

THE IMPACT OF BIAS PRESENT IN HIGH SCHOOL SCIENCE TEXTBOOKS

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Introduction

Textbooks are an important educational accompaniment to study the various subjects in schools. Students rely heavily on this instructional material to further supplement their learning both inside and outside of the classroom. Whether intentional or not, biases are present in these science textbooks which negatively influence student interest and achievement in science courses (Popham, 2010; Committee for Economic Development Research and Policy Committee, 2003). Bias can be defined as a belief, attitude, behaviour or practice that reflects an assumed superiority of one group in comparison to another (University of Massachusetts Amherst, 2017). According to Oxford University Press bias can also be defined as having a prejudice for or against one person or a group that is unfair (Oxford University Press, 2017). Bias can be seen outwardly or covertly, creating an imbalance of power in society between groups of people. Bias can also be institutionalized into policies, practices and structures. In the realm of education, bias can be seen in educational resources, policies and educational discourse which acts as a way to dehumanize and oppress certain people from their individual rights and academic success (Anyon, 2005). Research shows that science literacy is a challenge for individuals in high school when bias is present and this affects student involvement in science courses (Ragusa, 2013).

My paper revolves around the biases that are present in the domain of science. Let me first begin with a historical definition of science that captures the many of the key elements of the field as it is conceptualized in contemporary theory and practice. At the dawn of the previous century, Pearson (1900) argued,

...that the field of science lies solely among immediate sense-impressions. The object of the present work is to insist on a directly contrary proposition, namely that science is in reality a classification and analysis of the contents in the mind; and the scientific method

consists in drawing just comparisons and inferences from the stored impresses of past sense-impressions, and from the conceptions based upon them. Not till the immediate sense-impression has reached the level of a conception, or at least a perception, does it become material for science (p. 52).

Still today, we can think of science as an evidence-based analysis – and site of debate – about the meaning and functions of the life world. The field of science is broad and has many specialities, my paper focuses around the biology subset of sciences. Potochnik (2013) defines biology as a way that individuals try to understand how and why things happen. She says,

...scientists seek to uncover why things happen the way they do. In biology, explanations have been sought for why offspring generally have the same traits as their parents or for why one area has a greater variety of species than another. Biologists have also sought to understand the process by which plant cells convert sunlight into nutrients; the particular genetic influences on human smoking behavior; and why male seahorses, not females, gestate seahorse embryos. All of these—and many, many more besides—are attempts to explain biological phenomena, phenomena ranging from generalized to highly specific and from subcellular to encompassing vast swaths of the Earth (p. 49).

Biology is an important field of science to study the world around us. It gives us the foundation of theories and philosophy to understand why things occur the way they do. Since biology is the aspect of science that relies heavy on theories and facts, it is of interest to see who are the ones developing these facts, how the information is being presented through research and how are these individuals represented in the field of science.

Literature states that the biases present in science textbooks influence students' career choices in the fields of Science, Technology, Engineering and Mathematics (STEM) and may

impact the workforce dynamics (Clark Blickenstaff, 2005). Statistics Canada's data shows that men outnumber women in the field of science, leading to a loop that feeds into itself: more men pursue and therefore succeed in the field of science because it is seen as a masculine subject, which, in turn invites more men into its fold (Hango, 2013). This negatively impacts the choices of those who do not fit inside the category of maleness constituting the borders of the discipline (Brotman & Moore, 2008). Similarly, racialized minorities and those with disabilities may also be dissuaded from studying and pursuing a career in the sciences due to racialized, and ablelist meanings that secure dominant notions of *who* can and should rightly belong inside its borders (Sleeter & Grant, 2011).

There has been concerns raised by science educators that there is a discrepancy of scientific ability between boys and girls because of the insufficient academic support and negative messages that discourage girls from participating in science activities and developing scientific abilities (Mullis & Jenkins, 1988; Shepardson & Pizzini, 1992; Kennedy & Sundberg, 2017). Studies have also shown that differential educational treatment occurs during science instruction (Baker, 1988; Lee, 1984; Sax et al., 2015; Simon, Wagner, & Killion, 2016). For example, Jones and Wheatly (1990) have stated that the teachers' expectations, praise, and criticism differ between girls and boys. They claim that boys are encouraged more to succeed in sciences in comparison to girls. Research conducted globally has shown that gender inequity exists in science education, which is of concern (Elgar, 2007). In a study from Australia, Dawson (2000) speaks of how, from the 1980's onward

...a need for changing the direction of science teaching from preparing science specialists to one inclusive of all students have become apparent. Science for all, and the need for a widened "scientific literacy", became catchcries (p. 557).

Similarly, a study conducted in the United States concluded that little change has taken place in girls' and boys' attitudes towards the perceptions of science since the 1980s, with boys reporting a wider range of science interests and out-of-school experiences with science than girls (Jones et.al, 2000). Another study conducted in the United States by Andre et al. (1999) state that competency beliefs, positive affect, and gender stereotypes of elementary students and their parents about science differs versus other school subjects. The findings show that parents in the study rated their sons' abilities in science higher than their daughters' and considered science to be more beneficial for boys than girls. The authors decipher that parents' differential perceptions of the importance of science for boys and girls may have long lasting consequences ...as a child becomes older, importance is undoubtedly related to the belief of certain subject areas being important because they are important for future jobs (p. 742).

Moreover, Joshi and Anderson (1994) claim that this differential thinking comes about intentionally as science textbooks help to foster gender roles in society. Rennie (1998) argues that the discrepancy in thinking is due to that fact that the gender variable interacts with other social variables such as race, religion, culture, and socio-economic status. Elgar (2007) claims that research tries to account for this interaction between variables however, it often divides the research sample into smaller groups, which it then compares and thus does not effectively understand the variation within the groups but rather creates stereotypes.

Textbooks are used in the teaching of many subjects and have been questioned to determine if they provide fair and accurate information on the topics and or social groups under investigation. The increase in research effort in conducting textual analysis of educational resources is in itself an indication of the importance many researchers attach to the messages that the textbooks convey (Elgar, 2007). Now that we know there is a differential treatment and

implementation of the science curriculum between boys and girls and those of racialized minorities; it is vital to understand what influences this discrimination in science learning. Apple (1990) believes textbooks are important as they encompass particular constructions of reality and particular ways of selecting and organizing the vast possible knowledge. He comments,

...we simply cannot fully understand the power of the text, what it does ideologically and politically (or educationally, for that matter) unless we take very seriously the way students actually read them – not only as individuals but as members of social groups with their own particular cultures and histories (p. 30).

Additionally, Good et al. (2010) argue that stereotypic images induce stereotype threat in females and impair science performance. Students were required to read one of the lessons, containing text and images that varied according to gender stereotypes and then complete a comprehension test and anxiety measure. The findings revealed that female students had higher comprehension after viewing non-stereotypic images than viewing stereotypic images (Good, Woodzicka & Wingfield, 2010). Knowing that educational resources have biases in them, I would like to contribute to the debate about how bias is being reproduced in science classes today through the analysis of instructional materials, specifically biology science textbooks used with students in the academic and university stream. I chose this specific level and area of science as the grade 10 academic stream builds the foundation to lead into the grade 11 and 12 university stream courses. These university stream courses are generally a prerequisite requirement for students to enter a science related program in the university they are applying to. The study of biology is of interest to me as that is my area of domain as an educator and because this section of science relies on heavy theories, facts and many visuals. Though these facts and theories are supported with evidence that has been consistent over the years, I am interested in

analyzing how the information is presented to students and what the implications of it are. It has been stated that a picture is worth a thousand words. If multiple visuals are being utilized incorrectly or are omitted altogether from the textbook, this raises a concern of how valid and reliable are these educational resources. Science has always been evolving as constant research is being conducted, however the content presented to students may not necessarily reflect this change. The very print-based medium of textbooks has a tendency to stabilize knowledge that is, in actuality, constantly subject to debate, transformation, and disagreement. Since the content of textbooks remains the same, bias persists and continues to remain in textbooks. This research study will examine how biases are exhibited in biology textbooks. This study will look at a grade 10 academic science textbook published by Nelson. This book is used in schools in the Peel District School Board for the academic and pre-international bacculerate program. A grade 11 and 12 university level biology textbook published by McGraw-Hill Ryerson will also be analysed. These textbooks and publishing companies are of specific interest as they are the most commonly used publishers in the education system as they supply educational materials and textbooks for the different courses offered by the school board. With the changing time and more culturally diverse classrooms, it is vital to study how textbooks and science education are presented to students.

