
Illustrator	Maris Wicks
Publisher	Square Fish
Publication Date	2013
YALSA Award	2014 YALSA Great Graphic Novels for Teens
Publisher's Description	"Jim Ottaviani returns with an action-packed account of the three greatest primatologists of the last century: Jane Goodall, Dian Fossey, and Biruté Galdikas. These three ground-breaking researchers were all students of the great Louis Leakey, and each made profound contributions to primatology—and to our own understanding of ourselves. Tackling Goodall, Fossey, and Galdikas in turn, and covering the highlights of their respective careers, Primates is an accessible, entertaining, and informative look at the field of primatology and at the lives of three of the most remarkable women scientists of the twentieth century. Thanks to the charming and inviting illustrations by Maris Wicks, this is a nonfiction graphic novel with broad appeal." https://us.macmillan.com/primates/jimottaviani/9781250062932/
Cover Art	

Title	The Secret Science Alliance and the Copycat Crook
Author	Eleanor Davis
Illustrator	Eleanor Davis
Publisher	Bloomsbury
Publication Date	2009
YALSA Award	2010 YALSA Great Graphic Novels for Teens
Publisher's Description	"Super-smart Julian Calendar thinks starting junior high at a new school will mean he can shed his nerdy image-but then he meets Ben and Greta, two secret scientists like himself! The three form a secret club, complete with a high-tech lair. There, they can work to their hearts content on projects like the Stink-O-Meter, the Kablovsky Copter, and the Nightsneak Goggles. All that tinkering comes in handy when the trio discovers an evil scientist's dastardly plan to rob a museum. Can three inventors, armed with their wacky creations, hope to defeat this criminal mastermind?" https://www.bloomsbury.com/us/the-secret-science-alliance-and-the-copycat-crook-9781599903965/
Cover Art	

Title	T-Minus: The Race to the Moon
Author	Jim Ottaviani
Illustrator	Zander Cannon and Kevin Cannon
Publisher	Aladdin
Publication Date	2009
YALSA Award	2010 YALSA Great Graphic Novels for Teens
Publisher's Description	"Graphic fictionalized retelling of the moon landing timed for the fortieth anniversary! In *T-Minus* the exciting story of two world superpowers racing to land a man on the moon is depicted through compelling comics artwork, taking readers through the history of the race and turning the engineers and astronauts involved into vivid and real characters. The story unfolds through the eyes of the figures working behind the scenes to make this miracle happen, showing every triumph and catastrophe along the way, and culminating in the dramatic event itself." http://www.simonandschuster.com/books/T-Minus/Jim-Ottaviani/9781416949602
Cover Art	

Title	Trashed
Author	Derf Backderf
Illustrator	Derf Backderf
Publisher	Abrams ComicArts
Publication Date	2015
YALSA Award	2016 YALSA Great Graphic Novels for Teens
Publisher's Description	"Every week we pile our garbage on the curb and it disappears—like magic! The reality is anything but, of course. *Trashed*, Derf Backderf's follow-up to the critically acclaimed, award-winning international bestseller *My Friend Dahmer*, is an ode to the crap job of all crap jobs—garbage collector. Anyone who has ever been trapped in a soul-sucking gig will relate to this tale. *Trashed* follows the raucous escapades of three 20-something friends as they clean the streets of pile after pile of stinking garbage, while battling annoying small-town bureaucrats, bizarre townfolk, sweltering summer heat, and frigid winter storms. *Trashed* is fiction, but is inspired by Derf's own experiences as a garbage-man. Interspersed are nonfiction pages that detail what our garbage is and where it goes. The answers will stun you. Hop on the garbage truck named Betty and ride along with Derf on a journey into the vast, secret world of garbage. *Trashed* is a hilarious, stomach-churning tale that will leave you laughing and wincing in disbelief." http://www.abramsbooks.com/product/trashed_9781419714535/
Cover Art	

