EXPLORING THE ATTITUDES OF PRESERVICE SECONDARY SCIENCE TEACHERS TOWARDS IMPLEMENTING EQUITY, DIVERSITY AND INCLUSION IN SCIENCE EDUCATION

by

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Abstract

School boards throughout Ontario have a documented history of instances where both educators and students from historically marginalized communities have encountered discrimination, racism, homophobia, and/or transphobia. Over the past two decades, the ideas of Equity, Diversity, and Inclusion (EDI) have been formally articulated as primary objectives within elementary, intermediate, and secondary classrooms in the province.

Given the demographic disparities between larger urban cities and smaller cities within Ontario, focusing on pre-service science teachers (PSSTs) in smaller settings is essential to highlight the unique challenges PSSTs may face in navigating homogenous environments most often found in smaller cities. The hope them is to empower personalized strategies to address potential biases and ensure equitable teaching practices, thereby fostering a more EDI driven science education landscape in smaller cities and schoolboards.

This thesis aims to disseminate findings that delved into the attitudes of seven secondary pre-service science teachers (PSST) towards learning about Equity, Diversity, and Inclusion (EDI) within the Bachelor of Education program in a Southeastern city in Ontario. This study was grounded in critical pedagogy and culturally relevant and responsive pedagogy and was guided by the following research questions:

(1) What attitudes do secondary PSSTs hold regarding learning about EDI in their content area?

(2) How do secondary PSSTs conceptualize EDI within the contexts of science classrooms?

Implementing a case study, the two research questions were explored through focus groups. Findings highlight PSSTs awareness of EDI and the factors that influence PSSTs attitudes towards EDI in their content area but struggle to understand the relevance and importance of EDI. This study is important as it sheds light on the critical need to address EDI in science teacher education to establish critical teaching for safe, EDI focused classrooms.

Keywords: EDI, CRRP, critical pedagogy, qualitative

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List of Abbreviations

Below are a list of abbreviations that will provide more context with terms used in this thesis.

OME = Ontario Ministry of Education

EDI = Equity, Diversity and Inclusion

PSST = Preservice Science Teacher

CRRP = Culturally Relevant and Responsive Pedagogy

CP = Critical Pedagogy

Chapter 1: Introduction

During my years in my own Bachelor of Education program and now as a science educator and supply teacher, I have become more aware of how we live in a society that is racist, sexist, classist, heterosexist, ableist, and overall oppressive in many other ways towards marginalized and racialized groups of people. Many of these injustices operate though the socialization through, among others, aspects such as family values, religious beliefs, media and social media influences, and education. Education functions as a place of social reproduction as it works to maintain the status quo through dominant ideologies and values by continually highlighting those voices and excluding marginalized individuals (Kurt, 2015). These ideologies and values are continuously used to develop social constructs, such as gender, race, and class, for privileged members of the dominant group (Sensoy & DiAngelo, 2017). These constructs and practices continue to foster oppressive educational environments. In other words, the design of educational institutions serves as a framework to force all students to fit into dominant ideologies and conform to a normative vision of what a successful person is (Keenan & Lil Miss Hot Mess, 2020).

Yet, educational institutions from grade school to postsecondary can be or should be a place for fostering equitable and socially just behaviours. While there has been progress made towards creating more equitable educational spaces, this progress has been slow and yields few lasting results (Campbell, 2020). In the last 15 years, the notion of Equity, Diversity, and Inclusion (EDI) have been frequently communicated as goals of schoolboards across Ontario. This increased focus for EDI is underpinned by finding ways to better support student academic success, particularly, for those who fall outside of hegemonic norms. Thus, the Ontario Ministry of Education (OME) developed *Ontario's Equity and Inclusion Strategy* in 2009 and updated it in 2013. As of 2016, some Ontario public school boards began adding language around equity, diversity, and inclusion to strategic plans, specifically in consideration of culturally relevant and responsive pedagogy, which will be discussed in more detail in Chapter 2. Kathleen Wynne, Ontario's Minister of Education from 2006 – 2010, framed the importance of inclusion and equity as "student achievement and student success" to "help students develop into highly skilled, knowledgeable, and caring citizens who can contribute to a strong economy and cohesive society" (Ontario Ministry of Education, 2009, p. 2). The Ontario government's vision of equity and inclusion was also combined with three core priorities outlined in Ontario's Equity and Inclusive Strategy with the aim of "improving student achievement, reducing achievement gaps, and increasing public confidence in our education system" (Ontario Ministry of Education, 2013, p 50.). It is evident the Ministry has been considering the importance of equity, diversity, and inclusion (EDI) in school environments that focus heavily on academic success. The OME acknowledges the importance of EDI to initiate change; however, the examples above appear to demonstrate an insincere approach, that is, what appears to be missing are in-depth approaches and understanding of EDI, definitions, and access to vetted resources. The OME appears to use EDI as a means to achieve the "priorities" and "goals" of Ontario's Equity and Inclusive Strategy but neglects the importance of EDI on a more critical level and the impact for students. Instead of understanding EDI in education as multiple lenses to evaluate, modify and continue to reflect on the learning environment, EDI is viewed as a single objective that can be achieved easily. In other words, the documents provide a surface level approach to understanding and implementing EDI. This can prevent meaningful implementation of EDI and result in harmful effects on students. These limitations may be perpetuated by the understanding of how the terms equity, diversity and inclusion are defined by the OME.

The OME defines “diversity” as:

> The presence of a wide range of human qualities and attributes within a group, organization, or society. The dimensions of diversity include, but are not limited to, ancestry, culture, ethnicity, gender, gender identity, language, physical and intellectual ability, race, religion, sex, sexual orientation, and socioeconomic status. (2009, p.4)

The Government of Ontario (2009) defines “equity” as: “A condition or state of fair, inclusive and respectful treatment of all people. Equity does not mean treating people the same without regard for individual differences” (p.4) and “inclusion” as “education that is based on the principles of acceptance and inclusion of all students. Students see themselves reflected in their curriculum, their physical surroundings and the broader environment, in which diversity is honoured and all individuals are respected” (p.4).

The above definitions by the OME bring to the foreground the realities of the differences present in classrooms and demonstrated by “celebrating diversity” (Cepin, 2015), which are very simple approaches to implementing EDI. These definitions also do not acknowledge the history and politics of diversity, nor do they capture the essence or complexities or challenges of the terms. Celebrating diversity is important; however, by celebrating diversity without addressing oppression and being critical of power relations needed to effectively integrate EDI into classrooms, reinforces a “check box” approach and does not acknowledge the physical, social, or academic barriers to inclusion and equity for historically marginalized groups. As such, for the purposes of this study, “diversity” is defined as a difference or variance of any kind which can contribute to students feeling and being treated as ‘others’ in educational settings (Arndt, 2018). To achieve an inclusive educational environment, the structure of education must shift its understanding of what inclusion is. Dei (2006) explains that "inclusion is not bringing people into what already exists; it is making a new space, a better space for everyone" (p. 29). Within inclusive environments, marginalized students are afforded an equitable opportunity to participate, and enhance learning and life outcomes. Cochran-Smith et al. (2016) explains that "equity judges the presence and absence of systematic differences among population groups in terms of distribution of opportunities and resource as well as experiences and outcomes" (p. 68). This definition does not focus solely on fairness, inclusion and respect, but rather, it emphasizes justice as a tenet for equity. The above approaches and definitions of "inclusion" and "equity" will be the ones adopted for this study as they focus on moving beyond the performative intention of EDI and conceptualize the tenets of EDI as an ongoing process. Further, they provide an emphasis on the importance of power, oppression, bias, and positionality.

Implementing EDI well can result in great benefits for all students, such as improving critical thinking skills, promoting creativity, preparing students for good citizenship, and helping develop new perspectives outside of their own, among others benefits (Wells et. al., 2016). Further, teachers can empower students to become champions of their own learning when they engage students in work relevant to them (Freire, 1972). Importantly, to support all students, the lived realities of students from different groups, including recent immigrants, racialized students, students from low-income families, students with higher needs, among others, cannot be ignored, but rather understood (Campbell, 2020). This requires a lot of work and commitment from educators for whom it is challenging to incorporate for various reasons.

Incorporating EDI well in education is susceptible to barriers that include a spectrum of influences. Special consideration should be given to how education is developed and upheld that include both the visible (e.g., who is present, what voices are privileged, classroom layout, etc.)

and the invisible forces (e.g., teacher and staff bias, students' culture, etc.) that can impact the environment of a classroom that upholds unequal power dynamics unfit to include all students (Freire, 1972). Many preservice teachers and in-service teachers often display a resistance to abandoning dominant beliefs, values, and ways of teaching (Winton & Tuters, 2015) while conforming to and re-enforcing curricular documents that continue to be Eurocentric (Mujawamariya, et al., 2014). Preservice teachers' values, beliefs, and self-awareness are (wrongly) informed by this perpetual cycle of relying on Eurocentric teaching. Further, there is insufficient information on best practice for EDI (Universities Canada, 2021), and definitions of terms such as "equity", "diversity" and "inclusion" are ambiguous, lack consistency and are sometimes surface level, creating challenges for preservice teachers to implement EDI well, some of which will be discussed in more detail below and in later chapters.

These challenges have led authors to argue that EDI does not actually work in the current sociocultural and sociopolitical environments (Mujawamariya et al., 2014; Nganga, 2020), and arguably they continue to be buzzwords that educational institutions rely on to keep up with appearances (Ahsan, 2022). EDI continues to be poorly integrated into particular subjects such as science in Ontario (Akkari & Radhouane, 2022; Mujawamariya & Moldoveanu, 2010; Mujawamariya et al., 2014;), and teachers generally are lacking strategies (Rodriguez at al., 2010) and the attitudes to effectively engage in this work (Winton & Tuters, 2015). Further, the role of education in Canadian society has not changed, evidenced by policies that prioritize the work of EDI used for "improving student achievement, reducing achievement gaps, and increasing public confidence in our education system" (OME, 2014, p. 10) versus focusing on providing students with equitable learning opportunities to achieve higher academic outcomes and develop a sense of agency over their education, improve critical thinking skills, and prepare students for social accountability and autonomy.

It appears that most Ontario schools have suggested the importance of implementing EDI across disciplines, such as in secondary science. These include expectations and examples for preservice science teachers (PSSTs) that are introduced in their teacher education program to be able to better offer their students the opportunity to explore aspects of the content in different perspectives and gain knowledge in other cultures, for example. For the most part, the curricular expectations PSSTs are to adhere to are broad, and include terminology, such as “and/or” that make exploration of different perspectives optional. For example, the grade 10 science curriculum states to “evaluate the effectiveness of government initiatives ...and/or the efforts of societal groups... such as Aboriginal communities...” (OME, 2007, p 50). This example demonstrates there are attempts to make connection to Indigenous communities, however, it is written as an option through the inclusion of “or,” and demonstrates a surface level approach where EDI cannot rely only on the student’s exploration of different perspectives in examining “the efforts of societal groups.” In science classes, a subject area that continues to contribute to ignore marginalized voices (Gay, 2010), educators need to accompany these explorative prompts with a critical assessment of the inequalities created and perpetuated by science (Mujawamariya et al., 2014) that rely on Western and colonial frameworks. This cannot be accomplished without PSSTs first understanding what their positionality is in relation to the subject, students, and the school. By challenging PSSTs on their assumptions and biases, they can begin to develop a critical lens in which they view the content they are teaching and better integrate EDI. The science curriculum in Ontario has adapted culturally responsive pedagogy and culturally relevant pedagogy into “Culturally Relevant & Responsive Pedagogy” (CRRP) to challenge science educators to think critically about the way they are developing content for the class, who is and is not represented in the work, and examine the worldviews they bring to the class (OME, 2022). Educators bring their understanding of the world and the way oppression operates in society to their classrooms; however, critical examination of these beliefs is lacking for both secondary PSSTs and in-service science teachers. In order to implement EDI more effectively in education, PSSTs need to examine the influences that shape their worldviews. CRRP provides multiple connections for critical examination of one's attitudes towards equity, diversity, and inclusion in education. These are important practices for PSSTs to adopt because of the oppression and barriers marginalized students faced in the past and continue to face presently (James & Turner, 2017).

As the diversity of the student population continues to grow in Ontario with over 61% of Ontario's general population being racialized (Campbell, 2020), EDI in science teacher preparation classes can (and should) provide better relevant understanding of how to improve our education system to afford all students with equitable education opportunities (Eslinger, 2013). It could therefore be detrimental for students if science teachers do not possess adequate knowledge, positive attitudes towards EDI (Eslinger, 2013) and effective implementation of EDI in their teaching strategies (Rodriguez et. al., 2010). Understanding the attitudes of PSST could help identify barriers to engaging in content related to equity, diversity, and inclusivity. This could, in turn, help inform improvements in engaging PSSTs in EDI related content in teacher education. Providing PSSTs with appropriate training and understanding of topics related to EDI could help to inform their teaching approaches to, in the long run, better support all students in science classes, and specifically for historically marginalized students.

1.1 Autobiographical Signature

To examine, explore, employ, and work within the umbrella of EDI in education, my position as a researcher and educator must be critically examined (Cochran-Smith, 2012 & Picower, 2009). As an educator who occupies many positions of privilege, I must continue to examine my privilege and how my privilege has impacted my socialization before engaging others with this content (Martell, 2019). My positionality as a white, able bodied, straight-passing, cis-gendered, male educator living, learning, and working in a largely white community has influenced, and will continue to influence, the ways in which oppression and privilege is present in my life and throughout this research and during my work as an educator. I offer a brief history of my journey into this research journey below.

After completing an undergraduate degree in Kinesiology, I worked for a year as a faculty member at an international school in an urban city in central Ontario. From there, I attended a Bachelor of Education program in northern Ontario during the COVID-19 lockdown. The time I spent on coursework, on practicum, as an occasional teacher, and faculty shifted the perspective through which I viewed myself as a learner and teacher.

During teacher's college, I wrote reflexive pieces on my experience where I began to recognize the impact teacher attitudes have on student outcomes. I offer two examples from my journaling that, upon reflection, had significant impact on the way I viewed the role of science teachers in the classroom. I want to acknowledge that these two experiences cannot account for all the differences, needs, or attitudes of teachers and students in the classroom. They are also from my perspective at the time. The excerpts were from my experiences and observations from my practicum, during the first quad-mester which meant that at that time high school students were in one class/subject a day for the full week. Both excerpts brings light to some of my unexamined biases as a preservice science teacher. All names provided are pseudonyms.

This first example may be triggering for individuals affected by racism as it involves attitudes of my associate teacher (the supervising teacher I am assigned at my practicum school) and the Physical Education (Phys. Ed) department towards two Indigenous students in the class I was working with:

> This morning, I was warned about the behaviour of "the Indians" in the class. The label was striking, and I wasn't certain what Mrs. Smith meant by "the Indians". Once I took the attendance, and observed Mrs. Smith teaching, it was clear she was talking about Calus and Kevin, two Indigenous students in the class…

Reading though my reflections from this practicum block, I took note of the insidious pattern of prejudice and racism towards the brothers from the whole Phys. Ed. department. Teachers addressed the brothers by their names only a handful of times, they were the only two students who were not granted lenience for late assignments and were dismissed as being "lazy" when they showed disinterest. I could not help but think that the attitudes from Calus and Kevin were in direct correlation to the environment they were forced to be in. These attitudes of the brothers were a response to and not the reason for teachers' attitudes towards them. I felt I was torn between what I thought was right and what I should do to get good feedback on my practicum report. I did not share my concerns with my AT or the school in fear of jeopardizing my education, so in response, I gave every effort to include and encourage the brothers in all classroom activities as much as possible. As I look back on this event, I am still unsure of what I could have done differently to better support the students in an environment that gave them no time, support, or respect.

The second excerpt involved two students with Individual Education Plans (IEPs) making significant improvement towards a concept in science as an accumulation of my and the ATs constant encouragement and extra work:

> Val and Mack demonstrated an improvement of performance by scoring high on their substances and mixtures quiz. Mrs. Stark's accommodations seem to have been influential to the students' success.

The scenario with Val and Mack is not unique to this practicum or AT. We worked after school with the resources we had available including extra personnel such as educational assistants to help Val and Mack get the most out of their learning. We changed the layout of the classroom, offered alternatives to independent work and knowledge translation, and gave frequent feedback on all students' work. It was a very rewarding experience.