Many studies of science textbooks predominantly highlight the gender discrimination that is embedded within educational resources (Kennedy & Sundberg, 2017; Sax et al., 2015; Simon, Wagner, & Killion, 2016). However, there is limited research on how other biases are depicted in science textbooks and what their implications are on student attitudes and interest in science. Despite these textual analyses of science textbooks, most of the research is conducted in the 1990's and in the United States (Ragusa, 2013). Little research has been conducted in Canada

regarding textbook bias and therefore I focus my study on the biases present in science textbooks in Ontario. Through this study, I will explore the various biases that are present in high school academic, and university level textbooks. The biases to be explored will be related to gender, race, ethnicity and disability.

Theoretical Framework

The stereotypes, discrimination and racism towards groups of people have always existed within society and carried over to the realm of science. The study will use an intersectionality theoretical framework to explore the central research question. Kimberlé Williams Crenshaw a black feminist and American civil rights advocate introduced and developed the intersectionality theory, the study of how social identities and minority identities relate to systems and structures of oppression, domination and discrimination. Crenshaw argues that there is a problematic consequence of the tendency to treat race and gender as mutually exclusive categories of experience and analysis (Crenshaw, 1989). Essentially, it means forgetting the experiences of black women. As Crenshaw argues,

...this single-axis framework erases Black women in the conceptualization, identification and remediation of race and sex discrimination by limiting inquiry to the experiences of otherwise-privileged members of the group. This focus on the most privileged group members marginalizes those who are multiple burdened and obscures claims that cannot be understood as resulting from discrete sources of discrimination (p. 140).

Crenshaw's work sheds light on the imbalance of power and privilege that exists within society. She argues that many factors collectively intersect to create identity. A person's identity is an effect of social relations rather than an inborn set of traits (Tajfel, 1974). Identity is impacted by such constructions as gender, race, social class, ethnicity, nationality, sexual orientation, religion,

age and physical disability. This idea of multiplicity as the ground of identity can be used to interpret how systemic injustice and social inequality takes place on a multidimensional basis (Crenshaw, 1989). Also, it allows for an examination of how the multiple dimensions of identity interrelate and how oppression works across intersections among and between them (Knudsen, 2006). For example, the various levels of oppression black women face in society, encompasses the intersectionality of racism, gender discrimination, stereotypes and the rights of equity and equality (Crenshaw, 1989). Intersectionality can be described as dynamic and constantly evolving in response to formations of complex social inequalities. Crenshaw (1991) expanded on the framework in *Mapping the Margins: Intersectionality, Identity Politics, and Violence Against Women of Color*. In her writing, she emphasized the intersectionality to highlight the ways in which social movement organizations and advocacies around violence against women omitted the vulnerabilities of women of color, particularly those from immigrant and socially disadvantaged communities.

Similarly, the intersectionality theoretical framework can be defined as a set of assumptions regarding the experiences of groups that are politically, economically, educationally, sexually, culturally and/or otherwise marginalized within a larger societal context (Powell-Sears, 2012; Choy, 2003; Hune & Nomura, 2003; Shah, 1997). In simple terms, intersectionality means that social divisions intersect in terms of the production of social relations and in terms of people's lives (Anthias, 2013). Many scholars and activists have been studying the intersectionality within a wide range of issues, legal and political systems, social identities and power dynamics (Carbado, Crenshaw, Mays & Tomlinson, 2013). In this paper, I take intersectionality as axiomatic to identity, using this key assumption as a guiding framework to analyze how the information presented in the biology textbooks produce bias and uphold the

white privilege. Through textual analysis, my focus is on what hidden messages and views are propagated through science textbooks used in school boards in southwestern Ontario. I propose that this intersectionality framework can shed important light on the factors that influence biases and stereotypes within science textbooks, and have very real implications for how and *which* student can imagine their future (or not) in the field.

This paper also draws from Hall's critical race theory to understand a paradox: racism persists despite the universal adaptation of Canada's policy on multiculturalism. This policy also affects school boards, charging them with the responsibility to promote equity, equality and diversity in education. Research by Ladson-Billings (2010) shows that the use of critical race theory in understanding education inequity is in its infancy. Still, critical race theory offers a language and lens to analyze the persistence of unequal power within society on the basis of race. In particular, critical race theory shines a light on the colonial legacies that uphold stereotyped notions of race as a biological, or fixed entity. Hall argues that race is a sociological construct and is created to maintain the imbalance of power in society (Connerly, 2000; Murray, 1984; Hall, 1996). Hall in his paper *New Ethnicities* takes on a historical and sociological view point to understand the global context in which individual and group identities are created. Hall claims,

...if the black subject and black experience are not stabilized by nature or by some other essential guarantee, then it must be the case that they are constructed historically, culturally, politically - and the term that refers to this is 'ethnicity'. The term ethnicity acknowledges the place of history, language and culture in the construction of subjectivity and identity (Hall, 1996, p. 29).

Hall argues that the creation of this segregation oppresses those who are racialized minorities and deviate from the norm. Despite Hall's work being predominantly about the black population the notion of race being a sociological construct is of importance, as those with power have given meaning to what is valued and what is not in society. It is important to understand who is considered the norm and who isn't.

The idea of the white middle class Christian male being the norm constructs all those who do not fit this category as *others* who are considered inferior. Hall has expressed this perspective through his personal experiences when he emigrated from the Caribbean to England. He states:

...all of them inscribe me "in place" in signifying chain which constructs identity through the categories of color, ethnicity and race...The English system, by contrast, was organized around a simpler binary dichotomy, more appropriate to the colonizing order: *white/not-white*. Meaning is not a transparent reflection of the world in language but arises through the differences between the terms and categories, the systems of reference, which classify out the world and allow it to be in this way appropriated into social thought, common sense (Hall, 1985, p. 108).

Hall's experiences can be expanded to racialized minorities who face the same problems in today's world. According to the mythical norm of the white heterosexual Christian middle class male as the norm, every other characteristic would then be considered the *other*. If one is considered to be the *other* then they experience racism in everyday life situations due to their race, gender, ethnicity and physical status. Hall in his work has also argued that the media scrutinizes the image of a black individual, giving off a generalized stereotypic impression of that group of people. In his work, he claims that the mass media plays a crucial role in defining

the problems and issues of public concern. They are the main channels of public discourse in our segregated society (Hall, 1985). Though his work focuses on the black population, Hall claims that media misrepresents and omits certain groups of people due to their colour, social status, ability, and religion. This last claim is paramount to my study, for educational textbooks are arguably a form of media that visualizes various groups of people. They require a careful analysis, following Hall, because of the effects that generalized views can have on the ways social differences are represented.

While Hall focuses on the social construction of race, theorists Omi and Winant (1993) argue that race cannot be seen as either an ideological construct or as an objective condition as they both have shortcomings. If one thinks of race only as an ideological concept, there is a tendency to overlook the lived reality of a racialized society and its impact on people in their everyday lives. On the other hand, if race is seen as an only objective condition, this denies the socially constructed aspects of race and the impact it has on an individual's life. Drawing from Omi and Winant, it is important to note that race is embodied in everyday life even while it is a construct produced in history. Morrison (1992) claims,

...the world does not become raceless or will not become unracialized by assertion. The act of enforcing racelessness in literary discourse is itself a racial act (p. 46).

Toni Morrison (1992) argues that race is always present in every aspect of life, whether it be at work, school or any social place. It is because of the meaning and value inputted to whiteness, Ladson-Billings (1998) argues that critical race theory is an intellectual and social tool for

...deconstruction, reconstruction, and construction: deconstruction of oppressive structures and discourses, reconstruction of human agency, and construction of equitable and socially just relations of power (p. 9).