Title	Trinity: A Graphic History of the First Atomic Bomb
Author	Jonathan Fetter-Vorm
Illustrator	Jonathan Fetter-Vorm
Publisher	Hill & Wang
Publication Date	2013
YALSA Award	2013 YALSA Great Graphic Novels for Teens
Publisher's Description	"*Trinity*, the debut graphic book by Jonathan Fetter-Vorm, depicts the dramatic history of the race to build and the decision to drop the first atomic bomb in World War Two. This sweeping historical narrative traces the spark of invention from the laboratories of nineteenth-century Europe to the massive industrial and scientific efforts of the Manhattan Project, and even transports the reader into a nuclear reaction—into the splitting atoms themselves. The power of the atom was harnessed in a top-secret government compound in Los Alamos, New Mexico, by a group of brilliant scientists led by the enigmatic wunderkind J. Robert Oppenheimer. Focused from the start on the monumentally difficult task of building an atomic weapon, these men and women soon began to wrestle with the moral implications of actually succeeding. When they detonated the first bomb at a test site code-named Trinity, they recognized that they had irreversibly thrust the world into a new and terrifying age. With powerful renderings of WWII's catastrophic events at Hiroshima and Nagasaki, Fetter-Vorm unflinchingly chronicles the far-reaching political, environmental, and psychological effects of this new invention. Informative and thought-provoking, *Trinity* is the ideal introduction to one of the most significant events in history." https://us.macmillan.com/trinityagraphichistoryofthefirstatomicbomb/jonathanfettervorm/9780809093557/
Cover Art	

Appendix B

Criteria for Selecting Graphic Novels with Healthy Female Role Models

(Jorgensen & Lechan, 2013)

Criterion	Description
Strong Female Characters	
Main or secondary	Can be the focal point of the story, secondary characters, or part of an ensemble
	If secondary, she plays an important role in the storytelling
	Is necessary to the storytelling (e.g. interact with other characters)
Active role	Makes independent decisions affecting the plot
	Her actions are the driving force for the story
Non-traditional roles	Breaks cultural norms (non-traditional)
	Carefully plans decisions
	Takes responsibility for decisions
	The decision to stay or leave a forced situation should be made with regard to its effect on her (traditional)
Reliance on males	Does not rely on males for emotional well-being
	Gains power through personal effort
	Moves toward self-actualization
	Maintains focus beyond the male protagonist
Character portrayal	
Three-dimensional	Have back-stories, unique personalities, goals, and flaws
	Not overly idealized
Diversity	Represents different personalities, ages, backgrounds, relationships, and ethnicities
Unique to the story	Faces the consequences of her decisions without being rescued by a male or an adult
Personal identity	Defined by skills or talents, not relationships
	Decision maker; not a victim of circumstances or the actions of others
Power	If in a position of power, she uses it for good
	Does not remain in a state of perpetual weakness or distress
	If an adult, she is not dependent on others for emotional or physical welfare
	If a child, she becomes aware of her environment and her effect on it.
Storyline	
Genre	Storylines can come from multiple genres (e.g. Fantasy, historical fiction, romance, non-fiction, action, horror, biography)
Relatable to the reader	Ability for readers from different backgrounds to relate; incorporates different genders, races, ethnicities, classes, and sexual orientations
Violence against women	Sexual or physical violence against women is not used as a plot device; if violence against women is present, the consequences for both the perpetrator and the victim are depicted.

Criterion	Description
Artwork	
Any style or medium	From full-color to B&W, artwork to cartoon ink
Purposive images	Serves a purpose in the story or moves the plot along
	May enhance the text or convey more of the story (infer)
	Not used for shock value
Females are not hyper-sexualized	The female body is not exaggerated to accentuate or focus on her breasts, hips, or butt