The two excerpts I share above are completely different, which speaks to the complexity of EDI in Ontario. With the second example, both my AT and I were well equipped with resources, professional development, positive attitudes and support from the government, to attain a goal. Conversely, in other areas such as with the first example, we fell short of attaining our goal because there was a lack of resources, professional development, positive attitudes, and importantly, self-awareness of our biases. These two excepts have helped reframe my perspective on education and how teachers impact the environment students are learning in. There is much work that needs to be done at all levels of education from teachers up to government to truly achieve EDI in education.

One great opportunity for me during teachers college was enrolling in the course, Equity, Diversity and Inclusion. I took an interest in this class specifically because at the time there were several reports and live streamed targeted acts of hatred towards marginalized individuals and groups. The images and reports evoked a lot of strong emotions initially, but the lingering discomfort came from the seemingly unphased attitudes from my peers. Through the guidance from the course work, I began to see the world and myself in a different lens. The work introduced me to the invisible and complex forces of oppression that shape the attitudes of society and how these attitudes are closer to all of us than I understood.

What stood out the most during these classes and conversations was around the denial that oppression existed in the classrooms. While on placements, conversations in the staffroom involving both teachers and my peers included fatphobic, transphobic, homophobic, anti-Indigenous and anti-Black racism. In the classroom, students used similar language that the teachers let go unaddressed. All the preservice teachers and associate teachers that I was around expressed the importance of EDI, but through observations and conversations I felt as though there was an element of performance and no real commitment to change.

I was ill equipped to address and respond to the strong emotions related to the injustice happening around me and to the students. I realized there were large gaps in my knowledge that needed focus and effort to address to better understand my position and role as a straight-passing, white, male educator practicing in a culture that valued these identities. The greatest of these gaps being the capacity to recognize and understand how to remove myself and my priorities from the focus of this work. I would ask myself: “what is my role?” and “How do I know I’m doing a good job?”. I shifted my conceptualization of EDI from being a product in education to a more iterative and informative way to being a teacher. I continue to unlearn to work towards being an agent for change because I value EDI independently from education. The process of unlearning and reshaping my worldview has been foundational to the progress of my research journey.

I share the above examples since, as a recently qualified teacher, I cannot exclude myself from this work, rather, I continue to focus on my role both as an individual and educator working within the field of EDI. My imperfect journey began in the final year of my B.Ed. program and carries over into my research journey, and also influences me as an educator.

1.2 Purpose for this Study

The purpose of this research is to explore intermediate and senior (I/S) pre-service science teachers' (PSSTs) attitudes towards learning about EDI in their content area at a B.Ed. program in Eastern Ontario. This study seeks to examine the extent to which preservice science teachers' conceptualize EDI in science classrooms and is guided by the following two research questions:

1) What are the pre-service science teachers' attitudes towards learning about EDI in their content area?

2) How do pre-service teachers conceptualize EDI within the contexts of a science classrooms?

What follows in Chapter 2 is an examination and discussion of the available literature surrounding PSSTs attitudes towards EDI and the theoretical framework grounding this study. Chapter 3 outlines the methodology, data collection and analysis. Chapter 4 includes a discussion of the key findings from this study which is followed by Chapter 5 that frames a discussion centering back on the theoretical framework. Chapter 6 provides a conclusion and future direction of research in the area of EDI in science education. Findings from his study can add to the conversation around EDI in science and science education by identifying gaps in science teacher education and science teachers' perspectives towards EDI.

Chapter 2: Review of Literature and Theoretical Framework

This chapter provides an overview of the literature on discussions and literature related to equity, diversity and inclusion (EDI) and preservice secondary science teachers. First, I provide a discussion of the terms and acronyms around education in Ontario in relation to student achievement and how EDI is received in science education generally. I then provide a discussion of the theoretical frameworks that grounded my research, critical pedagogy and culturally relevant and responsive pedagogy (CRRP).

2.1 Acknowledgment of Competing Acronyms

As noted above, discussions around equity, diversity and inclusion (EDI) according to the Ontario Ministry of Education (OME, 2022) was introduced to increase student achievement, narrow the achievement gap, and increase public confidence in publicly funded education. However, there includes a vast number and variation of acronyms: Diversity, Equity, and Inclusion (DEI); Equity, Diversity, Inclusivity and Decolonization (EDID); Social Justice Education (SJE); and Indigenization, Equity, Diversity, Inclusion, Accessibility, and Anti-Racism (I-EDIAA). All these acronyms have been introduced, studied, and recommended as a means to improve all students' engagement and performance. DEI shares the same vision as EDI, that is, the belief that every individual can thrive in an inclusive environment with equal access to opportunities. EDID adds specific action afforded to decolonize education by critically reflecting on and recognizing that racism itself is institutional, structural, and systemic, therefore reform is imperative in places such as school policies (Kendi, 2019; MacMath et al., 2023). SJE focuses on the critical understandings of the social, historical, cultural, political, economic, and ethical contexts of education (Carlisle et. al., 2006). I-EDIAA is a new acronym that was adopted and announced by Queen's University's Human Rights and Equity Office in November 2022. The acronym strategically includes and places "Indigenization" at the front and separate from the rest of the acronym to emphasize the important and distinct differences Indigenous communities face that are not always met by equity and inclusive efforts. Further, the acronym explicitly includes "accessibility" and "antiracism" to narrow the intention, something that most other acronyms do not include. I do not discredit the importance of any of these or other approaches and acronyms not mentioned here. But for the purposes of this study, I am specifically using "EDI" because within the Ontario curriculum documents, the resource that PSSTs are most familiar with, includes the acronym and terms related to EDI specifically.

2.2 Grounding the need of Equity, Diversity and Inclusion in Teacher Education Programs

Racial, ethnic, and cultural matters have occupied a large place in discussions on education and on equality throughout Canada (Akkari & Radhouane, 2022). In the last 20 years, equity, diversity, and inclusion (EDI) has been articulated as a primary goal in all grades and subjects in Ontario. As the diversity of the province increases, so does the diversity of the classrooms. In the 2010 census, over 34% of students aged 15 and younger were born abroad (Statistics Canada, 2011). In 2016, this number increased to just under 38% (Statistics Canada, 2017a). Within Toronto, Canada's most diverse city, families who immigrated to Ontario represent 46% of the population (Statistics Canada, 2017b). While diversity exists to a smaller extent in smaller cities around Ontario, such as Kingston, EDI is important for PSSTs to be familiar with. Focusing this research on a smaller city such as Kingston is important because the population is not diverse and, as a result, implementing EDI should be included in teaching strategies to prevent students from (re)enacting injustices.

School boards across Ontario have a history of staff and students from marginalized communities facing different forms of discrimination, racism, homophobia, transphobia, and classism. Peel District School Board (PDSB) and Toronto District School Board (TDSB) are two highly racially and ethnically diverse school boards in the Greater Toronto Area (GTA) that have developed and distributed student surveys to help inform, address, and approach issues of discrimination to make schools more inclusive and improve student well-being (TDSB, 2022). These reports have emphasized ongoing marginalization and oppression of students based on their race, ethnic background, gender expression, sexual orientation, socioeconomic status, and citizenship as factors that impact students' well-being and a sense of belonging while in Ontario schools. Both school boards have seen an increased enrollment of students from diverse racial and ethnic background since 2012 with white student populations remaining at less than 25% in Toronto (TDSB Student and Parent Census, 2023) and 14% in Peel (PDSB Student and Parent Census, 2020). In contrast, Limestone District School Board (LDSB) in Kingston, among other school boards outside of the GTA, includes significantly less racially diverse student population with 86% of the student population being white (LDSB, 2021). Furthermore, across all three of these schoolboards, higher percentages of students are identifying outside of socially constructed norms such as sexual identity and gender expression, compared to ten years ago (PDSB 2020; LDSB, 2021; TDSB, 2021). Given these statistics, it would benefit the students and school boards, such as LDSB to, emphasize the importance of implementing EDI well in classrooms that are predominately white to help broaden the range of social values, attitudes, and beliefs needed for students and teachers to appreciate diversity and break social norms.

The impact of maintaining and reproducing social norms inside the classroom becomes a greater threat to students who are marginalized by race, gender, class, sexuality, nation, ideology, and other intersecting processes of power (Davies, 2020; James & Turner, 2017). This phenomenon highlights the importance of recognizing and addressing the overlapping web of power dynamics that influence educational spaces. Traditional norms often reflect dominant societal values, and when unquestioned or unexamined, this can create an environment that marginalizes students who do not conform to these established standards. With a lack of cultural competence, institutional factors, such as outdated curriculum, and limited training, teachers are ill equipped to teach and respond to student needs and diverse realities in the classroom (Nganga, 2020). Significant characteristics contributing towards this reproduction are the structural inequities in which teaching and learning is done, and the biases that teachers bring to their teaching practices (Russell & Russell, 2014). Moreover, the link between these challenges and effective implementation of EDI practices becomes evident when considering that teachers' attitudes are inherently shaped by the structural inequities within the educational system and the biases they bring to their teaching practices. Teachers' attitudes are a prerequisite to the successful implementation of EDI practices (Ahmmed et al., 2012), and should be considered at the start of an educator's career. Understanding teachers' attitudes and beliefs towards equity and inclusion, especially during their experiences in teachers college, may be instrumental in shaping educational policies and practices as it can enable post-secondary institutions to assess the impact of their teacher training programs and make necessary adjustments to align with the evolving needs of diverse classrooms.

Science education and science teachers, specifically, have been identified as especially resistant to developing inclusive pedagogies by falling into the comfort of teaching the way they themselves were taught. Often, science educators believe that cultural sensitivity does not belong in science courses because science only seeks objective truths (Gill & Levidow, 1987; Rodriguez et al., 2003). Yet attitudes are informed by personal experience and socio-cultural perspectives (Scorgie, 2010) and have an impact on teaching. New science teachers have communicated the importance of meeting the needs of diverse classrooms in recent years. Rodriguez at al., (2010) followed eleven new in-service elementary teachers for two years as they implemented a culturally relevant and responsive science curriculum. As noted earlier, the Ontario science curriculum makes explicit connections to culturally relevant and responsive pedagogy (CRRP), which will be discussed in more detail in Section 2.5 below. The teachers in the study created personal goals to develop a more culturally relevant and responsive praxis to implementing EDI. These personal goals were introduced to help bridge the teachers' expressed beliefs to their beliefs in action. Results demonstrated that teachers had an open-minded approach to the intervention but lacked initiative to consistently use strategies and available resources to integrate EDI through culturally relevant pedagogies. Further, the teachers showed low commitment to their personal goals, slowing the project by ineffectively or not using culturally relevant pedagogies. The teachers' reluctance to fully embrace and implement these pedagogies raises concerns about their commitment to fostering a culturally responsive environment. This emphasizes the importance of addressing not only teachers' attitudes but also their ability to translate open-mindedness into sustained actions that align with the intent of EDI and cultural responsiveness in education. While the above study focusses on elementary educators in the science classroom, the results are arguably not that different from the secondary science teacher. Therefore, understanding preservice secondary science teachers' attitudes towards EDI in their content area (i.e. biology, physics or chemistry) is a critical underpinning of preparing to make progress towards EDI in education.

2.2.1 Power and Privilege and Education

It is important to acknowledge the impact and presence power and privilege have and continue to have on sociopolitical concepts. Historically, those who hold power define social concepts that favour white, Christian male dominance that support an ideology of white supremacy and influence actors within society to perpetuate and legitimize the status quo (Liu, 2017). Education is a microcosm of societal climate and acts as a factory to mold students to become ideal citizens through both the explicit and hidden curriculum (Azimpour & Khalilzade, 2015), and these are ideas and discussions that should be discussed in greater detail in teacher education programs.

Violence towards students in Ontario outside the dominant norms is present in both explicit and hidden forms (Raisinghani, 2018). While blatant racist and sexist materials have been largely removed from education materials (explicit curriculum), there continues to be explicit resources being implement, with effects still linger, namely in the lack of representation and misrepresentation of groups of people in textbooks (Gulliver & Thurrell, 2016). Even more damaging is the “hidden” curriculum (Dewey, 1916; Giroux, 2010; hooks, 1994). The “hidden” curriculum refers to curriculum and pedagogy that is not formally ascribed and emerges from social, political, and cultural environments in society. The hidden curriculum manifests within classrooms, often unintentionally, through teachers' attitudes and assumptions about student groups, such as holding reduced expectations for their capabilities (Gay, 2010). For example, this can include what the teacher chooses to include and not include in their syllabi, or the ways in which a teacher responds to or not to an incident in the classroom.

The hidden curriculum, comprising the implicit messages conveyed through educational practices, intersects with broader systemic issues, notably how governments shape educational policies. One must also consider the ways in which governments have enacted and continue to perpetuate oppressive structures through policy that have great impacts on education, in this case, the introduction of “multicultural education.” Since the implementation of an official federal policy of multiculturalism in 1971, Canada's approach to liberation and empowerment in education has been inadequately informed and ineffective, heavily influenced by settler-colonialism and Eurocentrism (Akkari & Radhouane, 2022). Following the federal policy came the Multiculturalism Act in 1988 where schools were to implement multicultural education aimed at ensuring equal opportunity for all students by reducing barriers to access. The emphasis of the act in Ontario was to celebrate cultural diversity; however, it avoided critical reflection on recognizing and interrupting inequitable patterns and practices in society such as dominant narratives about people of colour (Hammond, 2020). Multicultural education is communicated as an acceptance of others but unjustly categorizes people who are not part of the dominant white population as "others," homogenizing racialized identities, and giving no attention to different lived realities of these groups. Without really understanding and critically examining multiculturalism and its challenges and harmful effects, teachers and preservice teachers continue to perpetuate notions of whiteness by subjugating other cultures (Raisinghani, 2018). Teachers must be aware of the ways they empower certain students and disadvantage others by examining their own values and the way they teach, and this needs to start in teacher education programs.

In 1993, the government of Ontario recognized that student performance gaps were not due to cultural differences, but rather "racial inequality in power and privileges" (Akkari & Radhouane, 2022, p. 85). The government of Ontario has been and is aware of systemic bias and barriers that have an implication on students and families that fall outside the dominant norm. The PDSB Anti-Racist Policy Report (PDSB-ARPR) outlines a tangible plan to address racism enacted in education through policies and teacher practice (PDSB-ARPR, 2022). For example, a significant barrier shared was focused on who was implementating anti-racism policies. A proposed solution to overcome these barriers involves hiring of racialized staff and fostering better inclusion of racialized parent committee members to more authentically engage with anti-racist policies. While there are recent calls to action to guide educators and school boards' journey to dismantle the systems of oppression in education, such as the PDSB-ARPR report, the progress is slow, and there are still instances of Eurocentric approaches in curriculum documents and teacher praxis all while excluding the existence of oppressive barriers. Steps are provided in the PDSB-ARPR to address these barriers effectively by consolidating with staff, families, and community members. The PDSB-ARPR is not a solution to dismantling all the existing barriers, but it does exist as a first step and a model to improve upon. The PDSB-ARPR helps to outline the scope, aim and objective of the policy while including effective implementation of the policy. Further, it stated where the accountability lies and how the duties must be undertaken (PDSB-ARPR , 2022). Despite such policies and initiatives, the attitudes of pre-service science teachers towards EDI are not considered and could consequently pose further, different obstacles, potentially impeding steps outlined by the PDSB-ARPR. Specifically, steps directed towards dismantling oppressive systems and inhibiting genuine progress towards a more EDI focused science education as new teachers, such as preservice teachers, can determine the future direction on how policies are carried out (or not) in the classroom. Without addressing and challenging preservice attitudes through comprehensive training and ongoing support, efforts to dismantle systems of oppression may be met with resistance and struggle to achieve meaningful change within educational institutions.

2.3 Pre-Service Teachers' Concepts and Behaviours towards EDI

Current research on pre-service teachers' conceptions of EDI appears to focus mostly on the conceptual change of EDI as an outcome of an EDI-related intervention during courses or as a specific teaching tool (Enterline, et al., 2008; Cochran-Smith, 2016). Researchers also explore how and why these conceptions evolve throughout a program and the various factors that influence the evolution of pre-service teachers' understanding of EDI (Struthers-Ahmed, 2020).

For some pre-service teachers, EDI exists within the presentation of work, such as pedagogy, while others emphasize “recognizing culture” and the importance of “student identity” (Gullberg et. al., 2018).