Through deconstruction and reconstruction, I analyze the representation of race, as an intersectional construct and experience, in science textbooks. The framework of intersectionality and critical race theory will be utilized in the textual analysis of this study to understand how gender, race, and disability are displayed in high school biology textbooks and the implications it has of upholding the mythical norm of the white privilege.

Textbook Selection

As a high school science teacher, I am charged with the responsibility to examine the intersectional construction of race in textbooks, with a focus on how it influences students. Within the education system in Ontario there are divisions of courses that are categorized in academic, applied, locally developed and workplace streams. Applied and academic courses were introduced in 1999 when the Ministry of Education implemented the *Ontario Secondary Schools, Grade 9-12: Program and Diploma Requirements, 1999* (Ministry of Education and Training, 1999). This policy was created to de-stigmatize streaming in Ontario high schools and allow students to have all course options open to them (Hamlin & Cameron, 2015). Academic courses are intended to focus on abstract applications of essential concepts and applied courses gives students a platform to apply the practical and concrete applications of concepts taught. It is also commonly known that academic courses gears students for university and applied courses gears students towards college courses. The locally developed and workplace stream on the other hand is for students who need and want to finish high school and obtain a diploma to readily enter the labour workforce. As nice as it sounds, giving students the autonomy to make their decisions of what courses they would like to take and pursue, there are consequences associated with this type of streaming. Data from the Ministry of Education on course selections in 2014 show that 60% of students taking applied math were taking three or more applied courses

(Hamlin & Cameron, 2015). Once a student begins their journey in the applied stream they are obligated to continue in it, limiting their post-secondary education options (Parekh, 2014).

This paper aims to understand how textbooks used in the academic education stream represent race, ethnicity, gender and disability and influence students' interest in the science discipline. Specifically, this study will analyze multiple textbooks by two well-known publishers to analyze the construction of race within each. I intentionally chose to study science textbooks in high schools as those are the grades where students heavily rely on textbooks to assist their learning. Likewise, the high school context was chosen intentionally because students start planning for their post-secondary education by choosing courses they would like to pursue. The workplace and locally developed stream was intentionally left out as they do not utilize textbooks with heavy content. I have observed this through my teaching practice as they have different curriculum expectations and guidelines. Also the students do not necessarily pursue post-secondary education in the sciences.

This study will examine three textbooks one at the grade 10 academic stream level and a grade 11 and 12 biology textbook at the university (academic) stream level. The Grade 10 *Science Perspectives 10* book is published by Nelson which is a prominent publishing company that prints educational resources and supplies them to Canadian schools (Adam-Carr et al., 2010). The Grade 11 *Biology 11: University Preparation* textbook (Dunlop et al., 2010) and Grade 12 *Biology 12* textbook are both published by McGraw-Hill Ryerson (Gerards, Ramlochan, Ramlochan, Parrington & Mccallum, 2011). These two publishing companies were intentionally chosen as their printed resources are commonly used in Ontario schools. Likewise, biology deals with the contemporary issues of physiology and anatomy and its implications on the human body and mind. Also, there has been a constant debate about the terms of sex and

gender which are used interchangeably and how it is being reinforced in sciences promoting gender discrimination (Joshi & Anderson, 1994). Biology is an important component of many social, ecological and economic issues. Biology provides solutions to large-scale environmental and health problems. This branch of science educates students about relatable life lessons and survival from simple things such as nutrition to complex health and environmental issues. As a biology teacher, I believe that biology educates individuals to learn about themselves and their surroundings, which is very important in order to sustain and survive in society. Also, being a biology educator it is vital that I am familiar with the resources being used and aware of the biases present that can hinder student academic achievement and interest in science.

The textbooks under examination were chosen from one of the largest and most culturally diverse school boards in Canada. It is of personal interest to see how inclusive the Peel District School Board is with their educational resources as they attempt to encourage equality, equity and diversity and have a mission statement of

...promoting hope, confidence and success in each and every student (Peel District School Board, 2017).

The Peel District School Board was chosen not only because I work within its borders, but because it is a region with a great deal of racial diversity and is a place where a large number of immigrants reside. Particularly in this context, it is important to understand how textbooks portray race, as impacted by gender and ability.

Literature Review

Canada is a multicultural and diverse country; however, the education curriculum in sciences does not promote unity but rather reminds us of the segregation that exists within these disciplines. Likewise, there is a gap in the number of women in science disciplines in

comparison to men (Hango, 2013). Gender discrimination has always been present in many disciplines, nevertheless science has a particularly masculine history. The fact is that more men enter this profession (Hango, 2013). Alongside gender discrimination are groups of people of various cultural backgrounds that have been misrepresented or excluded from the sciences. For example, research shows that Indigenous knowledge in secondary school science textbooks in Canada are undermined by western perspectives of ethnocentrism, racism and cultural imperialism (Ninnes, 2000). Ndura (2004), states that instructional materials that do not include students' diverse life experiences fail to empower them. This is because students cannot relate to the concept being taught, or become negatively impacted by the stigma associated with the stereotypes present in the educational resources. Moreover, textbooks *over*-represent particular social identities in the field of science (Sleeter & Grant, 2011). Sleeter and Grant (2011) argue that little change has occurred

...in the racial, social class, gender, and disability inequalities that exist in school curricula. There is a struggle for power between social groups and representations contained in textbooks provide legitimacy or dominant status for the groups presented (p. 183).

These constructions tend to propagate the political and economic views of those with power; knowledge that I argue is essential for teachers, such as myself, to engage, unpack, and analyze as part and parcel of pedagogy (Brantlinger, 2006b).

Gender in science textbooks

As an aspect of race, gender is also constructed in instructional materials. West and Zimmerman (1987) in their paper *Doing gender* distinguish between sex and gender, they state

...sex was ascribed by biology: anatomy, hormones, and physiology. Gender, we said, was an achieved status: that which is constructed through psychological, cultural and social means (p. 125).

Constructions of identity in science textbooks can be analyzed as operative on a number of levels. With specific reference to gender, one can examine representation from the following vantage points: a) exclusion/invisibility and the underrepresentation of women; b) stereotyping and assigning gender roles, undermining women's contribution and those of different ethnic backgrounds to the field of science; c) linguistic constructions of language that rely on masculine metaphors, undermining the feminine aspects of science; and d) isolation of women from the realm of science (Sadker & Sadker, 2001). Because gender is an aspect of my analysis of race, the following section will analyze research studies on the construction of gender in textbooks.

Tindall and Hamil's (2004) research findings reveal that gender discrimination in schools remain predominantly in the areas of science and mathematics. They argue that,

...girls do not receive the same quality or even quantity of education as their male counterparts in schools. Gender discrimination within the science classrooms influences students' interest in science (p. 282).

Despite the commitment of education to equality and equity, there is still a question of why gender discrimination exists in the realm of science. Statistics Canada states that there are more males than females in the STEM fields of study (Hango, 2013). Science disciplines generally require further post-secondary education to specialize in a certain field. Since more men enter the sciences, they are more likely to study further and obtain multiple designations and higher education degrees in comparison to their female colleagues (Clark Blickenstaff, 2005; Simon, Wagner, & Killion, 2016). This again creates an education gap between males and females in

science fields. This is actually much more complicated when statistics are broken down by discipline. While the numbers are approaching parity with mathematics, chemistry and biology, the percent of women remains abysmal in physics. Hazari and colleagues (2007) state,

...among the sciences, physics is the most extreme in its male dominance. In the 2001–2002 academic year, women earned 62% of U.S. bachelor’s degrees in biology, 49% in chemistry, 47% in mathematics, but a mere 22% in physics (p. 848).