Appendix C

Coding Themes, Rules, Definitions, and Examples

Coding Theme	**Rule**	**Definition**	**Example**
Counter Stereotypes of Women	Focused on her career (adult) or shows ambition towards a career (youth) Physical appearance is not stereotypical: Does not wear makeup or skirts/dresses in informal settings, not hypersexualized, realistic body shape Active, goal-oriented, and exhibits self-confidence, self-reliance, and decisiveness in her actions	This theme accounts for the ideas opposing prejudicial beliefs about women that are universally held by a social group, such as career-minded, physical appearance, and risk-takers.	*Primates:* Goodall saving her money to move to Africa to study primates (p. 4) *Primates*: Galdikas was always illustrated with no makeup on and wearing pants or shorts (pp. 83, 92) *Legends of Zita the Spacegirl*: When stranded on an alien planet, Zita is left to survive using only her intelligence and abilities (pp. 48, 57, 147)
Self-Identity	Positively identifies herself by her skills or abilities Acknowledges herself as a scientist or inventor	"The recognition of one's potential and qualities as an individual" (English Oxford Living Dictionaries, 2017)	*Last of the Sandwalkers:* Lucy was aware of her achievements as a scientist and an inventor, as well as her rank of expedition leader (pp. 88, 98, 209) *Secret Science Alliance:* Greta believed her inventions were so great that they were coveted by others enough to steal them (p. 55)

Coding Theme	Rule	Definition	Example
Positive Growth	If in a position of power, they use their power to accomplish good Personally overcomes weakness (i.e., without the assistance of men) Emotionally, physically, and intellectually independent from others. If a child dependent on her parents/guardians, then she becomes more aware of her effect on others and her environment.	This theme focuses on realizing one's full potential, using power for good, overcoming weakness, and becoming emotionally, physically, and intellectually independent of others/ aware of her personal effect on others/environment.	*Last of the Sandwalkers*: Lucy leads a team on an expedition to the forbidden desert. With her leadership (power), she educates the insects back home (p. 2) *Clan Apis*: Nyuki frees herself from the mantis (p. 68) *Legends of Zita the Spacegirl*: Zita desires to return to Earth. Yet she leaves to save Pizzicato, whom she says is "in trouble and it's [Zita's] fault" (p. 200)
Relational Approach	Demonstrates her interconnectedness to others[1] and the evolving natural environment[2]	Emphasizes the co-construction of knowledge through their relationships within their contextual settings (Thayer-Bacon, 2003)	[1]*Clan Apis:* Young Nyuki befriends Sisyphus, a dung beetle, who teaches Nyuki about honeybees, mutualism, and the interconnecting roles different organisms play in the circle of life (p. 83) [2]*Clan Apis:* Nyuki and Bloomington's coevolutionary relationship between a honeybee and a flower (p. 123)

VITA

Christopher Ryan Bowen was born in Allentown, PA, to the parents of Roger and Linda Bowen. After growing up in the suburbs of Richmond, Virginia and the suburbs of Washington, D.C., his family moved to East Tennessee. Christopher graduated high school and then attended East Tennessee State University (ETSU) where he pursued a degree in Biological Science with a minor in Vocal Music Performance. After earning his Bachelor of Science, he began working in the corporate world as a human resources officer for a credit card services company and later as a computer applications and web design instructor. While teaching computer application courses to adult professionals, Christopher discovered his true passion was education. As a result, he pursued a Master's degree in Education (K-8) at East Tennessee State University. Immediately following graduation, Christopher accepted a teaching position in Johnson City Schools as a seventh grade science and social studies teacher. In addition, he began teaching undergraduate and graduate courses as an adjunct faculty member of ETSU's Department of Curriculum and Instruction. Following his twelfth year of middle school teaching, Christopher decided to go back to school – this time as a doctoral student at the University of Tennessee, Knoxville. Throughout his tenure as a postgraduate student, Christopher continued to work as a full-time middle school science educator and part-time adjunct professor. He has presented at local, state, national, and international conferences. During the final months of writing his dissertation (and after fourteen years of teaching), Christopher was offered the position of District K-8 Science and Math Curriculum Coach for the Johnson City school system. He graduated with a Doctor of Philosophy in Education with a cognate in feminist studies in December 2017.