Literature also reports that some of the concerns lies within the fact that many teachers lack the awareness and recognition of one’s positionality and privilege. Jupp and Lensmire (2016) reported that white preservice and in-service teachers rarely saw themselves as an actor or contributor to systems of oppression. This is consistent with the behaviour of evading issues associated with social injustice and marginalization (Sleeter, 2017). There are also patterns of pre-service teachers being resistant to adapt reflexivity and critical praxis as a tool for transformative education and pedagogies (Arvanitis, 2017); however, the effectiveness of pre-service teachers’ participation is also dependent on other external factors such as experts and teacher educators. For example, Goddard and Evans (2018) examined primary pre-service teachers’ attitudes towards inclusive education across their program. Their study showed that professional training can have a positive impact on pre-service teachers’ attitudes towards EDI. While results show the pre-service teachers’ attitudes towards EDI as positive, the pedagogical relevance and reality of teaching for EDI are not studied. This could be because Goddard and Evans’ study only addressed the inclusion of the theories and principles of EDI, yet what most pre-service teachers are seeking is guidance in being able to implement the theories into practice. Further, the attitudes towards learning about EDI in teacher education are not addressed. It is important that all pre-service teachers emerge from their courses with positive attitudes towards EDI as these may predict inclusive classroom practice (Swain et al., 2012) and work towards dismantling the oppressive cycle in science classrooms.

The above mentioned studies, among others, are insightful for uncovering perceptions about EDI; however, the pre-service secondary science teachers' attitudes towards learning about EDI in their content area remains limited. A commitment to the political and powered dimensions of learning would incite programs that focus on learning to more intentionally support secondary pre-service science teachers (PSSTs) to learn about race, gender, class, sexuality, nation, ideology, settler-colonialism, and other intersecting processes of power. Making such links would allow a new generation of science teachers to not only build on EDI but also extend it by attending to the specific dynamics of human learning and the nuanced interactional and relational dimensions of power that are often glossed over in Western scientific approaches, including the science curriculum. This study aims to address this gap by exploring the attitudes that pre-service science teachers hold towards EDI education in their content area.

2.4 Establishing Steppingstones to EDI in Science Education

Teacher education programs are adopting policies that support inclusion of EDI (Morales-Doyle et. al., 2020). In response to Canada's increasingly diverse classrooms, teacher education programs have implemented various models of EDI (Russell & Russell, 2014) such as: "multicultural education," anti-racist education," "sovereignty and auto determination for the native peoples in the domain of education" (Akkari & Radhouane, 2022). These models attempt to introduce practices in favour of both equality and the social integration of minoritized populations. In a multicultural education class that was one semester in length, Nganga (2020) assigned elementary preservice teachers a task where they intentionally analyzed hidden bias in children's books to help them develop cultural competence. The preservice teachers were also assigned in-class written reflections, open-ended questions, discussions, and course summary papers. The challenge faced in this class was the skewed understanding of "multicultural education" that mimicked political correctness. That is, that Nganga (2020) argues that infusing multicultural education into all classes is not an effective way to teach it based on the students' baseline knowledge of multicultural education in addition to teacher educators tending to shy away from teaching subjects related to diversity. Because "they feel less prepared to address controversial topics" (p. 101), it is likely that faculty were not infusing multicultural and diversity matters into other courses; therefore Nganga (2020) argues that standalone diversity courses that explicitly teach diversity topics using a critical education lens will be a more effective approach to teaching. While focusing on multicultural education, Nganga (2020) did share that there were benefits of participants analyzing children's books for hidden bias that are important to consider in research related to EDI. Learning explicitly about human differences and hidden bias in children's books that challenge power dynamics in young learners helped preservice teachers to develop interest in equitable and inclusive education; this is also important to consider within the science classroom. However, there is contention with how to best explore how teacher education programs prepare preservice teachers to enact equitable practices (Kwok et al., 2021). Specifically, focus on preservice teachers' skills and focus on conceptualization of EDI are debated.

As schools have approached first steps to becoming agents of change in Ontario, EDI frameworks are being implemented in all or some teacher education courses but are not mandatory for graduating. Furthermore, the preservice teachers who do take these courses do not always share positive shifts in attitudes about EDI, and when positive shifts occur, it does not always translate to implementing EDI effectively (Morales-Doyle et. al., 2021; Rodriguez et. al., 2010). Facilitating teaching spaces that productively address the powered and political dimensions of learning is difficult. It is fraught with challenges (Philip et al., 2012), which can lead to avoidance by teachers (Nganga, 2020). Consistent with other aspects of teacher preparation programs, self-efficacy is an important part for pre-service teachers to effectively achieve any goal in relation to teaching towards inclusive classrooms (Friesen & Cunning, 2020). If preservice teachers' self-efficacy is low in relation to addressing EDI, it may affect their attitudes towards these courses.

In teacher education programs, some instructors have used different methods in implementing EDI courses to increase preservice teachers' self-efficacy. Butler and Leahy, (2021) analyzed a series of journal reflections from preservice teachers' perceptions of teaching in urban schools to determine whether exposure to service-learning opportunities within an urban school influenced their views. The authors found that the preservice teachers initial views of urban schools evolved over the duration of the course, shifting from a deficit orientation to a more inclusive one with heightened sensitivity to and awareness of diverse learners. Uzum, et al., (2019) examined implications for designing telecollaborations that promote language and practices to unpack issues of sociopolitical and sociocultural issues in two different countries. Findings suggest that when preservice teachers engage more frequently on critical topics, they become quick to make others feel comfortable and prioritize the mood over the context of the discussion. While preservice teachers may prioritize maintaining a comfortable emotional atmosphere during critical conversations, they may inadvertently avoid addressing the deeper contextual nuances of the topics. This tendency could hinder preservice teachers' ability to fully engage with complex sociopolitical and sociocultural issues, potentially limiting the depth of understanding and meaningful dialogue necessary for understanding factors contributing to these issues. These conditions may have also led preservice teachers to develop a false sense of capacity to engage in content related to EDI. Nganga (2020) examined and addressed teacher educator roles and the impact the tools they implemented have on preservice teachers' conceptualization of EDI. Because preservice teachers were less likely to engage with topics that are challenging, Nganga (2020) strongly recommends continuous professional development as preservice teachers progress into their careers to prevent them from becoming complacent. Rivera and Ibourk, 2020 also suggests continuous professional development but emphasizes the importance of starting during teacher education programs. A missing component to this study is that it does not address the preservice teachers' own biases and the consequential attitudes they may have towards learning about the realities of marginalized students. Addressing bias through identity work is an approach used by Moore Mensah (2009) that shows encouraging results. The study outline how using book clubs, preservice teachers had the opportunity to examine and begin to understand their positionalities, reveal their ideological beliefs, learn how power dynamics work and the ways in which their biases impact the classroom. While the studies included preservice teachers in the elementary school stream (K-8) and different content areas, they remain important when considering the objectives of this study in exploring the attitudes of preservice secondary science teachers and their conceptualization of EDI. Underlying these studies is the theme of reflexivity and self-awareness, which I believe are the steppingstones towards effectively implementing EDI in science classrooms and starts with understanding who we are, not just as educators, but also as individuals, and what our presence means in the classroom. These studies afford preservice teachers relevant and practical implications working through the dynamic nature and complexities of EDI. Still, there are some limitations to consider. Some studies did not include the teacher education instructors' ideological beliefs, praxis, or pedagogies (Nganga, 2020; Underwood & Mensah, 2018), and focused more on the approach to integrating EDI as an individual effort and less attention to the importance of collaborative opportunities. This is not to say that preservice teachers should put less effort towards individual growth, rather, they should be made aware of how to seek out resources to aid their growth. For example, teachers in the schoolboard I work in rely on collaborative, team-working, reflective opportunities to implement the new grade 9 science curriculum and navigate culturally relevant and responsive pedagogy (CRRP), which is discussed in Section 2.5. Although the studies referenced above may not have directly addressed preservice science teachers, their findings underscore a need for considering collaborative approaches in teacher education. By integrating collaborative practices, preservice science teachers can collectively create ideas and methods to cultivate what EDI focused science classrooms look like. While individual effort remains crucial for better understanding EDI, PSST may require guidance on what their individual effort need to be focused.

It's crucial to incorporate studies on EDI, as well as concepts like positionality, reflexivity, and self-awareness, when discussing preservice science teachers' attitudes towards these topics for several reasons. Such studies provide insights into the diverse perspectives and experiences that preservice teachers bring to the classroom, informing approaches to creating EDI focused learning environments. They shed light on the potential impact of educators' own identities and biases on teaching practices, highlighting the importance of self-awareness and reflexivity in fostering equitable education. By considering these factors, researchers and educators can develop more comprehensive strategies to address systemic inequalities and genuinely address EDI within science education, ultimately enhancing the quality and relevance of teacher preparation programs.

2.5 Science Teachers and the Science Curriculum

Secondary preservice science teacher (PSST) attitudes towards EDI appears to be an emerging area of research. It could be argued that science educators teaching to/for EDI are in an a unique and challenging position because of the value society places on scientific knowledge and truth, and the resulting perceptions of power (Moore Mensah, & Jackson, 2018). Science has been used to define and legitimize knowledge systems which influence the way the world is perceived (Liu, 2017). This includes gender, socioeconomic, and racial bias and prejudice which has led to underrepresentation and violence in Science, Technology, Engineering, and Mathematics (STEM) towards women and Black, Indigenous and other racialized peoples (Alfred et al., 2019; James & Turner, 2017). The forms of pedagogy that continue to be relied on in many science classrooms reflect a more traditional view, driven largely by outdated and Western focused textbooks, national standards, and a focus on content that is largely disconnected from students' lives (Brickhouse et al., 2000). In exploring the grade 10 academic science curricular documents, for example, expectations under "Scientific Investigation and Career Exploration," suggest exploring career opportunities that have and continue to alienate underrepresented populations: "identify and describe a variety of careers related to the fields of science under study (e.g., astrophysicist, geophysicist, conservation officer, park warden, fire protection engineer, hydrologist, electrician)" (p. 49). This description is followed by examples of mostly white male Canadian scientists who conform to dominant norms. These are missed opportunities for students from underrepresented populations to explore what aspects of science are interesting to them, engage meaningfully with science in schools, and more importantly to see that they belong in these classes and fields. This gap is further exacerbated by phrases included in the instructional planning section, ironically titled, "Anti-discrimination," that include phrases such as: "There may be cultural sensitivities for some students" or "Teachers should be open to adjusting their instruction, if feasible, when concerns are brought to their attention" (p. 37). By framing these considerations as optional adjustments rather than integral components of the curriculum, there's an implication that not all cultural issues are deemed equally relevant or prioritized within the science curriculum. This approach may inadvertently marginalize certain cultural perspectives or perpetuate the hierarchy of cultural relevance, hindering efforts to foster EDI in science education. Further, within the curricular documents, there exists contradictory wording between the considerations for planning for anti-discrimination education and the specific expectations in each unit. For example, on one hand, teachers are expected to plan activities that include Indigenous points of view and their contribution to science “or” how they have been affected by scientific processes (p 37). As with the example shared earlier, “or” is an important conjunction because teachers are not specifically directed to include the ways science has mistreated Indigenous communities in the past. On the other hand, Indigenous communities are represented as a group or groups of people to be studied in relation to various units of science (biology, chemistry, space, etc.) and not as contributing voices in these fields of science.

Another area where the documents fall short, is through the limited instruction for teachers on how to create work that is be “inclusive and reflect the diversity of the student population and the population of the province” (p.16). In a grade 10 science textbook, students are encouraged to think about ways in which climate change has negatively affected Indigenous communities living on reserves but does not ask why and how Indigenous communities were forced to live there, or how the communities practice sustainable living patterns, the latter of which is a direct connection to science curricula. The lack of instructional strategies and guidance from curricular documents certainly contribute to the state of EDI in science classrooms. The absence of clear instructional strategies and guidance regarding EDI within curricular documents may lead PSSTS to struggle to effectively address EDI issues in science classrooms, leading to a perpetuation of inequitable practices and exclusionary environments, hampering their ability to meet the diverse needs of students.

Many science teachers have relied on instructional tactics such as memorization and recitation for knowledge retention. Because cultural and linguistic barriers exist in each classroom, these tactics excludes the needs of students marginalized by these barriers (Jones & Donaldson, 2021). As a science teacher, I, along with other science educators, have been socialized into and have propagated a narrative of deficit thinking. Deficit thinking is described as a way in which those in positions of power and privilege often have a "victim blaming" orientation toward communities that face inequalities in society (Devlin & McKay, 2016). This type of ideology perpetuates the assumption that an individual's traits and environments (communities and family) are the source of their failures (Sleeter, 2004) and ignores the systemic influences that shape disparities in educational outcomes (Davies, 2020). In education, deficit thinking presents as educators having low expectations of students from historically oppressed groups and can predispose these students to disengagement (Ladson-Billings & Donner, 2005) while avoiding how this deficit thinking undermines success. In an attempt to combat these traditional forms of dominant ideologies and practices within science classrooms, and as noted earlier, CRRP was introduced by the OME as a method to work towards better integrating EDI into the science curriculum in Ontario, and which will be discussed in more detail in the next section.

2.6 Theoretical Framework

The research will be grounded within a critical pedagogy and culturally relevant and responsive pedagogy framework.

2.6.1 Critical Pedagogy

The aim of critical pedagogy is to develop and enact a culture of support and empowerment for students who experience cultural marginalization and economical disenfranchisement (Scully, 2021). Early educational theorists such as Freire (1972) and Bourdieu and Passeron (1978) focused on social economic status as a level of risk for student outcome. More recently, educational theorists focus on other forms of oppression marginalizing women, Black and Indigenous peoples and people of colour (BIPOC), individuals who identify with 2SLGBTQ+ communities, and learners with disabilities (Saunders & Wong, 2020). Critical pedagogy is an approach to dismantling asymmetrical power balance with teachers being the main actor. Critical pedagogy calls on teachers to recognize how schools have upheld and embraced theories and practices that reinforce knowledge and power in ways that sustain asymmetrical relations of power (Darder, 2012) and offers a model for inclusive teaching by going beyond theory and demanding transformative teacher praxis. Through critical pedagogy, education can be used as a tool for empowerment by creating personally meaningful content and develop agency over student learning. This agency can be used to enact change in the world beyond the classroom (Tewell, 2015).

Critical pedagogy demands that teachers recognize how the issues of knowledge, authority, and power embedded in relationships between teacher and students, classrooms and community, institutions, and society influence the teachers' perspectives, classroom instruction and assessment activities (Raisinghani, 2018). Critical pedagogy challenges teachers to understand the implications of their teaching on shaping their students' lives within sociopolitical and sociocultural contexts (Nikolakaki, 2012; Pykett, 2009). Understanding the relationship between knowledge, authority, and power in educational contexts is critical for preservice science teachers because the power that has been privileged to scientific knowledge through the ways in which this knowledge intersects with various social, political, and cultural factors.

2.6.2 Culturally Relevant and Responsive Pedagogy

Culturally Relevant and Responsive Pedagogy (CRRP) is a student-centered teaching approach wherein diversity is affirmed, and students are empowered to challenge the status quo by purposefully using academic content as part of the learning process (Ladson-Billings, 2000; 2014). The goal of CRRP is to collectively empower all students towards deconstructing societies inequalities (Ladson-Billings, 1995; 2000; 2014). Originally coined "culturally relevant pedagogy" (Ladson-Billings, 1995), the focus of the teaching style was to engage marginalized students, namely "African-American students" (p.159) in the classrooms and has since been adapted as a framework to engage all students (Ladson-Billings, 2014; Underwood & Moore Mensah, 2018). CRRP is used today to develop all students' critical thinking and sense of democratic citizenship through uncovering the hidden curriculum, rules of the status quo, and societal injustices in the content being taught in schools (Ladson-Billings, 2014). CRRP rejects traditional methodologies of teaching, such as fact memorization, by leaning heavily into finding solutions to societal problems as a means of engaging students in higher-level thinking through the implementation of teaching methods involving EDI. There are three main tenets of CRRP that operationalize the teaching style: Academic Success, Cultural Competence, and Critical Consciousness. Academic success is encouraged by using problem-based learning to apply what students have learned in contextually meaningful ways. This teaching method helps cultivate a student academic success but that also encourages students to become active and critical citizens. Cultural competence refers to the students' ability to understand one's culture and connect that to the content taught (Ladson-Billings, 2000; Warren Grice, 2017). To build cultural competence, teachers must develop content to empower students while navigating the challenging work of uncovering social injustice by making connection to student's home culture, language, and traditions. Critical consciousness is the product of the previous two tenets. Students will develop an ability to actively critique and challenge the status quo while establishing a sense of self-worth (Ladson-Billings, 1995; 2014).