Hazari and Potvin (2005) argue that females are underrepresented in the field of physics for three main reasons; *inherent differences*, *social differences* and *cultural bias*. Inherent differences is described as the nature and genetics that separate females from males and is one of the reasons discussed for women being underrepresented in physics yet equally or slightly higher represented in biology. Both authors claim that physicists and scientists believe females have inherent differences due to genetics and a

...natural tendency to be more concerned with ‘people science’. This would be their explanation for why there has been consistent evidence across the world for girls being more interested in biology topics and boys being more interested in physical science topics (p. 6).

Furthermore, researchers Lie and Bryhni noted that

...girls’ interests are characterized by a close connection of science to the human being, to society, and to ethic and aesthetic aspects. Boys more than girls are particularly interested in the technical aspects of science” (Lie and Bryhni, 1983, p. 209).

Another reason why many women are not in the field of physics is due to the socialized differences. Hazari and Potvin argue that

... females are less inclined towards physics than males due to values and behavioral dispositions that are transmitted by society, family, education, and other influences surrounding them (p. 5).

Many behaviorists have stated in studies of social behavior that these patterns may be transmitted through direct socialization and children adopt actions that are considered typical or valued for their own sex when gender-appropriate actions are positively reinforced by teachers, parents, or other children and actions associated with the opposite sex are negatively reinforced (Maccoby, 2000).

Lastly, cultural bias heavily influences the reason why females refrain from entering the field of sciences and if they do, they tend to only pursue the “soft sciences” considered appropriate for women to pursue. According to Hazari and Potvin, the culture bias of physics is more profound than that of the other sciences but many science education researches believe that cultural bias exists for the sciences in general. Lederman (2003) summarizes this idea that

... science is hegemonic and androcentric, two characteristics that proceed from the fact that practitioners of science as we know it have traditionally been white, male, and Western. It is they who define the rules, methods, instrumentation, descriptions of results, and criteria for knowledge production. It is they who define what counts as science, both theoretically and in practice. It is they who are the gatekeepers for access to, and definers of, a life in science (p.604).

It is clearly evident that science is a male dominated discipline and some women have been able to penetrate the barriers created by men. Despite women pursuing science education and working in occupations related to the field of science there remains self-selected segregation in the type of science they pursue. It can be stated that some sects of sciences are reserved solely for men,

making it hard for women to pursue an occupation in the sciences. Research shows that there is an under-representation of women in the STEM fields, and there are less women in senior leadership positions (Page, Bailey & Van Delinder, 2009). Culture also plays a crucial role in influencing student interest in the field of science. Many Asian countries intentionally make women and men choose traditional jobs that are seen as appropriate to their gender roles in society. More men are encouraged to study in the field of science and become doctors or engineers and obtain higher degrees in comparison to females (Joshi & Anderson, 1994; Klasen & Lamanna, 2009). Despite being in the twenty first century, the ideology of traditional roles still exists, where women are seen as homemakers and men as the bread winner of the house; widening the gender gap in science and promoting gender discrimination (Klasen & Lamanna, 2009).

Potter and Rosser (1992) have reasoned that textbooks are an important factor that may influence girls' science education. They claim,

...because the textbook is a major factor that influences the teaching of science, it stands as an important element that may aid in attracting girls to or deterring them from studying science (p. 669).

An example of gender discrimination in life science books is from Alexanderson and Wingren's (1998) study on the gender perspective of textbooks on dermatology, epidemiology and occupational medicine, and public health used in the training of medical students at a Swedish university. Their findings show how, in these textbooks, the male often represents the norm with which the female is compared to biologically and psychologically for medical research and practice. They go on to argue that omitting women from the field of medical sciences would

leave students ill-prepared for the problems they will face in medical practice that surround women.

Page and colleagues (2009) argue that male dominance is rooted in socially created gender barriers, which creates the status quo and reinforces inequalities as natural. Moreover, they find that science textbooks tend to use examples and make reference to scientists who are typically of, for, and about men (Heikkinen, 1978; Warren, 1988). Textbooks rarely portray women as scientists, researchers, or engineers; rather, they generally portray women in more traditional roles such as teachers, nurses, and homemakers (Blumberg, 2008). Keller (1989) argues that language also tends to exclude women from scientific practice. The language of gender in science emphasizes masculinity and downplays the feminine aspect of science. Keller states,

...the exclusion of the feminine from science has been historically constitutive of a particular definition of science – as incontrovertibly objective, universal, impersonal—and masculine a definition that serves simultaneously to demarcate masculine from feminine and scientists from nonscientists – even good science from bad (p. 47).

Keller (1989) claims that the exclusion of females and feminism from science is intentionally done to make sciences a masculine discipline.

Additionally, women's contributions are greatly understated in the realm of science as their intelligence is considered less than that of men (Spear, 1984). Textbooks reproduce the ideology that women should be confined in their traditional roles society has created for them, isolating women from the field of science (Blumberg, 2008). Blumberg (2008) argues that the construction of gender in textbooks is an obstacle on the road to creating equality in education. The author further claims that textbooks occupy approximately 80% of classroom time and

therefore contribute to lowering girls' investments, imaginations and achievements as scientists. A study conducted in China shows that teachers draw from stereotypes while assessing their students (Song, 2003). Song's results show that 71% of teachers who read a description of a student with a male name ranked him as a good science student, whereas when the same description was associated with a woman, only 20% of teachers rated her as a good student. Other studies reach similar conclusions, supporting the idea that science education is geared more towards boys and men (Bassi, Blumberg, & Mateo Díaz, 2016). There is some evidence that girls who see science as a male dominated discipline of study achieve less in the subject (Smail & Kelly, 1985). Since textbooks reinforce gender bias, it can be argued as one of the reasons why women feel detached from and disinterested in studying courses related to science and entering occupations related to that subject of study (Hill, Corbett & St Rose, 2010). The intersectionality of race, disability and gender is more harmful for women as they face oppression due to the multiple barriers society has created for them. Therefore, fewer females enter the field of science to avoid prejudice (National Science Foundation, 2003).

Gender discrimination reinforces the social division of labour and reinforces the traditional roles for men and women. The contrast pairing of men and women is not what scientific biology teaches us, but rather what the dominant societal ideology promotes. Many theories and content selection tends to be oversimplified and selective in science textbooks, which is unavoidable due to the publishers' discretion (Lemke, 2011). Publishing companies are usually funded by politicians and businessman and therefore propagate the perspectives of those people in textbooks and educational resources (Brantlinger, 2006b). Brantlinger (2006b) in her book cites the following authors and her position on the view that publishing companies and those with power influence the content presented in textbooks,

...Apple (1991) found that a few large publishers (Prentice-Hall, McGraw-Hill, CBS publishing group, Scott, Foresman) controlled 75% of the total sales of college texts. Metcalf (2002) claimed that numerous politicians, including the current U.S. president and his cabinet members, own substantial shares in test and textbook companies. Thus, because they benefit from test and text sales connected with the tightening of standards around disciplinary knowledge, a conflict of interest is evident in these politicians' education decisions. Furthermore, the prescribed text and test content preserves the societal hierarchies from which they benefit (p. 68).

It can clearly be said that the education system is influenced by those with power to create the realm of education and workforce as they desire by excluding women, individuals with disabilities and those of minority cultures (Brantlinger, 2006b). The fact that two of the books I am doing a textual analysis on are published by McGraw-Hill Ryerson, it is of interest to me to see what bias is present and what hidden messages are being presented to students.

It is vital to understand that the science discipline of biology, which is used to teach students about genetics and reproduction, is unable to do so without imposing gender roles and influencing prejudice. As a science educator, I am concerned that students receive stereotyped images that could affect how one embodies a sense of self in society but also particularly in science. It is important to note that gender roles are socially constructed and identity is in a continuum as it is constantly being changed and formed (Oakley, 2015). It is vital to note that gender roles are socially constructed ideologies that were consistent with the acceptable rules of society some fifty plus years ago. Modern day influences consist of politicians and the wealthy businessmen who are able to influence stereotypes against minorities through textbooks and educational resources. Lemke (2011) argues that it is disturbing to hear that this ideology of

traditional gender roles still exists in the twenty-first century. It is unfortunate that the ideology of traditionally gender roles is still reinforced and continues to impact the enrolment of women in the STEM fields.