In thinking about the context of this study, some have adopted the idea of culturally relevant science teaching (Boutte, et al., 2010) as a method to integrate EDI and motivate science teachers to become culturally aware and actively use relevant and inclusive specifically in science classrooms. Through this process, teaching builds on scientific inquiry that prioritizes students' agency and "awareness of social inequity and power relations including the cultural, political, and historical forces that shape one's status in society" (Jones & Donaldson, 2021, p. 4). Similar to Ladson-Billings' three tenets, the three tenets of science specific pedagogies to consider are: 1) academic success in science, (2) cultural competence in science, and (3) sociopolitical consciousness in science. In both models, it is often the third tenet, arguably the most important, that is often overlooked. Some studies that look directly at CRRP focus on the teacher's understanding and their own sociopolitical consciousness. Underwood and Moore Mensah (2018) found that participants described cultural relevance in terms of their beliefs and practices related to teaching and looked at the first two tenets but failed to address the third. Jones and Donaldson (2021) also indicate that science teachers' lack of sociopolitical consciousness is a hinderance to culturally relevant science teaching. Upadhyay et al., (2020) note that science education research has explored sociocultural aspects of teaching but has not addressed the relevance of student culture. Yet, sociopolitical consciousness is necessary to perceive the oppressive nature of society and use this knowledge for social action against oppressive systems (Jemal, 2019).

The work to dismantle inequalities is as complex as the systems themselves. The education systems that reproduce and perpetuate the status quo took years to establish, therefore, efforts to dismantle these systems must be ongoing and sustained. This efforts needed to dismantle inequalities is not about finding solutions and forgetting about the problem, but rather becoming aware of, acknowledging, and reflecting on these problems to develop criticality of EDI. Therefore, the conceptualization of managing these complexities needs to be fluid and reflexive. For the purpose of this study, I conceptualized the three tenets of CRRP—academic success, cultural competence, and critical consciousness—differently by focusing more on the critical and reflexive lenses. To fully embrace CRRP, science teachers need to critically assess power dynamics within the education system, particularly between teachers and students, and acknowledge the presence of oppression as a fundamental step before engaging with the three tenets of CRRP; to do this, science teachers must continuously consider their positionality and biases. Academic success is not focused only on numerical values of student performance, instead, it is the ability of a PSST to instill curiosity in their students' and relate concepts by utilizing student centered teaching, that includes the importance for students to ask questions and take risks. Cultural competence is conceptualized as PSSTs awareness and openness to learn about their students' various cultural backgrounds, integrate these diverse perspectives into the classroom and apply that learning to address critical social justice issues, specifically those that relate to the science curriculum; this tenet is underpinned by how PSSTs value diversity, and how they see their role in supporting cultural differences, and effectively incorporate cultural knowledge into contexts. Finally, critical consciousness is conceptualized by how PSSTs support students to explore and challenge social inequities and also includes the willingness of PSSTs shifting their pedagogy away from hegemonic norms, engage in work that allows them to examine their own bias, reflect on their positionality and seek opportunities to continue to develop their understanding of cultures to better support students as they critically examine the world around them.

2.6.3 Critical Pedagogy & Culturally Responsive Pedagogy

Critical pedagogy provides a broad approach for PSSTs planning for EDI but emphasizes the important role teachers have in dismantling injustices. Combined with critical pedagogy, CRRP provides a narrower and tangible framework for PSSTs agendas for change. By engaging in critical questions about PSSTs positionality, society's influence on their socialization, their conceptualizations of EDI, and teaching philosophies, participants will have the opportunity to share insight into their attitudes towards implementing EDI in science classes. Further, in answering these questions, teachers will describe how they position themselves, in reference to their role, in the classroom. Analysis of this project will be informed by participant responses and characteristics of CRRP tenets: Academic Success, Cultural Competence, and Critical Consciousness. To add, CRRP shares a similar goal to critical pedagogy, in that its purpose is to support teachers' consciousness in connection to EDI (Ladson-Billings, 2014). The sociopolitical and sociocultural connections PSSTs make to EDI will be dependent on their understanding of what EDI is. This in turn, will also give insight into why they hold the attitudes they have towards EDI and CRRP.

Chapter 3: Methodology

The goal of this research was to explore the attitudes preservice science teachers (PSSTs) hold towards implementing EDI in their classes and to understand their conceptualization of EDI. I implemented a qualitative single case study (Stake, 1995; Yin, 2014) and utilized focus groups (Creswell & Poth, 2018). A focus group captured the authenticity of a group dynamic and helped to reduce power relations that may have occurred during one-on-one interviews. Further, focus groups offer the benefit of gathering high-quality data in a short timeframe, allowing for more focused and deeper analysis of the data.

This study was guided by two research questions: 1) What are pre-service science teachers' attitudes towards learning about EDI in their content area? 2) How do pre-service teachers conceptualize EDI within the contexts of a science classrooms?

In this chapter, I present the research design and context of the study, followed by the limitations of qualitative research. Finally, I briefly discuss details of data collection and the analysis processes.

3.1 Case Study

Qualitative research has a place across many disciplines. It seeks to address human or social problems. Qualitative research relies on complex descriptions of the problem, participant voices, researcher reflexivity, and contribution to the literature or call for change to guide further inquiry and understanding of a phenomenon (Creswell & Poth, 2018, p. 35). Qualitative research is many things at once: it is interpretive, naturalistic, experimental, situational, and flexible (Aspers & Corte, 2019). It attempts to make sense of an issue in terms of the meanings people bring to them and describe what those meanings are (Denzin & Lincoln, 2011). Within education, qualitative research can be a methodology used to explore how dominant cultures have influenced and continues to influence the classroom environment. For this research, case study was the chosen methodology to explore the attitudes science teachers hold towards implementing EDI in science education by engaging them in a small focus group.

Case study research has a long, distinguished history across many disciplines. Case study involves the study of one case or multiple cases within a real-life, existing context or setting (Yin, 2014). Case study research is defined by Creswell and Poth (2018) as a “qualitative approach in which the investigator explores a real-life, contemporary bounded system (a case) or multiple bounded systems (cases) over time” (p. 153). Central to writing a case study, the researcher describes the case in detail, and mentions several issues or focuses on a single issue that emerged when examining the case (Stake, 1995). The goal is to provide descriptive and interpretive understanding of the object of study, or case. In this single case study, preservice science teacher attitudes towards EDI in one eastern Ontario teacher education program constitute the case for the study and implanting focus group interviews allowed me to gain important in-depth data from participants regarding their thoughts, ideas, opinions, and perspectives (Stake, 2013). The case study approach made it possible to a) take complexity into account and b) preserve the integrity of the phenomena studied (Nilholm, 2020).

The case of secondary PSSTs at an eastern Ontario teacher Faculty of Education was chosen for a few reasons. The demographic makeup of the university teacher education program shares many similarities to the demographics of the other teacher education programs offered in Ontario (Abawi & Eizadard, 2020). Further, I chose science teachers in the intermediate/senior division (grades 7-12) because I am qualified to teach those divisions and subjects, therefore, I share familiarity with the curriculum. Also, I have been socialized through science education with work and school experiences in the science fields and, as shared in my Autobiographic

Signature in Chapter 1, have also observed many issues and continue to navigate the complexities. Finally, as noted earlier, critical pedagogy and CRRP are rarely implemented well in science classes and literature on the perspectives and attitudes of PSSTs and their conceptualization of EDI is limited. As such, in considering my participant pool, findings have the potential to increase students' success in science, create safer learning spaces, and hopefully retain students' interest who have been underrepresented in science classes increase (Wilton et. al, 2019).

3.2 Data Collection

For this single case study, two focus groups of three to four intermediate/senior PSSTs with one teachable in any of the secondary science disciplines (biology, physics or chemistry) were conducted.

The selection criteria for this research included criterion sampling (Patton, 1990) and included the following: a) the participants were enrolled in their final year of the BEd program b) had completed at least two practicum blocks and c) were in the intermediate/senior science division with one subject teachable in science. This purposeful selection criteria allowed exploration of PSSTs conceptualization and attitudes of EDI as a benchmark for their beliefs, values, and attitudes moving into the workforce.

The selection criteria for this research included criterion sampling (Patton, 2001) and included the following: a) the participants were enrolled in their final year of the BEd program b) had completed at least two practicum blocks and c) were in the intermediate/senior science division with one subject teachable in science. This purposeful selection criteria allowed exploration of PSSTs conceptualization and attitudes of EDI as a benchmark for their beliefs, values, and attitudes moving into the workforce.

Participants were recruited starting June 2023. I sent an email out to the Bachelor of Education science instructors asking them to share information about the study with their students. When interested participants reached out to me via email, we organized a time to meet on Zoom to first obtain verbal consent. Initially, eight PSSTs reached out, however, only seven agreed to participate in the study as one PSST ceased communication before scheduling a time for our preliminary meeting. All participants who reached out were eligible to participate. During the initial Zoom meeting, I read the verbal script of the Letter of Information (LOI), invited participants to ask any questions, and sought verbal consent to begin with answering demographic information (see Appendix A for demographic questions), then to participate in the focus group (see Appendix B for focus groups guideline questions). As gratitude for their time, participants were also notified that they would receive a $20 e-gift card to a merchant of their choice. The demographic information collected was important to consider for data analysis. It was also important to acknowledge which perspectives are present and which are missing from the conversations. As noted above, in total seven participants were recruited. See Table 1 below for more information regarding participant demographic information. Despite the homogeneity of the program, it is worth noting the diversity of the participants which demonstrates the interest in the research topic from individuals with varied backgrounds and experiences. As a quick note, participants in this teacher education program were required to have two teaching subjects and enroll in a course that focused on a specific topic of their interest, the concentration or FOCI. The latter provides opportunities for preservice teachers to explore certain issues and topics more in-depth, such as around social justice or environmental education.

Table 1: Demographic Information

Pseudonym	Pronouns	Cultural Background/ Race	Teaching Subjects	Concentration/FOCI
Quinn	They/Them	Second gen Korean Bi-racial	English & Biology	Social Justice
Frankie	She/Her	White	Physics & Math	Environmental Ed.
Morgan	She/Her	White	Chemistry & Math	Leadership
Finn	He/Him	Chinese Canadian; Second generation	Chemistry & Math	Exceptional Learners
Jessie	She/Her	Thai; born in Canada	English & Biology	Arts and Exceptional Learners
Rhys	He/Him	White Canadian	Physics & Math	Assessment
Avery	She/Her	Romanian; first generation Canadian	Biology & Chemistry	Environmental Ed.

After scheduling an agreed upon date, focus group interviews were conducted in June and July 2023, in-person, in a booked and private conference room in the Education Library. There were two focus groups; one group included four participants (Finn, Jessie, Rhys, Frankie) and the other included three (Quinn, Avery, Morgan) (see Appendix B for guiding questions used for both focus groups). Focus group interviews were recorded with two digital voice recorder devices and lasted 90 minutes. The recordings were then transcribed by me.

Both focus groups included participants with a diverse range of experiences and backgrounds. Both groups included participants that represented each of the three science teachables (Biology, Chemistry, Physics), and a range of different concentrations/FOCI courses (see Table 1). Some participants did not disclose the locations of their practicum placements; however, those who did share revealed that their practicum placements were undertaken in regions spanning Southern and Eastern Ontario.

In general, the focus group conversations occurred organically where participants were open to sharing their thoughts and feelings about the topic or question, and felt comfortable enough to allow each other uninterrupted time to express their viewpoints. While some participants initially shared less, throughout the conversations in both groups participants became more comfortable ultimately leading to continued dialogue where they encouraged one another to elaborate and provide further clarity on their perspectives.

Specific safeguards were utilized to maintain confidentiality. Any personal information was stored separately from anonymized information. For anonymized information, I ensured participants' confidentiality by encrypting files and using pseudonyms for participant names and any schools they attended or completed practicum placements so they cannot be identified. Further, confidentiality of participants' identity was ensured by transcribing and anonymizing raw data as soon as possible. All study data was password protected in a OneDrive folder. Only my supervisor and I have access to this data. Physical safeguards included a secluded interview room and the recording devices are stored in a secured location away from public access. Participants were also informed and reminded that they did not have to answer all the questions, could stop the interview and/or leave the room at any time, and contacts for Queen's University Student Wellness and Empower Me were also shared should participant need/require further support.

3.3 Data Analysis

Data analysis included a thematic analysis that incorporated an inductive approach (Creswell & Poth, 2018). This approach allowed for me to discover themes as they emerged directly from the data in relation to the research questions (Braun & Clarke, 2022). I initially transcribed the interviews on a Word document prior to uploading to analysis using NVIVO 12, a qualitative data analysis software program, as part of my coding. Through many iterations of analysis, themes emerged that informed the research questions (Braun & Clark, 2022).

In the first phase of analysis, I reviewed the transcripts and relistened to the focus groups multiple times to develop and document initial themes in a journal and Word document. I used a colour coding process on the Word document to identify the initial themes that emerged from the responses in the focus group. These initial codes were then grouped into the first round of themes that resulted in eight themes.

During the second phase of analysis, the transcripts and themes were uploaded to NVIVO 12. During this phase of coding, I added memos whenever I came across themes that did not fit with the first round of analysis but seemed to align with the research questions. This was an iterative and interactive process of categorizing and re-categorizing the quotes based on similarities and differences to discover emergent themes. For instance, the theme "Barriers of EDI" is the amalgamation of original three main themes: "Social barriers", "Structural barriers" and "Access to resources." As I revisited the themes, each iteration of analysis pointed towards the overarching main theme of 'barriers', prompting my decision to categorize them as subthemes.

For the final phase of analysis, I created a chart that included names of the themes and a definition of the theme. For my own reference, I included quotes from the speaker and the question they were responding to. The chart was revisited as themes were more refined and clearly defined during the final stages of analysis. I constantly revisited the raw data, journal notes, and memos during each phase of the coding process. While the processes presented above appear the be linear, it was an iterative process where I revisited different phases at different times. At the end of the analysis, there were six main themes but for the purpose of my study and the scope of my research, I am focusing on three themes that best address the research questions for this study (see Table 2 below). These three themes will outline the discussion of findings in Chapter 4.

Table 2: Themes and definitions

Theme	**Definition**
Awareness of EDI	• Where participants have seen, heard, or used EDI in both educational and non-educational (job postings, company values, etc.) settings
Conceptualizations of EDI Subthemes: • Approaches to integrating EDI • Relevancy of EDI	• How participants refer to and/or define EDI in education.
Barriers to EDI Subthemes: • Social aspects • Structural issues • Access to resources	• Science educators and professors/instructors “buy-in” and/or attitudes towards EDI.

In this single case study, two focus groups were conducted with Intermediate/Senior Preservice Science Teachers (PSSTs). These focus groups comprised of three to four participants with a teachable subject in Biology, Physics, and/or Chemistry. The research aimed to explore PSSTs' conceptualizations and attitudes towards equity, diversity, and inclusion (EDI) as they transition into the teaching workforce. Recruitment occurred via email networks, with interested participants providing verbal consent and demographic information prior to participation in the focus groups. Focus groups were recorded and transcribed for analysis after which three themes. What follows in Chapter 4 is a discussion of findings and implications in connection to the three main tenets of culturally relevant and responsive pedagogy.

Chapter 4: Findings

This chapter will share and discuss the main themes from the two focus group interviews. The data shared from participants refer to their experiences, observations, and perceptions with respect to their time spent on practicum placements and/or non-classroom teaching, such as tutoring and extra-curriculars in relation to inclusivity clubs such as gender and sexuality alliances for folks identifying as 2SLGBTQ+, Harmony movement for empowering students to become agents of social change, and Speak-Up-Day for anti-bullying. As discussed in Chapter 3, there were three themes that emerged from the focus groups and will frame the discussion of the findings of this chapter: PSSTs Awareness of EDI, conceptualization of EDI and Barriers to EDI.

4.1 Awareness of Equity, Diversity, and Inclusion

Strategies to promoting fundamental human rights in Ontario schools, such as to equity, diversity, and inclusion (EDI) have been mandated for most school boards since 2012 as detailed by the Ontario Ministry of Education (OME, 2014). Within these strategies, "all school boards are required to develop and implement an equity and inclusive education policy" (pg. 9) that conforms to the Accepting Schools Act of 2012. The goal of these strategies is to prevent harm based on the intersecting ground of discrimination, such as race, religion, and disability, and improve the quality of education for all students (OME, 2014).

As science educators work towards fostering an inclusive learning environment that reflects the diverse backgrounds and experiences of students, engaging the unique perspectives of each learner is essential for participation, achievement, and the development of critical thinking skills, promoting creativity, and helping develop new perspectives outside of their own. (Tschida, et al., 2014).

When asked where they heard of the term EDI, participants shared they learned or heard about ‘EDI’ in little snippets throughout their daily life and in their teacher education classes. They mentioned the first time they heard the term EDI, and how it has evolved over the years as they complete their B.Ed classes. Jessie, whose teachables were biology and English, explained: “When I started university, I think the word equity started floating around. It wasn’t quite like EDI yet... As I started my English courses [in teachers' college], I heard about it way, way, way more”. Finn, whose teachables were in chemistry and math added to this by briefly talking about how his undergraduate classes/instructors “just didn’t care, it seems... especially when it comes to Math and Science.” Frankie, whose teachables were in physics and math, also noted that university Science, Technology, Engineering, and Math (STEM) programs have a reputation of needing to be hard, or there is an idea that “if you’re not struggling and stressed out, then you’re not trying hard enough.” This prompted Jessie, who identified as Thai but was born in Canada, to add that a struggle beyond just learning science or math, and that seeking outlets and supports as a marginalized student has been perceived as “trying to use this background to get ahead of everybody else.” Jessie’s note highlights a concerning perspective where marginalized students seeking outlets and support are perceived negatively, as if their efforts to overcome obstacles are viewed as an attempt to gain an unfair advantage over their peers. These perspectives may feed into further marginalizing these students by discouraging them from seeking assistance and resources they may need to succeed.

Participants mentioned the use of “EDI statements” on company job postings, sections on course syllabi starting with “commitment to EDI,” and email signatures noting different acronyms. Morgan viewed these kinds of statements as companies or institutions keeping up with a positive social image and felt as though they are disingenuous and hollow because "people or companies are doing them because [it] will make them more money" mentioning "that is the way society is going in Ontario." Agreeing with Morgan, Quinn mentioned these statements are in writing so, "even if they don't uphold it, they can still be held accountable." According to the participants, the level of superficial use of the term EDI has made it a buzzword and folks are not being held to a high standard. Although Quinn mentioned accountability of companies and institutions having these commitments in writing, they bring up the criticism that just because companies include EDI in their "LinkedIn or job application, [it] doesn't necessarily mean that they're going to follow through on it." Of course, this accountability does not only lie with institutions or companies like LinkedIn. School boards and individual educators have a big part to play in ways in which EDI is implemented well or not, but the way participants viewed EDI in science education were not all consistent with each other.

4.2. Conceptualization of Equity, Diversity, and Inclusion

Exploring the conceptualization of Equity, Diversity, and Inclusion (EDI) among preservice science teachers (PSST) led to two sub-themes emerging: "Approaches to integrating EDI in secondary classes" and "Relevancy of EDI in secondary science classes." These two sub-themes captured the nuanced perspectives and considerations that PSSTs bring to the forefront when contemplating the incorporation of EDI into their teaching practices. The first sub-theme considers the varied strategies and pedagogies perceived by PSSTs as effective for integrating EDI within science classrooms. The second sub-theme considers the perceived relevance of EDI within the realm of secondary science education, shedding light on the ways in which PSSTs conceptualize the alignment of EDI with the specific subject matter they are tasked with teaching throughout the duration of a semester.

4.2.1. Approaches to Integrating EDI Secondary Science Classes

Building from the conversation about participants' awareness of EDI, they were asked about where they integrate EDI into their teaching. Participants' conceptualization of EDI was reflected as being incorporated into their pedagogy through different means such as diversity in representation of work, tailoring assignments to the student's cultural background, and utilizing available resources and pedagogies, such as Universal Design for Learning and the Medicine Wheel, to name a few. Quinn shared their experience leading a lesson and discussion in their Indigenous Literature class about positionality and identity while teaching Indigenous literature on practicum. They described that as they moved through the lesson, they "encouraged [students] to start reflecting on their own identity" leading to "some really lovely discussion." Quinn also mentioned that students were "encouraged or felt they could speak up about less physical differences." and that the impact the lesson had on the class was highly personal. Quinn expanded: "I certainly felt more connected to them and [some of them] were surprised about the diversity of the classroom." The example shared by Quinn demonstrates the power that EDI-related pedagogical approaches have in classrooms. While Quinn's example was in an English classroom, their anecdote is significant in the context of discussing the importance of EDI in science education by drawing attention to the impact of this pedagogy. Though PSSTs require a different approach then English teachers or preservice teachers, encouraging science educators to recognize the value of diversity and inclusion seen in other classrooms and possibly their own may foster a sense of connection and appreciation for including better diverse perspectives for students. When students feel seen and are actively part of co-creating knowledge in the classroom, it establishes a sense of community where students have agency over their learning through having the ability to interact with the knowledge being shared (Werwoord, et al., 2021). This environment cannot be established with a teacher who is less committed to EDI. Without an intentional focus on EDI, teachers may not create an environment that values the contributions of all students and could hinder a strong sense of community in the classroom.

Rhys' conceptualization to incorporating EDI in science classes came from his work experience of being a tutor and a teacher assistant in university to his time during his BEd program and practicum. Rhys recalls being uncomfortable in the position of a first-time teacher on practicum, a sentiment that is elaborated later, but he tried to make sure students were given the best opportunity to engage with the work. He described his effort to incorporate EDI as "active" and "an ongoing process." Specifically, he stated: "I have to be more intentional about [EDI] when designing lessons" by "including different levels of difficulty… to avoid punishing students who weren't going to get through tough questions." As Rhys talked about his process of getting settled into the teacher role, he chose to focus on a familiar concept he learned in his math curriculum class that was EDI adjacent: tiered questioning. Tiered questioning, according to Rhys, is an instructional technique in which an educator appropriately challenges students based on their abilities by varying the level of difficulty for the same task. This allows all students to find success and make progress by providing entry points for all students to understand the concepts being taught. Rhys' examples of how he engaged with EDI in his teaching demonstrated a willingness to adapt and adjust to further engaging with other frameworks specific to science curriculum, such as CRRP which will be discussed further in Section 4.3 and in Chapter 5.

Jessie added that she adjusted the way she viewed EDI once she got into teachers' college, that EDI was not only about trying to understand students' cultures, but how she designed assignments and lessons to encourage participation from all students. She described her teaching as being "much more tiered" rather than having the same marking scheme for all students. Further, she commented on her “use of different perspectives and diverse representation” in both her English and biology classes but observed that science felt more restricted with what resources students can learn from, sharing that “it’s easier to do with English. Lots of stories in English; lots of people you can talk about… It just comes naturally.” She further added, “there are a lot of discussion-based classes, whereas with science, a lot of it is like what I’m going to show you.” While the conceptualization of bringing in diverse perspectives in English classes is seen as more feasible, the content in science classes is frequently perceived as presenting challenges in accommodating a breadth of perspectives and will be discussed in more detail in Section 4.2.2. The idea that science in secondary school is more restrictive in the scope in which EDI can be incorporated may pose a barrier for PSSTs because it is not viewed as “easy” to incorporate. Teachers may be eager to dive into EDI, but recognizing the nuance of this work, PSSTs may want to, and need to, be shown how to approach it with established frameworks, such as Universal Design for Learning (UDL). As Jessie shared “I’ve also tried to incorporate UDL. So, things that I feel would still benefit everybody.” According to the participants it appears as though they were not receiving concrete frameworks from their science instructors and were perhaps bringing preconceived assumptions to their training in EDI. This can present as a barrier by perpetuating biases, hindering a genuine understanding and engagement of EDI, and impeding the effective implementation. Openness to learning and unlearning is crucial in EDI training (Buitendijk et. al., 2020; Rudman et al., 2001), and preconceived assumptions might stop PSSTs from learning approaches to EDI in science. Frankie, directed her focus to the relevance of bringing EDI out of the classroom in the form of extracurriculars and clubs, adding to the observation that “implementing [EDI] more in classrooms depends on the class” because grade 11 and 12 science classes are content heavy and “there is so much curriculum to get through, it’s hard to incorporate other perspectives.” However, when designing lessons for intermediate grades, such as in grades 7 and 8 Frankie found it “easier to incorporate [EDI]” given the “lighter” nature of the content and she explained: “I don’t think I would be able to incorporate as easily in more senior level courses.” These quotes demonstrate a general conceptualization of EDI and problematic attitudes towards unfamiliar experiences specifically in that one cannot include EDI in “harder, higher” level courses especially in science. Frankie elaborated: “Planning for my grade 8 class, I was looking through science curriculum and I was like ‘Awesome. It’s all about water, pretty much.’” Specifically, Frankie made connections to what she already had knowledge of and therefore was able to more readily plan for various lessons and integrate EDI components throughout the her practicum, sharing “I’m going to focus everything on water, and the health around water and quality of life and settlement patterns... especially since I’ll be teaching in a community who’s had boil water advisories and have settled next to a lake”, adding “so, there’s going to be a lot of personal connection.” It could also be that Frankie felt more comfortable doing so because, echoing her own comments, in lower grades it is “easier” to integrate EDI.

Like Rhys, Finn focused his efforts of EDI on an aspect of his teaching that he was more familiar with. Given his FOCI was Exceptional Learners, he directed his efforts in making sure to “reach all ability levels” and shared that he “was not successful” at making that goal. Finn engaged with the idea that EDI is ongoing by reflecting on how he did not consider the realities of the home life for some students and how that impacted their learning. To engage the students more meaningfully, Finn shared an example of how he adjusted his assignments to include options that were more relevant to the students: “I gave a lot of choice like [to] investigate a scientist from where your grandparents came from” and options to engage with content about social matters such as how one “could consider these issues affecting Indigenous Peoples.” Finn followed up by stating that he “should have emphasized [the social matters] more” to have students engage more deeply with the content. Reviewing this reflection, there is some conscious effort on Finn’s part to be more mindful of important social justice matters affecting Indigenous people, however, the effort seems to stop at giving students choice in assignments. Considering further into why these matters exist and how they began remains unexamined, which perpetuates settler knowledge of these matters.

Although Jessie and Rhys are qualified in different teachables, English and biology, and physics and math respectively, they expanded on their exposure to EDI because they had professors who intentionally taught them social justice content. Rhys had a class in which he spoke about his professor’s area of research. Frankie, who was in Rhys’ math curriculum class noted: “I find that our math curriculum [course] was focused on making math accessible and reducing math anxiety because that was our prof’s area of study.” Jessie shared:

> The English [curriculum] courses have really helped me to understand EDI better and I feel that in terms of the training for what to include in the science, in terms of EDI, it’s just not there... I do feel that my [science] instructor maybe didn’t know very much about it himself.

Above, Jessie expressed a perceived absence of EDI training in the context of science teacher education. This suggests that science educators may not be adequately equipped with the knowledge and tools to integrate EDI principles into their teaching practices by missing valuable exposure during their teacher training.

4.2.2 Relevancy of EDI in Secondary Science Classes

As mentioned above, participants viewed EDI as mostly integrated into their teaching by offering alterations to assessment or representation in teaching materials. However, participants also conceptualized EDI as something that was to be added in if there was space, only if it is relevant. PSSTs are tasked with making endless decisions throughout the day starting before the first bell, during the school day, and after dismissal. As participants reflected on this, they spoke of the pressure that they must get through all the content during a semester. When asked about how they implemented EDI, there were references to examples such as heritage months, days of recognition, extra-curricular clubs and activities, Individual Education Plans (IEPs), and designing assessments. Participants shared some observations from their practicum during the month of February and the use of Afro-centered teaching for Black History Month, Have a Heart Day for Valentine's Day (a child and youth-led reconciliation event to help First Nations children grow, learn and play with a high quality of life), and Red Dress Day for Missing and Murdered Indigenous Women and Children. Where these days can provide some level of professional development, any substantial structural and ideological changes remain lacking. There appears to be a lack of sustained effort and accountability towards incorporating EDI fully into teaching, which reinforces the problematic idea that if educators show up to professional development training, they can go back to teaching the way they have been. Further, limiting the time in which days for awareness are taught also reinforces the idea that EDI is not necessarily a priority in the bigger picture, that it is not relevant, and that it interferes with maintaining the rigour of science education. Furthermore, it is ultimately the responsibility of educators to decide how extensively they will utilize resources during Black History Month, Have a Heart Day, Red Dress Day and any other day of bringing awareness to marginalized and oppressed groups of people. Some teachers may opt not to continue using these resources beyond the designated awareness periods and may still rely on traditional teaching methods.

Participants frequently referred to senior level science specifically as not having time and space in the curriculum to implement EDI and that other classes were more flexible in allowing the exploration of different perspectives. Jessie commented on the flexibility and support other classes outside of senior science have for implementing EDI when noted that “in English, and even grades 7, 8, 9 and 10 sciences, the curriculum offers so much more space for exploration.” A notion that all participants agreed with was that in science, they felt restricted with how to include EDI. As Jessie noted:

> There isn’t time to talk about anything else basically. The thing is, the teacher knows that these students, most of them are going to go into science programs in university, so it’s like, I need to prepare them by giving them this content.

Other participants agreed that in senior level science, the “hard” content took a lot of time to get through, as such, there was not enough time to include EDI. Frankie added that the topic for a particular lesson in a senior science class is “all that could be talked about” therefore, she believed that the senior science teacher’s responsibility is to “push the students through to the next lesson.” But, Jessie also noted “it would be great to have discussions about other things, like Indigenous ways of knowing and who’s spearheading Indigenous ways of knowing in science but is there space for it?.” Morgan shared a similar view and stated: “There isn’t the same amount of time to kind of add things in” while commenting that the responsibility for a senior level science teacher is to prepare students for university. Avery added “for STEM, because the atomic theory is not perspective based, it’s a theory” it was her “duty to explain who created it.”

From the above examples it appears as though PSSTs in this study view EDI as an “add-on,” which is similar to how other preservice teachers view EDI (Cochran-Smith, 2012). There seems to be more of a focus on result centered pedagogy where PSSTs are concerned that incorporating EDI into their teaching will interfere with the curricular outcomes in senior science classes and effect student achievement in the more traditional sense. Morgan also commented that adding aspects of EDI brings into question the responsibility of a science teacher’s contribution to EDI in the classroom:

> Putting more responsibility on teachers... in all these areas beyond the curriculum... to me is still a job, I want to be a teacher, get to know my students, make connections with them, and I want them to come to me if things happen.

Morgan delved into the complex and evolving role of teachers, highlighting the increasing responsibilities placed on educators beyond traditional curriculum delivery creating a cognitive dissonance between seeing EDI as important and being held to a professional standard to deliver curriculum in a traditional manner to yield the best success for her students.

While talking about the structure of the science curriculum, Finn brought up the rigour of university courses, commenting: “so my mindset is, if you’re in a university streamed course, most people are not taking grade 12U chem for fun.” This notion of grade 12 university level chemistry being unenjoyable is similar to the earlier statement that PSSTs must keep the standards of rigour high in secondary science classes to best prepare students for post-secondary, demonstrating that participants prioritized the course content and by adding in EDI components, the rigour of science education may be lowered or that some aspect of student’s academic success will be in jeopardy. Both Avery and Morgan added similar points to Finn. Morgan shared:

> during COVID [lockdown] they didn't do many tests. They didn't do exams. So, I think it is a disservice to not at least familiarize them with what they might be expecting in university. Considering the whole course code has the word university in it.

According to participants, like Morgan, diverting from traditional ways of teaching science would leave students with large gaps in their knowledge when entering university by getting in the way of “these goals [students have] in 3U and 4U chemistry” and by focusing on EDI Morgan wondered “am I doing them a disservice?.” Finn also commented on this by mentioning the intentions that students have when taking senior level sciences who are most likely going to be taking “a science related degree in university” therefore, he was cautious about where EDI fit in the curriculum given that, in his view, university courses are different from high school courses. Finn also shared that it may be a disservice to include EDI in senior level classes because “if I lower the standards now, and you pass, you’re going to fail there.” Implying that incorporating EDI may lower academic standards, which is not necessarily true, and can perpetuate discriminatory or resistive attitudes towards equity deserving groups. Additionally, these views towards EDI in senior science overlook the importance of integrating EDI principles into all levels of education to foster EDI focused learning environments and prepare students for interacting with others in diverse workplaces and society. Such perspectives risk marginalizing students and reinforcing systemic inequalities rather than promoting equitable education for all students. What participants shared explicitly demonstrate how traditional ways of teaching a linear, bottleneck approach in science continues to be perpetuated. The societal prominence of Western-centric approaches still influence curriculum development and teaching methodologies, favouring linear and colonial perspectives. Traditional teaching methods prioritize memorization and standardized testing over critical thinking and interdisciplinary approaches. Consequently, curricula may prioritize certain scientific disciplines, while marginalizing others, hindering students' understanding and limiting exposure to diverse scientific perspectives. As a result, participants viewed EDI as something that can be "added" to the curriculum depending on how much content the class can get through and/or if it impedes academic success. Dismissing EDI as a "disservice" is problematic, particularly in STEM fields which have historically relied on Western colonial frameworks and struggled with implementing and acknowledging alternative ways of knowing and diverse perspectives. Dismissing EDI in this light in science education perpetuates this issue, potentially discouraging students from underrepresented groups from pursuing careers in STEM (Martin, 2019; Suárez & Beatty, 2022).