Race and Ethnicity in Science Textbooks

Research has shown that in many North American textbooks individuals belonging to a minority race are usually misrepresented or omitted altogether (Sleeter & Grant, 2011). Many stereotypes surround an individual's ethnic background and culture. For example, in many American textbooks, Mexicans are frequently photographically represented as working in the trade industry and are rarely illustrated as being intelligent and having white collar jobs (Blumberg, 2008). Also, Mexicans are hardly portrayed with visuals or described in the field of science. People of these ethnicities would generally be over represented in having trade jobs subtly stating the fact that these individuals are not smart enough to obtain science related occupations (Sleeter & Grant, 2011). Popham (2010) claims that when bias is explicitly targeting certain types of people, their academic achievement and interest in that particular subject diminishes. This could be argued as one of the reasons why individuals of minority cultures do not continue studying science courses when they are exposed to racism.

Research states that the number of Black, Hispanic and American Indian graduates taking chemistry and physics courses are much less than those of Caucasians and Asians (National Science Foundation, 2003). Delgado (2009) analyzed a few biology textbooks for the presence of multicultural science educational material. The study examined how minority groups were represented through text and pictures, with an emphasis on the Indigenous community. The findings of the study revealed that minority groups were often underrepresented and if

represented then shown as being undereducated (Delgado, 2009). Delgado (2009) analyzed various studies and came to the conclusion that

...depictions in textbook limit career opportunities for minorities in science by limiting the number of photographs that depict minorities “doing science” (p. 31).

If minority individuals are not represented doing science then minority students cannot relate to this discipline of study and do not feel empowered to learn the subject. This could also be said due to the rough history of the Indigenous community and being exploited by the Europeans in the past. Moreover, many North American companies tend to intentionally underrepresent the African American communities' contribution to science (Delgado, 2009). The unfairness towards the Black population in the education system is seen everywhere (Crenshaw, 1989). The existence of biases that are present in the textbooks make minority individuals feel unwanted in this field of study. Since there is a lack of role models to minority students, it is difficult for them to physically relate to this field of study resulting in a disinterest in the subject area for those individuals. It is evident that educational resources have bias which affects students' perception of the study and their decision if they would like to continue learning that subject or not. It is disheartening to see that individuals of specific races are portrayed in a negative stereotypical manner which is not necessarily accurate. Race and ethnicity are important concepts as research shows that individuals of colour tend to be ignored and devalued in the realm of science, impacting the academic and social structure of science (Ninnes, 2000). Racism is deeply embedded within education and is used as a means to isolate certain people from specific disciplines of study.

Disability in Science Textbooks

Disability has a long history of negative perception, particularly in the field of science. The medical model tends to place the blame on the individual themselves rather than the external surroundings, disease, trauma and social ideas – rewarding neuronormativity – as themselves contributing factors (Wolbring, 2003). Science textbooks tend to locate disability in biological claims about mutations, making one incapable of functioning normally in life. Wolbring (2003) claims,

...within the medical model, disability is viewed as a defect, a problem inherent in the person directly caused by disease, trauma, or other health condition and a deviation from certain norms. Management of the disability of the disabled person or person-to-be is aimed at cure, prevention, or adaptation of the person (p. 234).

The undesirable connotation associated with disability illustrates the image that disabled people are deficient (Chapman, 2014). Historically, having a disability or being classified as having a disability was considered a sin in the sixteenth century. Chapman (2014) argues that the thinking of eugenics was,

...in killing what is constituted as defect, the potential valuable human might be saved. And if the human dies as a direct result, there is no need to grieve because we had not yet made a valuable human from the defective one. Only the defect dies (p. 36).

Society continues to alienate those with disabilities through disabling environments that bar access to everyday forms of existence in public places. Society tends to create negative stigma and stereotypes about people with disabilities and isolates them. This is seen in the education system when individuals with disabilities or those that are racialized minorities are labelled as inferior individuals who are powerless and streamed into special education classes (Charlton,

2006). That is, “disability remains the acceptable line of separation between us and them” (Erevelles, 2014, p. 93).

In the realm of education, disability is met with exclusions. Erevelles (2014) finds that many educators and administrators are against the idea of inclusive education and agree with the idea of the creation of special education classes. From this perspective, it is argued that in order for regular mainstream education to continue, it is important to uphold the borders of special education classrooms (Brantlinger, 2006a). However, Brantlinger (2006a) argues that the streaming practices are a

...paradox for low achieving children is that they are not able to get general education until they are normal (average), but can never be normal if they are boxed into special education spaces with dummed down curriculum (Brantlinger, 2006a, p. 238).

In special education classes, minority students do not have an equal opportunity to succeed as their White counterparts. Danforth, Taff and Ferguson (2006) argue that the need for special education classes was a deliberate initiative to segregate immigrants and individuals with disabilities. It was a way to remove minority students from the regular system as they were considered inferior and a threat. These students were then isolated and put into classrooms that did not teach them and challenge their learning. There is a negative spiral attached to this process, as these individuals are forced to lead a poor quality of life. O'Connor and Fernandez (2006) state that the minority students are more likely to be poor and that being poor heightens their exposure to risk factors that compromise human development and increase the need for special services.

In a context where increasing numbers of students are being identified as having some form of disability (Reid & Knight, 2006), it is significant, too, that as many more of these are

from minority cultures in comparison to their white counterparts (Reid & Knight, 2006). A study conducted by Reid and Knight (2006) shows how history infiltrates current schooling practices by labeling minority students as learning disabled. The notion of identifying

...different others through this technical-rational lens (i.e. as defective) is that it seems natural to many Americans that students of color, the poor, and immigrants lie outside the predominant norm and, therefore, belong in special education (Reid & Knight, 2006, p. 19).

These authors argue that there is inequality towards ethnic minority students as they are overrepresented in special education classes in high schools and underrepresented in post-secondary institutions (Knight & Reid, 2006). According to Ferri and Connor (2005), “the rhetoric of race and disability overlap and are used to justify exclusions on the basis of race” (p. 454). Indeed, this is how inequity continues to be produced through the education system.

On top of this, many individuals with disabilities and students from minority cultures with a disability are misrepresented or ignored in textbooks, thereby undervaluing these people in mainstream education (Reid & Knight, 2006). Sleeter and Grant’s (2011) study mentioned above also shows that textbooks exclude people with disabilities and disregard the contributions that people with disabilities have made to science. Labels of racism masquerades as disability insofar as they collapse social difference with deficiency. In education, this leads to segregation through streaming. The school-to-prison pipeline can be described as an intentional channeling of minority students by placing them in special education classes in schools to then obtaining lower achieving occupations ultimately going to prison. The lower quality of education leads to these students making poor life choices ultimately ending up in jail and incarcerated from society. Erevelles (2014) defines the school to prison-pipe line as

... a multidimensional process that funnels large numbers of minority students from the classroom into the adult prison system (p. 82). Additionally, Erevelles (2014) argues how *disability* becomes the animating logic of dis-location that hustles racialized youth along the dreadful trajectory of the school-to-prison pipeline via the everyday normative practices of schooling (p. 82).

Alexander (2010) describes the school-to-prison pipeline as numerous institutional actions that collectively under-educate and over-incarcerate students of color at disparate rates. Due to majority of visible minorities being negatively represented in science textbooks, it causes a lack of motivation to succeed in science courses. This unfortunately causes a downhill cycle, which leads to many visible minorities avoiding pursuing further education and thus being heavily represented in special needs classrooms, which eventually leads to lower income jobs and incarceration for many. It is alarming that well known institutions purposefully create an unjust platform in education, which gives certain power and privilege to some and excludes minority individuals.

Why Textbooks?