The theme of EDI as being added to science curriculum is amplified by the conversation about how Individualized Education Plans (IEPs) are implemented somewhat ineffectively into teaching. As an established practice of teaching, with multiple levels of professional development dedicated to learning about and writing IEPs, Avery mentioned there was a low priority of teachers consulting IEPs when stating "that was so on the backburner; I had to ask multiple times to see the IEPs." Quinn brought up how vague IEPs are and that they did not include all the information that the student would consider as important. At the same time, considering the training required of educators before they can write IEPs, Avery questioned why the same effort and consideration was not given to EDI in teacher training and the teachers are responsible for figuring it all out by themselves stating "we shouldn't have to always do this outside of schools" because "you have to take some much time to educate yourself."

With the above conversation, an interesting point of data that emerged and that is important to consider is one's background experiences. That is, how participants are observing EDI in both in their high-school experience and in day-to-day life may also be influencing their awareness and understanding of EDI. Jessie, who identified her background as being Thai but born in Canada, reflected on the how attitudes towards marginalized groups around high schools today are different from when she was in high school, sharing:

> because I am a [person of colour] POC and most of my school is POC, I didn't hear any racist things being said, but there were a lot of homophobic and transphobic views. So, looking back on it now as a teacher, I know there were problems.

Finn added to this by sharing his reflection of non-heteronormative relationships: "in high school, I didn't really have any concept that people could be not straight. I met a lot more people who were figuring themselves out during my undergrad. That changed my views a lot." Rhys, who identified as white, had the opposite experience to Jessie in high school with little diversity, reflected on his high school experiences noting that, at the time, the schools were only just implementing "the push to stop bullying" later mentioning that when he returned to that school as a PSST he noticed "there was a lot more clubs and groups and overall awareness of different experiences." When prompted to and given the time to reflect on social changes and understanding differences, participants made connections to their proximity to various walks of life and these realities in secondary school. As Jessie summarized with her experience in secondary school:

> at the time, I feel like some people held some pretty homophobic views and transphobic views... but nobody talked about being gay. Looking back on it now as a teacher, I know there were problems, and I know that it was probably very hard for a lot of people.

Recognizing our own positions in relation to the various ongoing harmful behaviours towards marginalized people and students can help with our understanding of the criticality of EDI as a praxis, a fully involved way of teaching, and not something that is added into the curriculum when there is time or to check off a list. For PSSTs, recognizing their own experience in education is also helpful for the purpose of being reflexive about their teaching practice to be aware of and remove their own biases as a teacher. These biases can manifest in various ways, such as favouring teaching styles similar to how the PSST learned and overlooking the diverse learning needs of students from particular cultural backgrounds. In not checking one's own biases, educators may inadvertently perpetuate systemic inequalities by reinforcing the status quo rather than challenging existing norms. Therefore, it is essential for teachers to critically reflect on their own personal and educational experiences and actively be more aware to seek out diverse perspectives to ensure equitable and inclusive teaching practices. Focusing specifically on the school context, while participants took the time to reflect on how the culture around schools have change since they were in high school, regarding what is socially acceptable and what is not, little was mentioned about how their personal experiences and observations as high school students influenced how they were incorporating EDI into their overall teaching in science classes. This suggests an opportunity to fill a gap in Bachelor of Education programs wherein PSSTs can engage in class work to unpack their own biases, in addition to their subject-focused instruction.

4.3 Culturally Relevant and Responsive Pedagogy

As discussions around EDI have become more evident within teacher education, grade schools and school communities, the Ontario Ministry of Education adopted a specific framework for science teachers to use as a tool to work towards EDI focused classrooms: Culturally Relevant and Responsive Pedagogy (CRRP). CRRP is a framework that was introduced to help educators understand their role and how to adjust their teaching to better integrate EDI. Within the CRRP framework, there are three tenets, as described in Chapter 2, that can aid in guiding educators: academic success, cultural competence, and critical consciousness. Participants were asked to explain their understanding of each tenet, offering insight into how PSSTs are conceptualizing EDI in science education.

Participants' understanding of CRRP, like EDI, were mostly reflected as needing to be incorporated into their teaching through different means such as diversity in representation of work, tailoring assignments to the student's cultural background, and utilizing available resources and pedagogies. When asked about CRRP, participants asked for clarification on what CRRP was and were given the opportunity to share their initial thoughts if they were not familiar with the framework. Rhys stated "I don't think I've had much experience, at least not [in teacher's college], with those terms." Agreeing, Finn also mentioned the lack of instruction involving CRRP in his science courses but mentioned that "it comes up a lot in board documents." Like Finn, Avery and Quinn conversed about their limited exposure to the framework in their science classes but read about other methods and lenses that align with CRRP, such as when Quinn discussed their use of Two-Eye Seeing and using the Medicine Wheel. Two-Eyed Seeing refers to "learning to see from one eye with the strengths of Indigenous knowledges and ways of knowing, and from the other eye with the strengths of Western knowledges and ways of knowing" (Barlett et. al., 2012); it brings together two ways of knowing to allow a diverse group of people to use all ways of understanding to improve the world (Kovach, 2012). Quinn, whose FOCI was Social Justice Education, was aware of CRRP sharing: "There is some interesting criticisms that CRRP is being veered away from its initial conception. It is forgetting about the Black students, from whom it was initially created." These quotes speak to the lack of meaningful exposure that PSSTs are getting in their science courses, leaving some PSSTs with a general awareness without advocating for CRRP as part of a bigger picture. It is worth noting that Quinn was the only participant that was enrolled in the social justice FOCI, and likely because of their concentration focus was more aware of concepts around EDI and thus the only participant who shared their awareness and knowledge of science perspectives outside of the dominant Western approaches. Where Two-Eye Seeing and The Medicine Wheel are highly useful approaches to science education, there was no mention of these approaches by other participants, implying that topics around EDI and CRRP are only being introduced in courses in their BEd program that are deemed "relevant" and not often in any other courses, such as subject matter classes, like science curriculum courses. A more detailed discussion about CRRP and its three tenets in relation to findings from this study will be discussed in Chapter 5.

4.4 Barriers to Implementing EDI in the Science Classroom

As participants engaged in reflecting on the challenges they faced while implementing EDI, the theme of "barriers" was consistent among all participants. The barriers to incorporating EDI in science classrooms are broken down into three subthemes: (1) social influences, (2) structural barriers, and (3) access to EDI.

4.4.1. Social Influence

I define social influence as factors beyond the curriculum and impact the way PSSTs feel they will be perceived. These includes media representations, family members, and other educators (i.e., more senior science teachers, principals and administrators). For some participants, social perspectives on EDI were perceived to be a great barrier to implementing EDI that participants were struggling to engage with EDI even when they could see the importance. Morgan explained that "it makes me a bit anxious if I teach something that's not explicitly in the curriculum, that I'm going to be seen as just trying to indoctrinate an agenda." She later referenced that "teachers are losing their jobs" for buying books and being criticized for diverging from traditional ways of teaching if, for example, a teacher takes a class outside to learn. It is worth noting that based on what Morgan shared, she was not referring to the Canadian context. When talking about a specific example of implementing EDI, Quinn brought up using questionnaires to connect with students in a safe and confidential manner. The questionnaire gave the students the opportunity to share their goals for the course, and personal information such as preferred pronouns and how they identify. Such questionnaires foster a supportive and inclusive classroom environment by demonstrating a teacher's commitment to understanding and respecting the diverse backgrounds and identities of their students. However, if teachers do not reflect on their unconscious biases, they may inadvertently favour certain students or disregard the perspectives of others, undermining the intended purpose of the questionnaire in promoting safe learning spaces. Therefore, it is essential for PSSTs to critically reflect on their own biases and ensure that they approach the responses with sensitivity and openness to diverse perspectives.

Participants also shared their fear of making mistakes when using pronouns, for example; as Morgan shared, "I didn't want to get axed on my first practicum for misgendering someone" as that is a "pretty big deal" adding she would rather stay quiet than make a mistake that, from her perspective, could lead to professional repercussions. These perceptions about misgendering students being a severe mistake may be internalized through social influences, as Morgan cited examples of controversies in both the United States and Canada such as “educators are being attacked... because of the learning pronouns and stuff” further acknowledging “that’s catering to the wrong crowd but at the same time I’m doing this job because it’s a job.” Morgan's perspective on fear of making mistakes when using pronouns reflects that she prioritizes personal apprehension over the respect and dignity of students. Her concern about being "axed" for misgendering someone illustrates a narrow focus on self-preservation rather than a genuine commitment to creating an inclusive and supportive learning environment. Additionally, her reference to controversies surrounding pronoun use in education suggests a reluctance to challenge societal norms or advocate for marginalized groups, highlighting the impact of broader social influences on PSSTs attitudes and behaviors. Conversely, after talking about the value of teachers making mistakes, and how teachers help shape the social environment of the class, Avery did share that making mistakes is natural in the process of learning.

Another perceived barrier participants shared were parents and family values. Jessie mentioned that during her tutoring sessions, it was apparent that parents influenced what her students should be expected to learn, especially in higher level subjects like science. Similarly, Morgan brought up her observation that some communities reject some components of EDI, making her question if she should “just stick to the science.” Morgan shared: “I see push back from different communities. Sometimes it’s Muslim families or people who are very Christian, or someone who is conservative.” thus leaving Morgan feeling nervous about incorporating principles of EDI into science classes.

Further, and equally impactful, is the teacher willingness to integrate of EDI in science education. While discussing her use of Afro-centered teaching to focus on celebrating Black people's achievements during Black History Month, Avery shared an experience with a teacher she was collaborating with. This teacher expressed their reservations about employing Afro-centric teaching methods, and believed that not all schools need or should have to integrate Afro-centric pedagogies. This teacher was also of the opinion that an Afro-centered teaching approach could be perceived by some parents as victimizing children in a more affluent neighbourhood. The concern about introducing particular pedagogies as victimizing "children in more affluent neighbourhoods" suggests potential stereotypes and biases about how certain educational methods or discussions about race may be received by different communities, potentially limiting the scope of how PSSTs perceive EDI in science classes.

Rhys, Quinn and Frankie did not appear to consider social influences as barriers to implementing EDI, instead, they considered the barriers as much more structural and inaccessible in nature. All participants agreed that the structure of science education overall and access to resources and support were big contributors to their ability to implement EDI, which will be discussed in the following section.

4.4.2 Structural Influence

I define structural barriers as standards the PSSTs felt they needed to meet to be successful during their teaching placements, and also in their careers as teachers. These include department culture, the science curriculum in general, the amount of content to cover, and time in a semester/school year and the size of the classes. Morgan and Finn both mentioned that more senior teachers greatly "impact the environment of the department" and their views towards EDI influenced how much the topic can come up in staffrooms because of the attitudes towards science education overall that EDI can interfere with getting through all of the curriculum, thus impacting the "rigour of science education". Finn noted that, based on his experiences, "if the more senior teachers do not prioritize EDI … then the department is not going to do it." Finn also added that there are "issues affecting Indigenous peoples in Canada, water quality is a big one [and] it shows up in grade 8, but it also shows up in grade 11 when you're talking about solutions" but working with a "department that intends on standardizing everything makes it hard to make [EDI] a priority when you don't have the flexibility to make it a priority." Finn highlights a challenge that often arises in promoting EDI within a department that prioritizes standardization of assessments and evaluation. Some senior teachers are of the opinion that all students should have access to the same knowledge by being given the same work as a way to reduce bias in science education. This perspective on trying to be "neutral" poses another factor of perpetuating the status quo. Without teachers interrogating what they see as neutral, as the authors of these "neutral" assessments, it is unavoidable that bias and will continue to impact student learning. Maintaining standardization can create an environment where there is resistance to change, making it difficult for PSSTs within the department to prioritize and incorporate EDI in science, and continuing a reliance on traditional ways that consequently can impact PSSTs' ability to address and prioritize social and cultural matters in their science classes. Finn's quote highlights that when a science department is overly focused on standardization, it can hinder the prioritization and integration of EDI efforts. The lack of flexibility may result in a disconnect between the department's goals and the perceived barrier that EDI cannot be adapted into standard curriculum. While talking about how he implemented EDI, Finn brought up concerns about the structure of Grade 12 classes. He "tried to be as flexible as [he] could" and this sentiment was shared by all participants in varying capacities.

Morgan highlighted the pressure that science teachers experience from the Ontario Ministry of Education to maintain a narrow margin between average and median grades. As the median grades are the ones included on report cards, Morgan pointed out that some science teachers may prioritize ensuring the median is around 75%, showing less concern for students who fall below this threshold. While designing a test question to be more relevant to English language learners, Morgan mentioned it was not fair for "students [not learning English] in the other chemistry class who are keeping this high standard of rigour" that often include questions considered to be of high caliber "that align with the four knowledge categories." The four knowledge categories that Morgan refers to are for assessment and evaluation in the Ontario Science Curriculum. These categories help teachers guide students to acquire appropriate content knowledge, but also develop skills such as thinking, communication, and application (Ontario Ministry of Education, 2010). The categories are: knowledge and understanding, thinking, communication, application. Avery mentioned that "it's [the teacher's] duty" to stick to the curriculum to teach to and meet what is expected in the documents. In contrast, Quinn brought attention to the structure of science education being based on "Western and settler colonialism values" to maintain its rigour, and "in order to be successful in science, students need to conform to these standards." Quinn highlights the challenges faced by individuals whose backgrounds deviate from the dominant cultural narrative embedded in the current science education system. Quinn's critique of the structure of science education, which is heavily influenced by Western and settler colonialism values, underscores the challenges faced by individuals whose backgrounds diverge from the dominant cultural narrative. This perspective has been informed through Quinn's concentration in social justice, where awareness of systemic issues is heightened. However, it also highlights the urgent need for better integration of such topics throughout all courses in teacher education, especially in science, rather than confining them to disciplines considered "appropriate" for social justice discussions. For science education to be truly rigorous, it should not only focus on academic challenges but also be inclusive and responsive to the diverse cultural backgrounds of the students and thus should be prioritized in science teacher education.

As briefly mentioned earlier, Jessie noticed “once you get into the more senior grades, there is just so much content to get through” sharing that she wanted to talk “about different perspectives on topics” but wondered about the science classroom: “is there space for it?.” Quinn elaborated that science teachers need to decide what they will teach and what they will omit, an issue that participants did not have with their other teachable subjects such as in English. These thoughts shared by participants suggest that the lack of implementation of EDI in the science curriculum is tied to the discretion teachers have in choosing what content to include or omit; in essence whether or not to integrate EDI and/or to what extent. Influenced by standardization and Western focused content, the structure in which the science curriculum is designed likely contributes to the limited incorporation of EDI-related topics in science classrooms and how PSSTs perceive its place in the curriculum.

As noted earlier, Rhys spoke to his confidence using tiered questioning in math class, and Frankie also felt her math classes were easier to integrate EDI while teaching to the grade seven and eight and even senior math curricula; both felt more comfortable because of the professor in their math classes who appeared to make the integration of EDI a focus. Jessie also shared before that “it’s easier to do with English” based on the structure of the classes lending themselves more readily to EDI pedagogies such as “representation, diversification of resources, discussion-based classes” and, as Quinn added a more seamless ability to include “anti-racist and anti-oppressive pedagogies” by questioning, for example, the overuse of specific materials such as Shakespeare. Rhys talked about the irony of science as a discipline being focused on asking questions and being curious, but the curriculum does not leave room for teachers to “push for inquiry based [learning]” outside of the way the traditional ways in which education is designed. Compounding all of this is the amount of time available to spend with students given the size of the classes. Even considering accommodations with student on IEPs, Avery mentioned “there isn’t enough space in a classroom to accommodate all students’ needs,” to which Morgan added because “you might only see these people for like 75 minutes a day.” Adding to the complexity, Quinn shared, “if you’re dealing with 90 students a day … no amount of training is going to prepare you to handle that much.” What participants shared collectively points to the need for systemic support and considerations in educational structures to better address the individual needs of students and to provide educators with the tools necessary for effective implementation of EDI. Further recognizing the need for systemic support, the issue of access and resources as a barrier to EDI is explored below.

4.4.3 Access to Teacher Training, Resources and Supports

As noted above, every participant shared their perceptions of the shortcomings of science education implementing EDI by juxtaposing experiences in other classes that had equal time and opportunity to talk about social justice matters and EDI in those content areas (i.e., English, Math and Indigenous Education). In connection, PSSTs also shared concerns about access to resources and support available to them (or not) such as workshops, texts, working with their associate teachers, their practicum school’s commitment and engagement with EDI, teacher training in science curriculum classes, and overall professional development.

Jessie shared that what she found difficult while implementing EDI in her time on practicum was in part due to the lack of attention EDI was given during course work in her BEd program. As mentioned earlier, Jessie noted that it was her English instructor helping her better understand EDI, whereas her science instructor did not incorporate anything. Rhys followed up in agreement that there were not enough specific examples to include EDI in his science classes compared to what he had in his math classes. Frankie, who shared the math class with Rhys, repeated the notion that there were more strategies touched on in the math courses, noting that their professor for the class did research in a related area. Additionally, Jessie touched on the potential of science to incorporate this knowledge of social justice matters and EDI focused pedagogies if professors "talked about actual social justice issues" and how one can introduce these issues into classes depending on the age group. Finn added that "the classes needed more case studies" to better understand the content, to which all the participants in his focus group agreed. Avery also mentioned the amount of time teachers must spend on finding resources and questioned why EDI was not already incorporated into the curriculum or teacher training by noting "we're a little undertrained here because like you don't get a chance to have someone tell us, or maybe give us [strategies]." Avery followed up by suggesting EDI should be integrated in a more holistic way to better support teachers and their journey to becoming comfortable with EDI and social justice matters.

Avery reflected on how she felt "anxiety around social justice issues and discussing them." Possibly, this can be attributed to what Jessie, Rhys, Finn and Frankie mentioned above, that PSSTs are not exposed to strategies on how to navigate social justice matters in their coursework before heading into a science classroom for their practicum experiences. Avery added: "I don't want to do the checkmark of discussing another perspective... It's just like, what resources and workshops are there?" Even though Avery shared she felt unguided about how to best embrace EDI as a teacher, she was aware of the patterns of how EDI has been superficially incorporated into teaching practices and did not want to perpetuate that pattern. Morgan also described her interaction with social justice matters in the classroom, and acknowledged that anxiety makes her hesitant to implement EDI that is not “explicitly in the curriculum” in fear of “upsetting parents.” Rhys noted: “I think teachers are in an interesting spot, because we are the leaders of the class but… department head or principal … are putting different pressures on you” which can create challenges in aligning teaching practices with broader educational priorities.

Quinn spoke directly to a challenge that many PSSTs face. While planning their lessons using the pedagogy of the Medicine Wheel, because their associate teacher lacked experience and knowledge of the Medicine Wheel pedagogy, it became a greater challenge for Quinn to reach all the content before their time on practicum was over. “I was basically teaching [the associate teacher] at the same time I was teaching my students.” Still, the success Quinn felt they had was likely because of the training they had from their FOCI classes, on social justice, during their coursework. Conversely, while other participants focused their interest on learning more about EDI, the others felt limited by the lack of conversation happening and were unfamiliar as to where and how to access resources. The anxiety and unpreparedness in combination with the lack of support for working towards an equitable and inclusive practice can be intimidating for PSSTs who already may feel uncomfortable with addressing social justice and related matters in class. Given time to experience these pedagogies and implementing EDI in addition to traditional ways of teaching may encourage more harmonized teaching in science education.

The three overarching themes and their respective subthemes were explored in this chapter. The first theme around awareness of Equity, Diversity, and Inclusion, highlighted the varying levels of exposure and understanding of EDI among participants, with concerns raised about its superficial adoption and the need for genuine commitment in educational contexts. Further, participants expanded on their experiences EDI as students and the way EDI has shifted in recent years. With the second theme, around conceptualization of Equity, Diversity, and Inclusion, the discussed explored participants' perceptions of the integration of EDI, emphasizing the need for intentional lesson design and diverse perspectives in science teacher education while acknowledging and unpacking challenges such as time constraints and concerns about compromising academic rigor. Finally, the last theme, in thinking of barriers to Implementing Equity, Diversity, and Inclusion, explored the social and structural obstacles as well as access to EDI curricula and pedagogies perceived by PSSTs, including societal pressures, curriculum demands, departmental culture, and limited resources. The last theme underscored the necessity for systemic reforms and comprehensive training to effectively implement EDI principles and frameworks, such as CRRP, in science education to create safe learning environments. As such, what follows in Chapter 5 is a discussion of findings based on the theoretical frameworks of this study.

Chapter 5: Discussion

The purpose of this study was to explore secondary pre-service science teachers' (PSSTs) attitudes towards learning about Equity Diversity and Inclusion (EDI) in their content area. Specifically, the research questions that guided my study were: (1) What are pre-service science teachers' attitudes towards learning about EDI in their content area? (2) How do pre-service teachers conceptualize EDI within the contexts of a science classroom. In this section, I discuss how the findings presented in Chapter 4 connect to the theoretical framework, critical pedagogy and culturally relevant and responsive pedagogy (CRRP).

5.1 Connections to Theoretical Framework

The theoretical framework for this study included critical pedagogy and culturally relevant and responsive pedagogy (CRRP). When considering the tenets of CRRP and the emergent themes from the focus groups, there is evidence of some engagement with the principles of EDI in science education. As demonstrated in this chapter, PSSTs are working towards a more thorough conceptualization of EDI in science education, namely, confronting the tenets of CRRP without even knowing it. Where there is great engagement with the first tenet, academic success, there is less evidence of PSSTs engaging with the foundations of the other two tenets, cultural competence, and critical consciousness.

5.2 Critical Pedagogy

Before delving deeper into CRRP, it is important to acknowledge the importance of critical pedagogy first in relation to CRRP because critical pedagogy is often considered foundational in the context of CRRP because it provides a framework for questioning, challenging, and transforming educational practices (Giroux, 2010). Critical pedagogy critiques traditional teacher-centered approaches and advocates for a more student-centered, transformative education that considers the lived experiences of student in relation to various oppressions such as marginalizing women, Black and Indigenous peoples, and people of colour (BIPOC), individuals who identify with 2SLGBTQ+ communities, and learners with disabilities (Saunders & Wong, 2020).Teachers are encouraged to critically examine existing power structures, societal norms, and internal biases that may be embedded in their pedagogy.

5.3 Shifting Perspectives to Culturally Relevant and Responsive Pedagogy

CRRP provides a narrower and tangible framework for PSSTs to attend to changing their pedagogical approaches, such as incorporating diverse perspectives and materials into their teaching to better engage students from different cultural backgrounds.

CRRP focuses on creating an inclusive and culturally responsive learning environment that recognizes and values the cultural backgrounds and experiences of diverse students. CRRP rejects traditional methodologies of teaching, such as fact memorization, by leaning heavily into finding solutions to societal problems as a means of engaging students in higher-level thinking (Ladson-Billings, 2014).

Checkbox and tokenistic approaches to EDI are not an effective way of addressing how social issues come up in learning environments. Some participants shared their views towards EDI in science as something that is terminal or an add-on to the science curriculum, demonstrating that EDI is best included through representation but only if there is space for it. Gullberg et. al., (2017) describes this as EDI existing within the presentation of work rather than recognizing culture and student identity, that is emphasis on presentation alone may lead to a superficial approach to EDI, lacking a deeper understanding of diverse perspectives and experiences, and inadvertently perpetuating harmful stereotypes. The CRRP framework acknowledges and respects the cultural and identity of students, fostering a more inclusive and meaningful educational experience (Ladson-Billings, 1994). Morgan and Avery described feelings of unpreparedness and mentioned they were unfamiliar with positionality and the impact of their own identity. Morgan mentioned that she found academic success in her high school education because her “teachers taught a more traditional way” and consequently she saw this as a benefit for her students because it will “prepare them for post-secondary.” These views closely resembles what Scorgie (2010) describes as socio-cultural perspectives explaining how science teachers are not likely to develop CRRP pedagogies when falling into the comfort of teaching the way they themselves were taught. Furthermore, this perpetuates a problematic cycle regarding the implementation of CRRP in science curriculum. By attributing her success to a traditional teaching style, Morgan implies that non-traditional methods, which includes integrating CRRP principles, are not as effective. Her belief suggests a preference for established teaching methods that may not inherently incorporate diverse perspectives or inclusive practices. This perspective can reinforce the notion that EDI does not belong in the science curriculum, perpetuating a cycle where educators may be hesitant to engage in EDI teaching practices.

Given the underscoring ideology of Western notions that influence the ways in which science is taught, science has been used to define and legitimize knowledge systems which influence the way the world is perceived (Liu, 2017). It is important that PSSTs emerge from their teacher education courses with positive attitudes towards equity, diversity and inclusion as these may predict better EDI-related classroom practice (Swain et al., 2012). Interestingly, all participants mentioned that their science classes fell short of including and, for some, meaningfully addressing CRRP. However, participants noted that their professors in their other classes (such as the FOCI or some other subject classes) provided strategies and connections to world issues, offered time to engage with the content and provided approaches to addressing social justice matters to different age groups, participants felt more comfortable exploring options to incorporate EDI in their classes. If this approach was consistent with all classes taught in teacher education programs, PSST attitudes towards EDI in science may also see a shift in fully understanding the potential of transformative pedagogies. To delve deeper into connections to CRRP, what follows are discussions centered around the three tenets.

5.3.1 Tenets of Culturally Relevant and Responsive Pedagogy

The three tenets of CRRP include academic success, cultural competence, and critical consciousness. While only a few participants were familiar with CRRP, their responses provided varying views towards CRRP and its tenets. Participants' experiences, as shared earlier, may be an indicator of feelings of preparedness and how to approach matters associated with discrimination related to race, ethnic background, gender expression, sexual orientation, socioeconomic status, and citizenship (Peters, 2020). Quinn mentioned the influence that colonial values have in the development and uptake of the Ontario science curriculum makes it hard to conceptualize EDI and CRRP in the Western view of science in the current context.

Academic Success. The tenet of academic success appears to be what participants were most concerned with, as they felt that they had a more concrete understanding of academic success. In part due to the way curricula is designed to meet standards, participants had a clear goal to aim for while preparing for a semester mostly concerned with meeting provincial standards and achieving "high grades and just being good at everything" as Frankie summarized. However, Frankie and other participants all chose to examine their own beliefs on what academic success means today. Reflecting on her initial summary that academic success is mostly based on grades and performance, Frankie aknowledged that the climate around education and her understanding of student capacity shifted her view of academic success to a more self-fulfilling and empowering process, sharing that "academic success is finding what you're interested in and finding joy in learning that and just leaving that grade at the end of the year knowing more about yourself and about the world." After hearing Frankie's reflection on academic success, Rhys shared an adjacent sentiment that focused more on the goals of the students rather than the goals of the curricula: "Success greatly for me depends on what the students want and also their starting point." The intention behind this conceptualization of academic success is also important to bring up here. Rhys acknowledged that each student has their own trajectory though education, but also acknowledged how that trajectory becomes more similar between students in higher, and more specific classes: "in grade 12U level courses, there's a certain expectation of what they are there for, which does influence what we define is academic success." This idea shared by Rhys reflects the same sentiments shared in Chapter 4 when Jessie and Finn discussed the importance of students doing well in senior level science classes and questioning the relevancy of EDI in the science curriculum. Rhys circled back to "success is still defined by the students in that, whatever they are happy with in the long term for what they get in that course." Finn shared his conceptualization of academic success that included assessing his ability to teach students to learn any content that they are interested in, defining it as "goal focused where whatever they do afterwards, are they able to do it to the best of their ability."

A common point among participants was reference to students learning how to learn and thinking critically about what they are learning. Student-focused pedagogies have a profound impact on students' academic success (Aytaç & Kula, 2020). However, research also indicates that a direct focus on race and culture in the classroom is not just beneficial, but necessary, especially when classrooms are not diverse (Byrd, 2016). Having high expectations, a component of being a culturally responsive teacher, also promotes academic success for racially, ethnically, culturally, and linguistically diverse students (Aronson & Laughter, 2016). Rhys summarized this by stating: “if I can teach them how to learn on their own, hopefully they can go on with whatever they’re interested in.” The participants’ placed the responsibility on themselves to get students to a place where they are comfortable thinking critically and making decisions on their own.

Morgan and Avery spoke to the goals of academic success as defined by good grades, going to a good school and having a good job. Avery shared “I also thought of marks – they dictate so much with in terms of opportunities in post-secondary.” Morgan’s focus for her class was tightly tied to their overall performance on assessments, a common understanding among all participants, sharing “for me it's really important, even if I can't reach every student, I'm doing everything possible, my mean is close to my median … and we're at the provincial standards.” Something that is interesting about what Morgan shared demonstrates a prioritization of her students' success within the guidelines established by the curriculum, specifically, in terms of a grade. Through our conversation, while expressing a dedicated commitment to employing every available means to support her students, Morgan encountered greater difficulty in embracing the implementation of CRRP and thus arguably EDI in general. Some participants came back to the notion that CRRP may be a hinderance to academic success, further enforcing the need for PSSTs to better engage with EDI in their coursework and practicum experiences through frameworks like CRRP that can better guide them. Continuously thinking that CRRP is resulting in leaving young students in science classes unprepared to “take formal tests” or progress through their education may also be contributed to participants’ conceptualization that academic success only exists in the form of progressing students through school to “meet the provincial standards.” Tuters (2015) describes these as preservice teachers being unable to abandon dominant beliefs, values, and ways of teaching, while conforming to and re-enforcing curricular documents and assessments that continue to be Eurocentric. This is even more important for PSSTs because they may find it challenging to deviate from dominant beliefs, values, and teaching methods deeply ingrained in traditional education systems and adhering to science curricular expectations and assessments that often reflect Eurocentric perspectives. As described in Chapter 4 Quinn criticized these systemic issues whereas Morgan, Finn, and Avery focused more on a traditional understanding of student success. As Nash (2018) points out in her analysis of preservice teachers using CRRP, others also viewed the framework as possibly interfering with students' outcomes. However, the research suggests that teachers who base their curriculum on the lived experiences of students, in relation to EDI and CRRP, i.e., what is relevant to the students experiences outside of school, and set high academic expectations tend to achieve greater success, particularly with students whose cultural and disciplinary norms are not dominant (Nash, 2018).

Academic success meant something different to each participant. Because Quinn was introduced to CRRP in their social justice concentration classes, they took time to analyze the tenet in its individual terms and their relation to the structure of the education system. Quinn observed:

> we're stuck in this system, and it kind of sucks we're stuck with these standards. I think of [the] institution and how deeply entrenched it is in Western and settler colonialism values and the metric that they use to measure the success … [Academic success] is like how well you can perform in order to conform to that standard.

The reference to institutional conformity to Western and settler colonial values speaks to the underlying ideologies shaping education in Ontario, and elsewhere in Canada. Despite the global recognition of Ontario's education system, racial disparities in academic achievement have been documented extensively over the past decades (Rezai-Rashti et al., 2017) and indicates a recognized and ongoing issue within the education system (Barrero Jaramillo, 2018), yet no significance changes appear to ever been made. Quinn, who identified as non-binary and bi-racial, also drew attention to the metrics used by the system to measure success, emphasizing the performative aspect required for conformity to established standards based on their own experiences: "Academic success, marks, it's all performance. I just knew how to take a test. I was literate in taking tests. I was good at strategizing my marks; I knew how to cozy up to teachers really well." Others, like Avery and Morgan, continued to embrace a conventional perspective on academic success, equating it with achieving academic milestones and meeting provincial standards.