My paper holds that it is vital to analyze science textbooks in order to understand the ways in which representation reproduces images, knowledge, and conditions that re-install inequities in relationship to race, gender, and ability. Research shows that when students are not represented equitably (or at all), they are less likely to engage in the material (Popham, 2010). Even though students are given the same textbooks to use in the course, purportedly offering a fair chance to succeed in their learning, academic success is divided along lines of race, gender, and disability. Further, Parmar and Cawley's research findings show (1993) that there are limited resources for teachers to support students with disabilities in the science classroom. They argue

that the textbooks do not provide recommendations for all categories of disabilities and do not specifically address the learning needs of this student population. Their findings show that special education and mainstream education teachers should be encouraged to be critical of the published materials they choose to use in the classroom.

The remainder of this paper looks at what images and content is in the textbook that leads to students being discouraged from studying sciences in the future. The issue that arises is that students are given an equal chance to succeed as their peers, but the resources that are given to them are tailored by those with power and privilege to hold some people back from prospering academically in the future. This then raises a concern if textbooks are really meant to help students learn better or is just a way to create a capitalist society that upholds the opinions of those with power and wealth by discriminating and segregating certain types of people from the education system and workforce.

Research Question

What is the role of gender, race, and disability in high school biology textbooks implemented by Peel District School Board (PDSB)? In what ways can a study of these social categories help educators think about the implication of textbooks in upholding a mythical norm – that Audre Lorde (1996) defines as “white, thin, male, young, heterosexual, Christian, and financially secure” (p. 163). If textbooks do reproduce this mythical norm, what are the implications for teachers who use them to teach?

Research Design

The focus of this study will include gender, race, and disability biases in science texts, described above. The texts will be analyzed to see *visual content bias* by using the photographic images to see how groups of people are presented, underrepresented and misrepresented. *Written*

content bias will be examined to see how certain groups of people are described in the text and to see the various gender biases that exist. *Publisher's perspective bias* will be looked at to see if the author is sending an underlying message to the readers and lastly *omission bias* is examined to see what types of groups are excluded from texts intentionally (Ragusa, 2013).

The research method that will be utilized is a textual analysis of images and written content. Images were thoroughly analyzed and interpreted to see what biases were being exhibited. The number of images of males and females were tallied and recorded in the textbooks. Similarly the way the images portrayed men and women were also analyzed to see what subliminal messages are being sent to the readers depicting who is considered dominant and more prevalent in the field of science. Additionally, the images were screened to see what ethnicities and races were represented, misrepresented and omitted in the textbooks, in order to understand what the created standards of science by those with privilege and power are. Again the number of individuals of various ethnicities was compared with the number of white individuals. Individuals who were portrayed incorrectly or omitted reinforced stereotypes of who is allowed in the field of sciences and what the norms of science are. Written content was analyzed to see what types of words are being used on the assumption that language is never neutral. The focus of my reading practices, in reading the textbooks, was therefore to examine how bias is exhibited through the way research findings are represented. My research design will allow for a thorough analysis of the texts to understand how members of various cultures and subcultures are interpreted and illustrated in educational resources. Finally, this method will shed light on how the various biases intersect one another.

Visual Content Bias

The *Science Perspectives 10* textbook published by Nelson has many illustrations to help the reader better understand the concepts presented. To begin with, gender bias is very prominent in this educational resource. The first unit itself in the textbook titled *Introduction to scientific investigation skills and career exploration* introduces the term science to students and what people in the field of sciences do. In an effort to give examples, the textbook uses multiple images which are predominately of men. In the 14 pictures that are of humans, 12 of them contain males and 8 contain females. While analyzing these images I noticed that the women are shown in subordinate roles to men. There are pictures of optometrists, doctors, archeologists and researchers: which are represented only by men. One picture in particular depicts both a man and a woman, the man's face looks towards the camera and the woman's back faces the reader. I interpreted this as the women not being important in the field of science, as they are portrayed as objects rather than being equitably represented like their male counterparts contributing to the field of science. Additionally, any women represented in these pictures are recipients of male observation (as patients) or they are assistants (technicians) to their male counterparts. Furthermore, men are shown in mentally powerful positions such as an archaeologist or marine biologist in outdoor settings. The textbook does not include a single photograph of a solitary female figure in a science related occupation. Another example is figure 12 on page 14, this image is used to describe how sharing information is a key characteristic of scientific investigations (Adam-Carr et al., 2010). The image shows men are engaged in a serious conversation, while the females are simply overlooking and listening to the conversation. Men are seen moving their hands and talking in this action picture, while females are looking over and hearing the men speak. This again confirms that socially created gender descriptions on science

occupations further create gender inequality in the science fields. Similar trends were found throughout the book.

In addition to gender bias, race bias was also present in this *Grade 10 Science* textbook. Most images used in this textbook are of the white population. Many images have mostly white men and some images of black individuals. On the contrary many individuals of South Asian, East Asian, South American and of Indigenous background were omitted from the images being used. Some pictures of experiments only show the individual's hand and no face, however, the hands are of white men, subtly ignoring those of colour in the realm of research and science. Likewise, the colour of the hands are mostly white and beige in colour again signifying the dominance of white ideology in the field of science. It is of importance to note that many other Asian, South American and First Nations individuals were excluded from this science textbook reinforcing the notion of who should be allowed within the science boundaries. Just as individuals of different races were absent from the textbook, individuals with physical disabilities were completely excluded from the text visually. There was not a single image of a person with a physical disability, limiting the diverse representation of individuals in science textbooks.

Likewise, the second resource chosen was a grade 11 *Biology 11 University Preparation* textbook by McGraw-Hill Ryerson. This resource also exhibited gender bias. For example, this text has an introduction and a STSE section (science, technology, society and environment), which both describe men and have visuals of men completely excluding women's achievements in the same domain. No achievement or discoveries by females is mentioned in these chapters, therefore, excluding women from their field of science yet again. Occupations depicted by females are very limited and gender role oriented. An image of a female employed as a genetic

counselor is shown however, in the field of science a counselor is considered a nurturing role. Additionally, there are photographs of women in this textbook; however, the number of pictures of men outnumbered those of women. In the entire textbook there are 33 images of men and 24 of women. When these images are further analyzed women are seen in a secondary role to men. Another important feature of this textbook is the STSE (Science, technology, society and environment) section entitled *Quirks and Quarks with Bob Mcdonald*. These STSE sections appear five times throughout the textbook and each time there is an image of this individual, never once was there an image or finding by a woman mentioned in this section, therefore excluding women's contribution in the sciences. Also, many of the discoveries mentioned in the textbook are of men and only credited men. There are six male researchers who are given credit for their findings and two women researchers, again underrepresenting female contribution. Furthermore, all outdoor science exploration always has images of men, and none of women. Again, women are omitted from outdoor science occupations and confined to being indoors, emphasizing the traditional views based on gender roles. This again places females in traditionally accepted gender roles. Overall in this textbook, there are very few images of people illustrated throughout the textbook and more images of chromosomes and genetic material.

Similarly, this grade 11 textbook also has race bias present. This textbook focuses more on genetics and cells, therefore there is limited amount of pictures of humans. This becomes a concern as there are fewer images of individuals themselves and when there are images of people they are predominantly of white individuals and barely any of those of colour. Most of the hand illustrations whether real or animated are consistently of white individuals. No non-dominant cultures or ethnicities were included. Another scenario in this textbook is in the STSE case study section in chapter seven which describes the topic of evolution. The issue of artificial selection

technology and food crops is described and then an image of farmers in Ethiopia is displayed. Much of the textbook omitted human pictures however, in a scenario where they could have actually gotten away with using a picture of farmland or crops they instead use an image of a group of black males as farmers. This image shows a misrepresentation of black individuals as being uneducated and thus only having the ability to only do laborious jobs. Lastly, there is no mention of contributions made by those with disabilities excluding these individuals from the realm of science.