Cultural Competence. Among most participants, a consensus emerged on the tenet of cultural competence. Cultural competence refers to the ability for educators to understand, respect, and effectively engage with the diverse cultural backgrounds and experiences of their students (Ladson-Billings, 1994). This involves recognizing the cultural assets that students bring to the learning environment and incorporating these diverse perspectives into the teaching and learning process (Ladson-Billings, 1995). Quinn and Finn converged on a shared viewpoint, emphasizing the diversity present in urban areas across Canada and highlighted the importance to educate students with a consideration for various cultures. Quinn shared that "to be a citizen living in [urban] areas, it's going to be hard for you to get by just with knowledge of one culture, if it's just the dominant western culture... they go out into the workforce, and they just seem ignorant." Finn also made connection between critical consciousness (which will be discussed in the next section) and cultural competences: "I think that cultural competence and critical consciousness are quite interlinked in daily life. If you're trying to understand your country or understand people's [perspectives] from different countries" there needs to be "a level of emotional intelligence." Jessie expanded on this by bringing in the importance of reinforcing important skills not always implemented while teaching about cultural competence such as learning about "empathy and humility, learning about other people's perspectives and realizing that my perspective is not the only correct one and I can learn a lot from other people and a lot from seeing other people's experiences." Avery spoke to her lack of understanding of cultural competence but reflected on the importance of building up towards this tenet to make her a better educator when considering of her positionality: "Privilege plays a big role" and "I want to be aware of [students] cultures … to learn about other cultures because that's really important." Even though Avery is aware of the importance of understanding student's cultures, is it hard to determine if she understands or sees the relevance of culture being integrated into the science curriculum. Research suggests that PSSTs who do get involved with professional development addressing positionality and unpacking bias through identity work show encouraging ongoing connections and learning towards responsive and relevant pedagogies, but that they must continue to remain open to interrogate and reveal structural forms of race, racism, and power that manifest through curriculum, structure, and pedagogy (Mensah, 2009; Sheth, 2018). As discussed in Chapter 4, Morgan shared a sense of uncertainty and concern regarding the implementation of cultural competence in science in fear of overstepping boundaries or introducing topics that may provoke backlash from parents or communities worried that she would be seen as "trying to indoctrinate an agenda." This internal struggle highlights Morgan's perceived challenge that certain topics are “too controversial” to bring into science classes, leading her to consider poorly informed questions and opinions such as “should I just stick to the science?.” Morgan's concerns serve to illustrate how some PSSTs may benefit from further engagement in identity work and a deeper understanding of their positionality in relation to teaching science. Encouraging ongoing professional development in these areas can empower educators to navigate cultural competence with confidence, fostering a more inclusive and effective teaching approach by continuously reflecting on pedagogical approaches to classroom diversity (Shesh, 2018; Rivera & Ibourk, 2020).

Critical Consciousness. While talking about the CRRP tenet critical consciousness, Finn stated that even though he never heard the term before and “he never would have put that name on it” as he understood the importance of bringing world matters into the classroom and discussing them. Critical consciousness is about cultivating a critical awareness of cultural, social, and historical factors that influence education and seeks to empower individuals to engage in meaningful reflection and action toward creating more inclusive, equitable, and socially just educational environments (Ladson-Billings,1995). Finn offered an example of how the science curriculum often focuses on isolated examples to contextualize concepts (i.e., as mentioned previously impacts of water quality), but more focus should be placed on “discussion of different viewpoints or different perspective or experience” so that high school students in science classes can “confront a different lived experience.” Jessie also added the importance of having current knowledge and information of local matters because “it is a baseline that everyone experiences” further adding that the presentation of the information is just as important for students to engage with and analyze and interpret information and develop “different perspective based on their backgrounds and what they want to believe” (the notion of “baseline” is addressed below). Jessie added that having opportunities for students to look at content and learn through a different lens will help develop “critical thinking” and interpersonal connection such as “empathy and humility.” Frankie brought up the importance of acknowledging the diversity of the classroom as part of CRRP. She stressed the importance for teachers to make their teaching culturally relevant and responsive to the diversity of the class: “you’re going to need to incorporate a lot more choice into your assignments.” While providing choices in activities and assessments can promote equity and inclusivity, this is only one very general option. Further, careful consideration and planning are necessary to address potential drawbacks. It is essential to ensure that the choices provided do not reinforce stereotypes or unintentionally favor certain groups of students. Offering choices may inadvertently lead to inequities if certain options are perceived as easier or more appealing. Offering choice is a positive step toward developing critical consciousness, but there requires a more thorough approach that addresses systemic issues, values cultural diversity, and promotes critical thinking. In this context, considering the concept of “windows, mirrors, and sliding glass doors” becomes particularly relevant. Implementing the notion of windows, mirrors and sliding glass doors offers students the opportunity to see into the lives and experiences of the people around them from different backgrounds (windows), seeing their own experiences and identities reflected in the curriculum (mirrors), while allowing them to step into and empathize with different perspectives (sliding glass doors) (Bishop, 1990). Quinn explained: “You could see through a glass door, but then you open and suddenly the barrier is gone” so that students are given the opportunity to observe and interact with different cultures in the classroom as a foundation for students to be more culturally competent. Quinn spoke to critical consciousness while reflecting on what was discussed in Chapter 4 and their use of Medicine Wheel pedagogy as students “were surprised about the diversity of the classroom” and how this strengthened the connection between educator and students, sharing that “some students who weren’t comfortable sharing with the class, afterwards coming up and telling me about certain things they were going through. Which is very useful to know as a teacher.” Both Finn and Rhys agreed that critical consciousness is “such a good baseline that [students] can then build off of for everything else” that students understanding the world not from only how they view it is necessary given the diversity of Canada’s population.

Establishing a “baseline” can be problematic while discussing the context of critical consciousness. Critical consciousness involves recognizing and valuing diverse perspectives, acknowledging one’s own background, bias, privilege, and develop the capacity to critique cultural norms, values, traditions, and institutions that produce and maintain social inequities (Ladson-Billings, 1994). An assumed baseline may overlook these diverse backgrounds, experiences, and perspectives and, ironically, neglect critical analysis of how information is accessed, and can overlook the fact that access to information and knowledge is influenced by social, economic, and cultural factors. In considering the complexity of social norms, individual backgrounds, and institutional pressures, conceptualizing what a baseline would look like poses concern. Attempting to establish a baseline in education, especially regarding critical consciousness, presents significant challenges. A baseline implies a standardized starting point or set of expectations, which inherently overlooks the diverse backgrounds, experiences, and perspectives of students. Moreover, it risks neglecting the critical analysis necessary for understanding how access to information and knowledge is shaped by social, economic, and cultural factors. Ladson-Billings (1994; 2014) emphasizes that educators fostering critical consciousness in their teaching practices should encourage students to question, analyze, and challenge societal norms and structures that may contribute to marginalization and discrimination. Thus, offering a choice as a way to incorporate CRRP is a start, but CRRP involves a much deeper and comprehensive transformation in PSSTs pedagogies and the structure of the educational systems, including teacher education programs incorporating EDI and CRRP in tandem, in all courses, particularly the core curriculum classes and not just the classes that are relevant to the topics. As noted in Section 4.4.2, Quinn understood the relevance and importance of EDI and CRRP, while others struggled.

As shared above, some participants viewed CRRP and EDI as an optional addition to the science curriculum, emphasizing its importance only if space and time are available, while others expressed uncertainty overall. While science courses within the teacher education program lacked any integration of CRRP, participants observed more meaningful engagement with EDI in non-science courses, indicating the need to better support PSSTs in science teacher preparation. Academic success was primarily understood through traditional educational standards, indicating a potential barrier to incorporating CRRP in science teaching. Consensus on the definition of cultural competence was less evident. Furthermore, apprehensions, such as potential backlash or controversy, were voiced regarding the incorporation of cultural competence in science education. Understanding of critical consciousness varied among participants. While strategies such as offering choices in activities and assessments are recognized as effective in promoting EDI and CRRP and fostering inclusive learning environments, it is acknowledged that offering a choice to integrate CRRP is just the beginning.

Chapter 6: Conclusion

I conclude this thesis with my own observations through this process, including a discussion on the limitations of this study, the future direction of research in science teacher education, and finish with my concluding thoughts.

6.1 Limitations

Limitations to this study include the restriction on time, the design of the study, data collection and analysis. This research is limited to the specific contexts of the PSSTs' living and learning in a teacher education program in a small city in southeastern Ontario. However, because the population of the teacher education program is similar to other institutions, the design and findings of this study can serve as a reference point for educators and policymakers in comparable settings. Another limitation may be the limited time for data collection methods. While time constraints are inevitable, a well-structured timeline, established in collaboration with my supervisor, aided in breaking down the research into manageable tasks. Additionally, constant check-in ensured steady progress over the course of the program. Another limitation may be my own personal biases. I acknowledge that the findings of this research study were perhaps informed by my own understandings and interpretations of teachers' perspectives. However, the utility of a qualitative case study approach is not based on its reproducibility but on the value of meanings generated (Stake, 2000). Further to this, all research is biased and, instead, I believe that my background experience helped to build rapport with participants and helped to also inform the analysis and discussion.

Another limitation might be the scope. That is, focusing solely on equity, diversity, and inclusion (EDI) without considering other forms of anti-oppressive education presents a notable limitation in the broader pursuit of social justice in education. While EDI initiatives in the Ontario curriculum are needed to promote fairness and addressing systemic inequalities, focusing on these aspects may inadvertently neglect historical and current dimensions of oppression and marginalization. An EDI-focused approach to teaching might overlook the complex ways students' intersecting identities contribute to unique forms of discrimination in classrooms (Tefera et. al., 2018). This limitation points to the direction future research may consider. Exploring the intersectionality of various forms of oppression within science education can lead researchers to investigate how factors such as race, gender, socioeconomic status, ability, and sexual orientation intersect to shape students' experiences and opportunities in science learning environments.

In addition, an exclusive focus on EDI may also overlook structural and systemic issues that perpetuate inequality. Anti-oppressive education in science, beyond EDI, involves critically examining and challenging the underlying structures and systems within science curricula that contribute to oppression. This includes questioning power dynamics, institutional policies, and cultural norms that sustain discriminatory practices. Ignoring these broader systemic issues, as we have seen in science teacher education, may limit the effectiveness of educational efforts, as it fails to address the root causes of oppression. A more integrated approach to anti-oppressive education across all curriculum courses in teacher education programs, with a much-needed focus in science curriculum courses, should incorporate a critical analysis of power structures, institutional practices, and historical factors that contribute to and perpetuate various forms of oppression. By broadening the scope beyond EDI, educators can work towards fostering a more inclusive, equitable, and just learning environment that considers the multifaceted nature of oppression.

6.2 Future Directions

In envisioning the future of science education, it is imperative for science teacher educators to embrace and integrate the principles of Equity, Diversity, and Inclusion (EDI) into their pedagogical approaches when instructing preservice science teachers (PSSTs). The landscape of education is evolving and acknowledging the diverse needs of learners is paramount for fostering an EDI focused learning environment. Examining how science teacher educators build their awareness of EDI, how they actively model EDI teaching practices, incorporate EDI principles into curriculum design, instructional strategies, and assessment methods, and how science teacher educators engage PSSTs in meaningful dialogues and activities that promote EDI are all areas of research that can help to better understand how science education can support EDI in science education.

By prioritizing EDI in science teacher education, we can better prepare future educators to create classrooms that celebrate diversity, promote equity, and nurture a genuine appreciation for the rich diversity of perspectives within school communities.

6.3 Final thoughts

The perspectives of preservice science teachers (PSSTs) on equity, diversity, and inclusion (EDI) in the Ontario curriculum vary significantly. While Quinn viewed EDI as an integral and integrated component of their pedagogy, the others struggled to see EDI in the same way. From participants, there was a need to support students through academic success, but failed to recognize the other two tenets of CRRP, perceiving both EDI and CRRP as add-ons, questioning their relevance in the curriculum. However, it is important to note that the CRRP framework is not merely an add-on, it is actually recommended by Ontario Education for fostering human rights, equity, and inclusive education. Within these two strains of thoughts, the perceived barriers to the effective implementation of EDI in classrooms—social influences, structural barriers, and access to EDI resources—highlight the multifaceted challenges that science educators face in fostering EDI focused learning environments. However, more focus needs to be put into science teacher education to develop a comprehensible foundation for PSSTs to build on. As the education landscape continues to evolve, addressing these diverse perspectives and overcoming barriers is essential for promoting equitable educational experiences for all students in Ontario.

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Appendix A: Demographic Questions

Personal and demographic information: Personal

1. Name
2. Age
3. Preferred pronouns
4. Cultural Background/Race
5. Do you live with any disabilities?
6. If practicing, what religion do you practice?
7. Preferred Pseudonym?
8. Preferred E-Gift card?

Personal and demographic information: Education

1. Name
2. What did you do before teacher’s college?
3. Where did you complete your undergrad?
4. What courses have you taken that address EDI?
5. How many practicum placements did you have? What subjects/grades?
6. What is your other teachable?
7. What is your FOCI/ Concentration?
8. What are your plans for after teacher’s college?

Appendix B: Focus Group Guiding Questions

1. Why did you choose I/S science as a teachable?
2. Have you heard of the terms EDI before? Where have you heard them most referred to?
3. In your experience, how have you integrated EDI in your teaching?
4. What were some successes? What resources did you use?
5. Describe a time where EDI [presented a challenge in your teaching and how you navigated that challenge.
6. How do you conceptualize culturally relevant and responsive pedagogy?
7. What does academic success, cultural competence, and critical consciousness mean to you?
8. Looking back on this interview, is there anything you wanted to add, or think could have been talked about?

Appendix C: Queen's University General Research Ethics Board Clearance Letter

Queen's University General Research Ethics Board (GREB)

GREB Initial Ethics Clearance

May 29, 2023

Mr. Hodges
Faculty of Education
Queen's University

TRAQ #: 6038655
Study Title: "GEDCU-1161-23: Exploring the Attitudes of Preservice Secondary Science Teachers Towards Implementing Equity, Diversity and Inclusion in Science Education"
Date Ethics Clearance Issued: May 29, 2023
Ethics Clearance Expiry Date: May 29, 2024

Dear Mr. Hodges:

The General Research Ethics Board (GREB), by means of a delegated board review, has cleared your proposal entitled **"GEDCU-1161-23: Exploring the Attitudes of Preservice Secondary Science Teachers Towards Implementing Equity, Diversity and Inclusion in Science Education"** for ethical compliance with the Tri-Council Guidelines (TCPS 2) and Queen's ethics policies. In accordance with the Tri-Council Guidelines (Article 6.14) and Standard Operating Procedures (405), your project has been cleared for one year.

Renewals: An annual renewal event form or a study closure event form must be submitted annually as per the TCPS 2 Article 6.14. As a courtesy, the Office of Research Ethics Compliance may send reminders 30 days in advance of the ethics clearance expiry date. All lapses in ethics clearance will be documented on the annual renewal clearance letter. A Suspension letter may be issued for lapses in ethics clearances, with subsequent termination and closure of the ethics file for lapses greater than 10 business days.

Completion/Termination: The GREB must be notified of the completion or termination of this study through the submission of a study closure event form in TRAQ. This should be submitted at the time of completion; there is no need to wait until the annual renewal due date.

Amendments: No deviation from, or changes to the protocol, informed consent form and conduct of study should be initiated without prior written clearance or an appropriate amendment event from the GREB, except when necessary to eliminate immediate hazard(s) to study participants or when the change(s) involves only administrative or logistical aspects of the study. For example, you must report changes to the level of risk, applicant characteristics, and implementation of new procedures. To submit an amendment form, access the application by at http://www.queensu.ca/traq/signon.html; click on "Events;" under "Create New Event" click on "General Research Ethics Board Request for the Amendment of Approved Studies." Once submitted, these changes will automatically be sent to the Ethics Coordinator, GREB, at University Research Services for further review and clearance by GREB or the Chair, GREB.

Adverse Events: You are reminded of your obligation to advise the GREB of any adverse event(s) that occur during this one-year period (access this form at http://www.queensu.ca/traq/signon.html/; click on "Events;"

under "Create New Event" click on "General Research Ethics Board Adverse Event Form"). An adverse event includes, but is not limited to, a complaint, a change or unexpected event that alters the level of risk for the researcher or participants or situation that requires a substantial change in approach to a participant(s). You are also advised that all adverse events must be reported to the GREB within 48 hours.

On behalf of the General Research Ethics Board, I wish you continued success in your research.

Sincerely,

Chair, General Research Ethics Board (GREB)
Associate Professor and Distinguished Faculty Fellow of Marketing
Master of Digital Product Management
Smith School of Business
Queen's University
chair.GREB@queensu.ca