On the contrary, the grade 12 *Biology 12* textbook published by McGraw-Hill Ryerson is more inclusive than the *Grade 10 Science* and *Biology 11: University Preparation* textbook. This textbook represents equally gender, race and disability. This is because both sexes were represented almost equally in the textbook along with images of some racialized individuals. There is one animated picture of a female with a hijab doing a science experiment and another female doing exercise in a wheelchair. This book could be argued as being more diverse in comparison to the previous two textbooks described. However, it can also be argued that since most of the images in this textbook had to do with genetics, molecules and processes, there are less images of humans in general. Most men are shown in outdoor and sports related activities, a common trend seen in the *Grade 10 Science* textbook as well. While women are more visually represented in the field of science, they appear mostly in indoor laboratory settings. For example, men are outside doing research, doing agriculture and exploring nature in various settings; whereas on the other hand women are shown sitting on a chair, looking through a microscope, holding a test tube or simply posing for a photograph. These qualitative differences reinforce traditional views of gender roles and what is considered appropriate for females and males to do in society. Men do laborious jobs and explore nature while women are confined to the indoors

and do less laborious jobs. Despite individuals of colour and disability being represented in the text, one image doesn't justify the inclusion and acceptance of these individuals in science. It can clearly be stated that these individuals are underrepresented in this textbook and in science.

Written Content Bias

While analyzing the *Science Perspectives 10* textbook's written content, bias in the choice of words and content is subtle if non-existent. However, most of the scientific research and discovery tends to credit males in comparison to females. This grade 10 science textbook has a "Did you Know?" section which states facts regarding the topics being discussed. This section is used in the book to present quick facts to the readers. Within these boxes, researcher contributions are also mentioned. There are three information boxes that state men's contribution to scientific research in comparison to one short description of a female's contribution. Despite this section being intriguing to the readers, women are barely getting any recognition for their contributions in the field of science. Similarly those of different races and with disabilities are not described or represented orally in this textbook.

In the grade 11 *Biology 11: University Preparation* textbook by McGraw-Hill Ryerson, there is a lot of information on genetics and for one example of a sex linked trait in humans they describe the disease Hemophilia. Hemophilia is a condition that affects the body's ability to produce proteins involved in blood clotting (Dunlop et al., 2010). The choice of words used reinforce the fact that the disease is passed on to the next generation due to the mother and it is her fault that this happens. The statement is

...Queen Victoria was a carrier who passed the allele on to some of her offspring...and is referred to as the royal disease as it spread among the royal families (Dunlop et al., 2010, p. 256).

The statement implies that women are the ones who are responsible for the defects in the child, when in this case the mother is only a carrier, which means she only carries the trait but does not have the disease. If the offspring were to have the disease it would only be possible if both the mother and father carry and pass on the gene for the disease to their child. Therefore simply because one parent has the disease it does not mean the child will have the disease. The misconception that genetic mutations only occur because of the mother needs to be cleared, when in fact it depends on what genes the offspring receives from both their parents. The way mutations are described in this book, make it seem like women are responsible for any abnormalities that occur to their offspring. It is clearly evident that gender discrimination exists in the written content in this grade 11 textbook.

To further add on this finding, disability bias is also present. The information is presented in such a way that it seems having a disease is a sin and is undesirable. In this *Biology 11: University Preparation* textbook they mention gene therapy and genetic counselling as a way to prevent having diseases and learning how to fix genetic disorders. The authors' state

...when there is a history of a genetic disorder in a family, the family is often referred to a *genetic counsellor*. Genetic counsellors have specialized training in human genetics and in counselling individuals and families who may have or be at risk for a genetic disorder. When working with a family, a genetic counsellor can use a pedigree to determine the genotypes of the family members in order to counsel them on options for genetic testing and to explain the probability of passing on a disease-causing allele to their children...*Gene therapy* is a technique aimed at correcting the effects of a mutated gene that is associated with a genetic disorder by inserting the correct form of the gene into the

genome of the patient. Thus, the goal is for gene therapy to be able to cure all genetic disorders (p. 225).

Having a disease is considered undesirable, as it means the body is not pure which is considered evil and bad. This aligns with Chapman's (2014) argument on eugenics trying to eliminate the deviants from society. Since those who have an illness are weak and no longer pure they deviate from the view of the mythical norm standard. No written content bias or stereotypes against those of colour were found in this grade 11 textbook.

In the grade 12 *Biology 12* textbook bias against women is present. This book focuses on the concept of genetics, giving recognition to six women researchers and seven male researchers. Though the numbers are at par, the description of the males' contribution to science is longer and more detailed in comparison to the females' contributions. There was one section which mentions Rosalind Franklin's discovery of the helical structure for deoxyribonucleic acid (DNA), however the credit is not solely given to her. The way she is described in the text is

...Rosalind Franklin (1920-1958) was a British chemist who was hired to work alongside Maurice Wilkins at the X-ray diffraction facilities at King's College (p. 210).

Rosalind Franklin's work is shared with her co-worker instead of being credited independently. Despite Rosalind Franklin's research on the composition of the DNA structure, credit in science resources is generally given to James Watson and Francis Crick as they expanded on her findings. This is one example of giving more importance to males' research than females.

Likewise, in the *Biology 12* textbook there is some bias against a certain race. In the populations and dynamics unit, students are introduced to the population pyramid. This is similar to a bar graph that demographers use to help assess a populations potential for growth. There are

two countries represented to model this example, Kenya and Sweden. Kenya's population pyramid was described as

...a triangular shape which predicts a future of explosive growth because a large portion of the population will enter their reproductive years at the same time. The pyramid shape also indicates a decreased average life span...because of the high fertility rate and the large number of women entering their reproductive years at about the same time, Kenya could double its population in less than 35 years. Compared to the estimated doubling time of the world's population –58 years—the doubling time for a country such as Kenya demonstrates the potential for explosive growth in a short period of time (p. 552).

Important to note is the two countries that are being compared which are Sweden and Kenya. Sweden's population is predominantly Caucasian while Kenya's population demographic is black. The intentional contrast between these two races show that there is a bias towards the black population. This shows the Kenyan population in a negative light as having the inability to control child growth and sustain life longevity. The example of Sweden is shown as the 'norm' and Kenya is shown as the 'other' in this scenario, reinforcing the mythical norm and white supremacy in the field of science yet again. Another important thing to note is that there was no citation embedded in the book stating where these statistics are coming from, raising an issue of validity and reliability of the information. Another important finding from this study is that researchers are credited throughout the grade 12 *Biology 12* textbook, however only three minority culture researchers who were of south Asian and East Asian heritage have an image and a short description of their findings. Those of East Asian, South Asian, African-American, South American, Latin Americans, First Nations and Middle Eastern backgrounds were omitted from this book visually and in written content. There are not many examples of distinct written content

bias in this *Biology 12* textbook, however the notion that disability is unwanted in society is reinforced from the choice of words used to describe genetic disorders and mutations. The textbook defines mutation as

...a change in the genetic materials of an organism...mutations are typically neutral or harmful to an organism. In rarer cases, they may be beneficial.

Mutations are described as an undesirable trait which is rarely valued in society as not many people may benefit from it, attaching a negative stigma towards those with disabilities.

Omission Bias

As mentioned in the above sections, omission bias is clearly present in all textbooks. In the *Science Perspectives 10* textbook, the publisher utilized a few pictures of physical human beings. Most of the images consisted of men and woman predominately of the Caucasian race, followed by a few of colour. However, there are certain types of people who are completely omitted or underrepresented. For example, Indigenous people, Hispanic people, Black people, East Asians and South Asian people. Also, when there are images of those of other cultures it is not necessarily depicted in a positive way. For example, in the same grade 10 academic textbook, an image of an Indian man in an Indian village shows him chewing on a stick containing neem to brush his teeth rather than the use of toothpaste. Many individuals may not think there is an issue with the picture as it is appropriate for the demographics of where neem is produced. However, this makes me wonder if Indian people can be visually represented in science textbooks then why were they not being represented in any other pictures related to science occupations? Also, the elimination of race creates this notion that only white people are qualified to study in the field of science. Reflecting on my textual analysis of visual content, all three academic textbooks omitted the Indigenous population altogether. There is not even one image or mention of an Indigenous

person, which I find astonishing since as Canadians we are trying to be inclusive and apologize for the injustices that we continue to propagate against these people.

As mentioned above in the *Biology 11: University Preparation* textbook individuals who were not white were completely omitted. There is not even a single illustration or mention about these individuals in the entire textbook. Similarly in the *Biology 12* textbook images of humans of various backgrounds are completely omitted.

Publisher Perspective Bias

The structure and layout of the book did not have any bias. The table of contents was well organized and easy to follow along. Individuals who are familiar with the English language will be able to understand the concepts being taught. Understanding the content would be difficult for those who are learning English as a second language again confining certain individuals of who will be given the privilege to study the science subject.

There are few authoritative individuals in the education industry who have immense power to reproduce biases. It is clearly evident that there is publisher bias in the textbook due to the demands of the racist education system and society. To begin with, the publisher clearly has control over what material is being presented and ignored. The selectivity of what and which content needs to be mentioned in the textbooks already illustrates the fact that bias is present. This aligns with the research, that publishing companies respond to the demands of the education system and have the power and authority to be selective with the content they show the readers (Brantlinger, 2006b). Apple and Christian-Smith (1991) claim that textbooks represent the ideas and interests of state-represented policy makers. In addition, Brantlinger (2006b) states that various politicians and cabinet members have a substantial amount of shares in test and textbook companies. As these textbook companies and politicians benefit by making profit from

assessments and textbooks, they can create the norm and standards of knowledge. These people have the power and privilege to propagate their views and opinions through the use of textbooks and assessments. Publishers cater to these individuals by exhibiting bias in textbooks to fulfill their hidden agenda of filtering who and what kinds of students will enter the respective academic fields based on the demands of the education system. A whole separate study can be conducted on what biases publishers exhibit and why they exhibit those biases. However since visual and written bias is present in these science textbooks it can be stated that publisher bias exists.

Discussion

The findings from all the textbooks show that directly or indirectly biases exist. Primarily there is more bias in visual content due to publisher bias in comparison to written content. It was evident that publishers had a lot of control on what concepts should be included in the book which resulted in gender discrimination, racism and bias against those with disabilities. Students from various cultural backgrounds lose interest in science disciplines when they do not have any role models or knowledge that people similar to them also exist in the field of science. These individuals become de-motivated and lose confidence in themselves and in their ability to succeed when negative bias is present. I would argue that the common use of pictures depicting males in dominant roles such as conducting experiments, in comparison to females who are shown as puzzled individuals following the males, reproduce male superiority and gender discrimination. The findings based on gender discrimination from this textual analysis reinforces past literature about gender bias being present in science textbooks and females being discouraged from pursuing science due to the underrepresentation of women in this field.

A picture is worth a thousand words and it is clear discrimination that the textbook re-enforces the concept that science is masculine (Kelly, 1985). Similar to research findings this science textbook reproduces society's ideology and replicates the social stratification of power in the education system. It can be inferred that these textbooks have certain bias present that has the ability to impact students' perception of academic disciplines and society's rigid views. Also, these biases extend outside of the textbook to the real world. This gender bias promotes gender harassment in science post-secondary education and workplaces.

It is important to understand that many individuals may face multiple barriers to getting science education. For example, women who are of a racialized minority and have a disability may face multiple barriers to gain science education, let alone succeeding and working in this field of study. This is why my study is of paramount, as Peel region has large amounts of immigrants who are new to this country and education system. Additionally, current trends show that most of the racial and ethnic minorities in Peel are Canadian-born. According to Region of Peel's most recent 2011 survey regarding the immigration socio-demographics there is an equal amount of immigrants and non-immigrants of various ethnicities such as Indian, Chinese, Italian Filipino, Pakistani, Irish and Portuguese to name a few residing in the area (Region of Peel, 2011). These visible minorities already have to overcome other obstacles to settle in this country, and when these individuals are underrepresented, misrepresented or completely omitted from educational resources, they are derailed from succeeding academically. This textual analysis is one example of where students of racialized minorities with or without disabilities and are or are not females will face obstacles in their science education in the Peel District School Board due to the bias present in science textbooks.

Future Direction

More research should be done in present day to understand the further effects of these biases that are present in science textbooks. There should also be more research done on additional educational resources besides textbooks to see if any bias is present that hinders the learning of the science subject. Despite trying to learn about biases in science textbooks there is much more research required in this domain. I chose to analyze these textbooks because students currently use these textbooks to supplement their learning. School boards usually have a budget and tend to reuse the same textbooks for years to manage cost control. Science is an area of study where discoveries are made daily and information is constantly changing, with this notion many discoveries are being made by different individuals and therefore their work should be acknowledged. There has been immense progress and discoveries in the research and development aspect of science, therefore it is important to mention the new data to students and allow for the diversity to be exhibited in science as these discoveries may be made by a male or female or by someone with a disability or of a minority culture. Science needs to become more objective and inclusive to individuals of all races, genders and physical abilities.

Despite new research being present in this area, there is limited research done on studying the impact of these biases in science textbooks used in Ontario. There needs to be more research done on textual analysis of science texts and other educational science resources. For example, various publishing companies' textbooks need to be analyzed to see if all companies have similar perspectives and exhibit the same biases. These textual analyses can then help teachers and other school administrative staff to decide what resources should be used in schools to maintain an inclusive learning environment. Similarly, there needs to be a qualitative longitudinal study done to see how science textbooks affect students' interest in science in post-

secondary education and influences their career choices to pursue a job related to this discipline in the future. This would be of interest to see what obstacles or hurdles individuals face in their educational journey to choosing a job related to science; and what the trends are of those entering the sciences. This will also shed light on how severe these biases are and how they impact individuals.

Publishers respond to the demands of the schools, which, as I have shown operate within a racist structure. If publishing companies respond to and reflect the demands and norms of the education system, then the problem is much larger than identifying publishing houses as the “problem”. Those of us working in the education system need to question, challenge, and revise dominant views of racism, gender discrimination and disability oppression to create a more conducive learning environment. Education institutions must consider creating more diverse and inclusive curriculum goals that publishing companies must adhere to while creating textbooks. Another initiative the school boards can take on is to hire a wide range of teachers from different cultures to create a sense of belonging for students in education and provide them the example that those of minority cultures can also succeed academically. These are just some suggestions that could be implemented to create a learning environment that is inclusive and does not promote any stereotypes. This paper serves as an eye opener to educators, administrative staff, students and parents that there is indeed bias in the educational resources, which directly or indirectly promotes bias and hinders student achievement for some.

Conclusion

My analysis matters as it is important for science educators to be aware of the resources that they are using to supplement their teaching and what negative impact it may have on some students. Working for the Peel District School Board who preaches equality and equity in its

learning approaches but utilizes resources that expresses a different ideology is alarming and concerning. This research study was conducted to educate individuals about the biases present in science textbooks and how it impacts student interest in science and future career aspirations in the subject of science. In addition, this paper aims to shed light on who is allowed to enter and prosper in the field of science. As stated many times from the research findings, this norm tends to exclude those that do not meet the standards of the norm. Through the analysis of three science textbooks implemented in Peel District School Board it is evident that gender discrimination, omission of minority individuals and those with disabilities are intentionally done in the realm of science. The issue of bias being present in textbooks is not exclusive to only science textbooks but to other educational resources as well in the education system. It is vital that school boards implement resources that are inclusive to all races, ethnicities, genders and individuals with disabilities. Since most school policies preach about equality, equity and having a diverse student population, the choice of resources used to assist student learning must also reflect the school's policy. Peel District School Board should reconsider their educational resource choices to stay true to their mission statement to provide an equitable platform for all students to succeed. It should be understood that the knowledge students learn in school helps them prepare for the real world outside and develop transferable skills. However, if the skills are not being taught properly, students will struggle fitting into society and will have to face discrimination due to characteristics they have no control over. This paper was an attempt to make teachers, parents and students aware of the biases that exist in educational resources and should not be discouraged pursuing science education due to the stereotypes present. Persevering through these obstacles and raising their voice to make science more inclusive is a must. I know that I will continue to persevere in my work as a Biology teacher, and I will also support my

colleagues, students, and administration to do the same in the name of creating together a more inclusive future of science education.

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